THE INCIDENCE OF MATCH PLAYING INJURIES IN JUNIOR NETBALL PLAYERS IN SOUTH AFRICA

by

CHRISTEL BOTHA

2009054970

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Master of Arts in Human Movement Sciences

Department of Exercise and Sport Sciences

School of Allied Health Professions

Faculty of Health Sciences

University of the Free State

Supervisor: Prof Frederik F. Coetzee

(Department of Exercise and Sport Sciences)

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DECLARATION

I, **Christel Botha** (student number: 2009054970), declare that the Master's Degree research dissertation or interrelated, publishable manuscripts/published articles, or coursework Master's Degree mini-dissertation that I herewith submit for the Master's Degree qualification in Sport Science at the University of the Free State is my independent work, and that I have not previously submitted it for a qualification at another institution of higher education.

Signature **Date**

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ABSTRACT

THE INCIDENCE OF MATCH PLAYING INJURIES IN JUNIOR NETBALL PLAYERS IN SOUTH AFRICA

Introduction:
Netball is a fast pace game, which consists of high physical demands such as quick acceleration, deceleration, and a sudden change of direction as well as repetitive jumping. Junior netball players frequently engage in adult training programs to meet these demands of the sport, being exposed to higher training loads and intensities. Epidemiological studies provide the proof of risks for sports injuries, as well as the effects of preventative and therapeutic intervention.

Objectives: *The objective of this research was to assess the incidence of injuries in a cohort of junior South African netball players.*

Methods: *Methods: The subjects included under fifteen, under sixteen and under nineteen netball players (N=560) who participated in two junior netball tournaments. Medical personnel and tournament organisers collected the data.*

Results: *An average incidence of 24.7 injuries per 1000 playing hours were reported. The most common injured body segment was the knee joint (30%), followed by the ankle joint (28%). Contributing factors of the mechanism of injury included time of play, player position, previous injury and limited sessions of detrimental training modalities in current training programs such as flexibility (4 sessions per week @ 24 min per session), neuromuscular and proprioceptive training (2 sessions per week @ 19 min per session), correction of biomechanics (2 sessions per week @ 24 min per session) as well as core stability training (2 sessions per week @ 32 min per session).*

Conclusions: *In an attempt to reduce the risk and incidence of injuries among junior netball players, it is advised to incorporate structured, evidence based injury prevention modalities based on the theory of specific adaptation to imposed demands of the game of netball. These programs must focus to improve core stability, neuromuscular control, balance / proprioception and correction of biomechanics during execution of functional activities of netball.*

Key words: *Netball, Incidence, Sports Injuries, Junior, Injury prevention.*

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LIST OF ABBREVIATIONS AND ACRONYMS

AAOS	American Academy of Orthopedic Surgeons
ACL	Anterior Cruciate Ligament
C	Center
DBE	Department of Basic Education
GA	Goal attack
FIFA	*Fédération Internationale de Football Association*
GD	Goal Defense
GK	Goal Keeper
GS	Goal Shooter
WA	Wing attack
WD	Wing defense
u/	Under
HR	Heart Rate
HRmax	Maximum Heart Rate

HRzone	Heart Rate Zone
RPE	Rate of Perceived Exertion
NATA	National Athletic Trainers' Association
NMT	Neuromuscular Training
NSA	Netball South Africa

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CHAPTER 1:

INTRODUCTORY REMARKS AND OUTLINE

CHAPTER 1

INTRODUCTORY REMARKS AND OUTLINE

Referencing within the chapter and the list of references at the end of this dissertation has been done in accordance with the guidelines of the Department Exercise and Sport Sciences, University of the Free State.

1.1. INTRODUCTION

Netball is a popular sport in South Africa in which the body is exposed to high physical demands, subsequently increasing the risk of injury (Coetzee, Langeveld & Holtzhausen, 2014:39). This fast-paced game consists of high physical demands, such as quick acceleration, deceleration, and sudden change of direction combined with frequent jumping and landing (Ryan, 2009). This team sport is enjoyed worldwide by players of all ages, from junior players to highly-skilled, elite athletes (Chandler, Pinder, Curran & Gabbett, 2014:2732). In a briefing by Netball South Africa in 2012, it was concluded that netball is the largest female sport in South Africa, as well as in other countries, such as England, New Zealand and Australia. In 2012, netball was also considered the second most popular sport in terms of participation in South Africa, with statistics of one million adult players and another 1.5 million school players. Recent achievements in netball in South Africa and internationally have improved the views and attitudes towards this sport globally, therefore increasing participation in the sport (Mdakane, 2012,1).

Studies on the incidence of injuries provide critical information about the risks of injuries in a selected population (Donaldson, Lloyd, Gabbe, Cook & Finch, 2017:273). Research conducted on the types of injuries and the mechanisms thereof is of significant value in order to determine the feasibility of designing and implementing evidence-based intervention programmes and efficient pre-rehabilitation techniques for common injuries that occur in netball throughout the season (Van Mechelen, Hlobil & Nkemper, 1992:84).

To prepare the body for the high demands mentioned above, the player often engages in training programmes with high intensities and frequencies (Chandler *et al*., 2014:2732). However, young netball players, who are exposed to greater training loads and higher intensities, frequently engage in adult training programmes to improve physical fitness. These players experience external pressure from coaches and parents to perform at their maximum, sometimes increasing their chances of sustaining injuries (Scholtz & Lucas, 2011). While confirming this statement, Gabbatt and Whiteley (2017:50) add that athletes can also be undertrained which leaves them prone to injury due to the fact that they are not physically prepared for the demands of their sport and/or their positional demands during play. When comparing these findings to the statistics pertaining to injuries in young athletes, the American Academy of Orthopedic Surgeons (AAOS) (2012) proved that there is a significant increase in overuse injuries amongst children, which are mostly due to sport-related activities. The AAOS expressed its concern regarding injuries in young athletes since these may have tremendous long-term effects on their wellbeing. As children are still growing, injuries may interfere with their growth patterns, leading to growth abnormalities and deficiencies (AAOS, 2012).

As the level of play and competition increases in popular school sport such as netball, players are exposed to even higher physical demands which include internal as well as external loads. Training loads are calculated in terms of variables, such as training volume and intensity, session duration, number of training sessions and netball matches with resting periods (Gabbett & Whiteley, 2017:50). Establishing the participation record of injured players in injury-prevention training modalities can also aid in examining the effectiveness of their training programmes compared to injury prediction. In contrast to high volumes and intensities, Gabbett and Whiteley (2017:50) add that players are sometimes not exposed to sufficient internal load to gain from the physical adaptations needed for the imposed demands set by the number of competitive games or the duration thereof. This is usually a great predictor of an overuse injury when the body is not sufficiently prepared for the loads experienced during play. Such injuries include, but are not limited to, stress fractures, tendinopathies and growth spurts. Overuse injuries are not easy to rehabilitate without sufficient rest, which leads to further loss of game time. This also results in financial loss in

terms of medical costs, or at a more professional level, it would mean loss of income for the player. The researcher examined the literature in order to provide evidence on which to base decision making regarding standardised injury prevention programmes and the implementation thereof in schools and at higher levels. This research will shed light on the necessity of standard, pre-rehabilitation and rehabilitation programmes in junior netball training.

1.2. PROBLEM STATEMENT

The participation of children in competitive sport with high training intensities and loads, particularly at a very young age, is a concern in the health and wellness of the sports industry (McLeod, 2011). Youth players often engage in training programmes designed for senior players, leaving them vulnerable to overuse injuries. Although movement and participation in sports are critical to children's physical and psychological development, these must be balanced so that the positive rewards outnumber the risks of injury and damage to anatomical and physiological structures, which can lead to long-term consequences (AAOS, 2012).

McLeod (2011) concludes that adolescents are especially vulnerable because of the specific growth and developmental phase they are in. Therefore, such injuries can result in more serious long-term effects on their growth and developmental patterns compared to those of senior or adult players. Netball consists of quick movements, such as accelerating, deaccelerating, jumping, landing and twisting, which place tremendous stress on joints, especially those vulnerable to joint injuries (Langeveld, Coetzee & Holtzhausen, 2012:83). The literature on the incidence of injuries among senior or elite netball players is quite extensive (Hopper, Elliott & Lalor, 1995:223; Langeveld *et al.,* 2012:83; McManus, Stevenson & Finch, 2006:119; McLaughlin, Nicholls & McMillan, 2004:15). However, there is a limited amount of literature available on the incidence of injuries among junior netball players. For this reason, adolescents are the focus of this study which aims to evaluate the problem amongst these players and to contribute to epidemiological research on netball in South Africa, especially on junior level.

1.3. AIM OF THE STUDY

The main aim of this research was firstly to determine the incidence of injuries during local tournaments among South African youth netball players at school level. Participants were between the ages of fifteen and nineteen years and participated in competitive netball. The aim of this research was to further evaluate the training modalities in the existing training programmes of these players.

1.4. OBJECTIVES OF THE STUDY

In order to achieve the main aim of this study, the following objectives were identified:

- To assess the incidence and severity of injuries in a cohort of junior netball players;
- To determine the types of injuries that occur among junior netball players in competitive tournaments;
- To assess the participation of injured netball players in preventative training modalities in order to reduce joint injuries;
- To establish whether there is any correlation between the incidence of injuries and player position; and
- To ascertain the frequency of injuries per match time intervals.

Meeting these research objectives assisted the researcher in shedding light on the incidence of injuries among junior netball players. Moreover, after having identified the gaps in the literature pertaining to this topic, meeting the objectives outlined above provided evidence on which to base intervention programmes.

1.5. MOTIVATION FOR THE STUDY

High participation rates in school netball is an indication of the popularity of the sport. While there are several benefits to being an active adolescent, it is important to ensure that the

risk of injuries and negative long-term effects do not outweigh the advantages (Coetzee *et al*., 2014:39).

The high demands of netball put the players at risk for injury that will influence the physiological structure of the injured segment as well as the rest of the kinetic chain of the athlete, predicting a higher probability of future injuries if the necessary interventions and precautions are not implemented (Chandler *et al*., 2014:2732). Bahr, Clarsen and Myklebust (2017:165) suggest that the greatest predictor of injury is a previous injury. However, the risk could be limited by implementing structured protocols on decision making for return to play after an injury once the incidence of injuries in the relevant population is known. Therefore, this study will contribute to the body of knowledge by conducting a needs analysis for further research regarding safety in netball.

Nevertheless, the motivation for this study was based predominantly on establishing a foundation for epidemiological studies regarding the incidence of injuries in netball at school level. Furthermore, the study will contribute towards the ability to adapt and implement safe and standardised training protocols with evidence-based injury prevention modalities. Therefore, it is the first step towards educating the netball population. According to Finch and White (2017:1735), in order to ensure the implementation of injury prevention programmes, it is necessary to start by educating coaches and influencing their beliefs regarding such programmes. Against this backdrop, the statistics presented in this study will provide solid evidence to the netball bodies which can then be provided to coaches in an attempt to gain their trust and interest in the recommended injury-prevention modalities.

1.6. STRUCTURE OF THE DISSERTATION

Chapter One provides a brief introduction to the study and highlights the shortcomings in the field of research pertaining to the incidence and severity of injuries among junior netball players. Furthermore, this chapter introduces the problem statement on which this research is based. Chapter Two reviews the literature relevant to the research aims, and outlines the structure of netball and the rules applicable to this sport. This is followed by a discussion

of the physical characteristics and physiological demands of a netball match. Next, the researcher evaluates the incidence statistics of injuries, and examines the relevant literature to form a structured, methodological approach for this study. Chapter Three outlines the research methodology used in this study, whereas Chapter Four presents the results of the study. Here, the data are presented according to a simplified yet scientific structure by using graphs, tables and figures where applicable. Chapter Five discusses the results of the study by comparing and contrasting these with those in the relevant literature reviewed in Chapter Two. Chapter Six includes the conclusions drawn and discusses the limitations of the current study in order to provide recommendations for future research. Finally, Chapter Seven takes the form of a comprehensive reflection on the research process, and describes some of the researcher's personal experiences and challenges faced in conducting this study.

CHAPTER 2:

LITERATURE REVIEW

CHAPTER 2
LITERATURE REVIEW

2.1. INTRODUCTION

The game of netball is a team sport and is well known internationally among all age groups as it includes a diverse level of skill, from novice to professional players (Chandler *et al.*, 2014:2732). South African netball is growing constantly in terms of the number of participants, both young and old (Mdakane, 2012). In an attempt to implement evidence-based protocols regarding training programmes and the necessary injury-prevention modalities, it is of the utmost importance firstly to quantify and understand the incidence of injury and, secondly, to attain valuable information regarding the types of injury and severity thereof, as well as an analysis of the time of play in which the injury occurred and the positional demands placed on the injured player during match time (Langeveld *et al.,* 2012:84). Van Mechelen *et al.* (1992:84) suggest that by determining the incidence of injury during match time, researchers can use the obtained evidence as a baseline to further establish the need for intervention strategies. Moreover, the findings can assist coaches in the optimal design and implementation of evidence-based injury prevention protocols. Finally, researchers, analysts and coaches can use the evidence to reduce the risk of injuries during the game.

It is important to understand how the sport is structured and regulated. Firstly, the researcher will outline the structure of netball in terms of its rules, the court layout and restrictions imposed upon the players. Secondly, the demands of netball will be described in order to identify the factors contributing to the risk of injury. Furthermore, the researcher will examine the effects of the demands on the immature skeletal structure of the adolescent player. Since the ages of the participants vary between fourteen and nineteen years, it is mandatory to examine the latter aspect due to the fact that the anatomical and physiological structures of the players are still in the growth and developmental stage, and will have a different long-

term effect on younger players than on a mature individual. Nevertheless, the immaturity of the physiological and anatomical structures cannot be emphasised enough. Therefore, the literature review will include a discussion on the evidence-based, chronic effects of an acute injury on an adolescent athlete.

A comprehensive literature review follows in an attempt to explain the above concepts used by the researcher to establish an appropriate methodological approach for the study.

2.2. THE GAME OF NETBALL

Netball is a popular team sport amongst females, especially in Australia, New Zealand, the United Kingdom and South Africa. A full game of netball consists of four quarters, each of which are fifteen minutes in duration, with a five-minute break at halftime and another three minutes between the remaining quarterly intervals. A full, outdoor netball team consists of seven players on the court at any given time. The various positions are outlined in this chapter together with an explanation of the court restrictions of each player. According to research, the court restrictions, as shown in Table 2, have a significant impact on the multiplicity of physical demands on different player positions during play (Chandler *et al*., 2014: 2732).

According to Neethling (2015:1), netball is the number one sport in which females participate and has more than two million active players at present. At school level, netball is rated as the third most popular sport in the country in terms of participation. In addition, corporate sponsors have ranked netball as the third most professionally-coordinated sport in South Africa, with more than 4.2 million followers, which makes it one of the top ten spectator sports in South Africa. Therefore, in view of the above statistics, netball can certainly be seen as a popular sport in South Africa. Not only is it important to focus on the positive contribution and popularity of this sporting code, but it is equally important to examine the implications thereof. As discussed in Chapter One, it is critical to determine whether the benefits of participating in netball outweigh the risks thereof.

Participation in sports and regular exercise is proven to be advantageous in terms of an individual's health. Nevertheless, any sport or exercise coincides with the risk of injury, especially those that involve contact or jumping as these are said to have the highest rate of injuries (Shanmugam & Maffulli, 2008:33; Langeveld *et al.,* 2012:85).

Langeveld *et al.* (2012:85) further observe that the greatest risk to be taken into consideration is the risk of injury as well as the long-term effects thereof. It can be of great value to determine the incidence of injuries in netball because of its repetitive nature which results in constant jumping, landing and physical contact during play, as discussed in Chapter One. Moreover, this will help to establish the need for an intervention programme or injury-prevention protocol based on scientific evidence. In order to fully understand the physical demands placed on the body, it is necessary to understand the core principles on which netball is based. Netball will be explained in the section below in terms of its background, rules and regulations, court layout combined with court restrictions and, finally, the physical demands of the sport. This will provide a better understanding in terms of what was previously explained as high physical demands placed on the player.

2.2.1. Background of Netball South Africa

Netball has proved to be the sport with the largest rate of participation among females in South Africa, and continues to grow in numbers as stated in a briefing by Mdakane (2012) for Netball South Africa (NSA). Netball South Africa based its vision on four strategic pillars which include growth, development, a winning culture and the generation of funds. Since 1994, there has been an estimated average growth of 9.5% in terms of participation per year (Mdakane, 2012).

Mdakane (2012) states that NSA had a great breakthrough with the launch of the Brutal Fruit Netball Premier League in 2014, resulting in the successful creation of the first fully professional women's league. This attracted popular sponsors, such as Gilbert, Canterbury, Energade, South African Breweries (SAB) and Tsogo Sun, who signed a five-year contract.

An analysis of the four pillars of NSA confirms the level of competitiveness and growing professionalism in netball, which is growing into a professional sport.

Table 1 and Figure 1 show the netball structure of South African schools in the nine provinces in South Africa, each of which has its own district (Shaw, 2018:29-30). A large part of this study included participants from the All Ages Tournament (see Table 1).

Table 1: School netball competitions

COMPETITION	AGE GROUP	PARTICIPATION LEVEL
U/18 Schools tour to Fiji	U/18	International
All Ages Tournament	All	Provincial
Secondary School Champs	U/14 – U19	School level
Fast 5	U/15 and U/18	School level
Kay Motsepe Schools Cup	U/15	School level
COSASSA Games	U/16	School level
U/15 Singapore Tournament	U/15	International

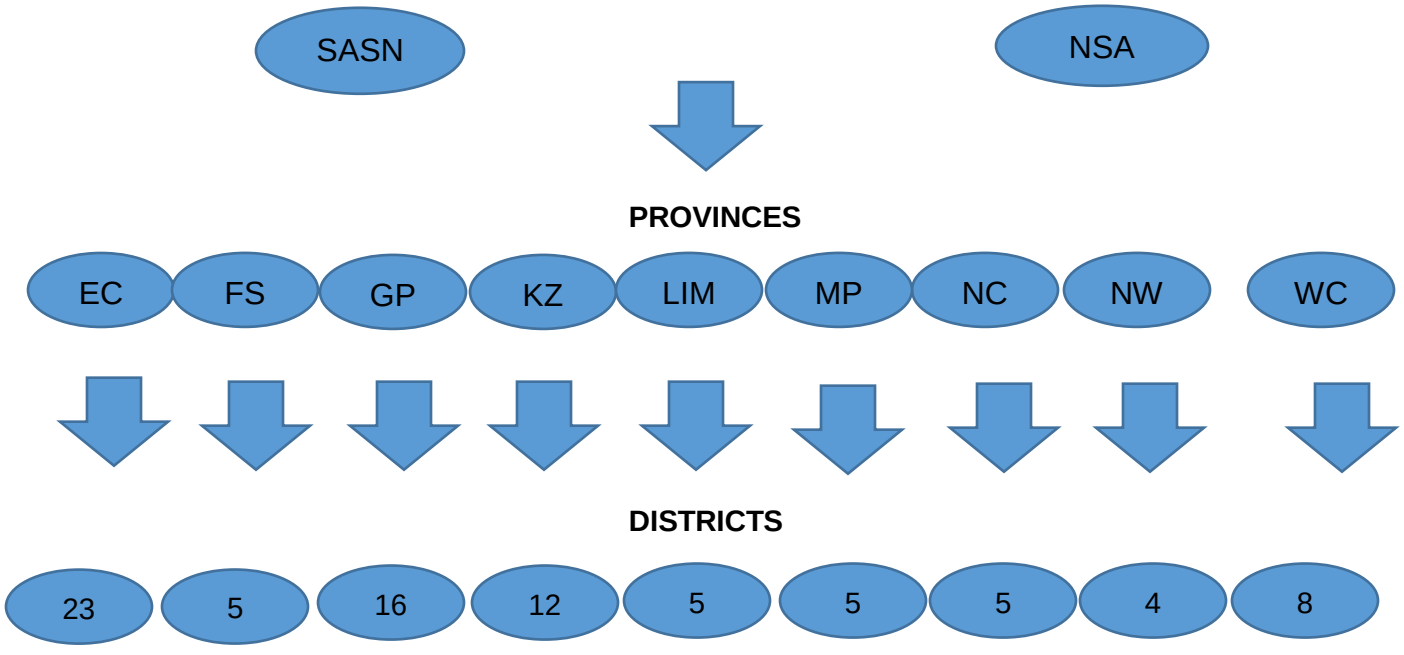

Figure 1: South African schools netball structures (SA Schools Netball, 2017)

2.2.2. Rules of Netball

The rules and regulations of netball, including the terminology used in this sport, as explained Wilcox (2011:40-44), are summarised below (see Table 2). Further insight into the game of netball is provided by means of a description of the court layout and restriction (see Figures 2 and 3).

Table 2: Rules and terminology as explained by Wilcox (2011)

Offside	When any of the players go into an area of the court that is restricted in terms of their position, the ball is immediately given to the opposition.
Held ball	Players are only allowed to have the ball in their possession for three seconds. Within this time, the player must pass the ball to another player or attempt a shot at goal. However, if the player fails to do so, the ball is handed over to the opposition.
Stepping	A player is never allowed to run while holding the ball during play. The first foot on which the player lands after catching the ball is called her 'grounded' foot. The player may lift the grounded foot while still in possession of the ball but may not place it back on the ground before releasing the ball as this is seen as a 'step' in which case the ball is given to the opposition.
Obstruction	A defending player must be a minimum of 0.9 m away from the person in play of the ball. This distance is measured from the first grounded foot of the player holding the ball to the closest foot of the defender. If someone is called out for obstruction, the player holding the ball will be awarded a penalty pass (or shot if the infringement occurs within the goal circle), and the defending player who was called out must stand next to her ('standing down') while the penalty is taken.
Contact	No player may accidentally or deliberately physically contact an opponent if it hinders that person's play. Like the obstruction call, if the player is called out for contact, she must stand down while the penalty pass (or shot) is taken.
Replay ball	A player cannot pick the ball up again if she loses control of it. Furthermore, she also cannot touch the ball after passing it until it has touched another player or hit the goalpost. A player may not bounce or pass the ball to herself,

	and a shooter may not catch the ball if her attempt at a goal did not hit the goalpost or hit another player.
Over a third	The ball cannot go through a third without being touched by at least one player. As a result, the ball cannot be passed directly from the defensive third to the attacking third.
Centre passes	At the beginning of each quarter and after each goal is scored, play begins with a centre pass. The Centre must step into the centre circle with the ball, with all other players behind the lines separating the middle third from the other two thirds and wait for the umpire's whistle to begin play. Once the whistle is blown, the other players may enter the middle third and the ball may be passed (note that the ball must be received within the middle third on the first pass). The two teams take alternate centre passes throughout the game, with the first pass of the game usually decided upon by a coin toss.
Feeding	This is the term commonly applied to a player passing the ball to a shooter in the circle such that the shooter receives the ball within reasonable shooting distance.
Intercept	An intercept is a clean gain in possession by a member of the team not in current possession of the ball. An intercept can be made either through a clean catch or through the player tipping the ball and then picking it up herself.
Tip	A tip is a deflection of the ball by a member of the team not in current possession of the ball. A tip may or may not lead to a gain in possession by the player's team depending on who picks up the ball following the tip. In either case, the player picking up the ball will not be the player who got the tip as this would be classified as an intercept.

2.2.3. Court Layout and Playing Positions

The standard netball court is divided into thirds by means of visible lines, determining where specific player positions can move on the court. At the end of the court there are two semi-circular goal circles where shots may be taken. Again, only certain players may enter these circles and are allowed to take a shot at a goal. In the middle of the court there is a small

circle from which play is started at the onset of each time frame after a goal is awarded (Wilcox, 2011:41).

The court dimensions are standardised, as outlined below and illustrated in Figures 2 and 3. The total court length is 30.5 m, with a court width of 15.25 m. In addition, there are two goal circles each of which have a 4.9 m radius, a goalpost height of 3.05 m and a hoop diameter of 0.38 m. The centre circle is a standard 0.9 m in diameter. It is important to note that the court can be made of synthetic grass or concrete. However, in this study, all games were played on concrete courts (Wilcox, 2011:41).

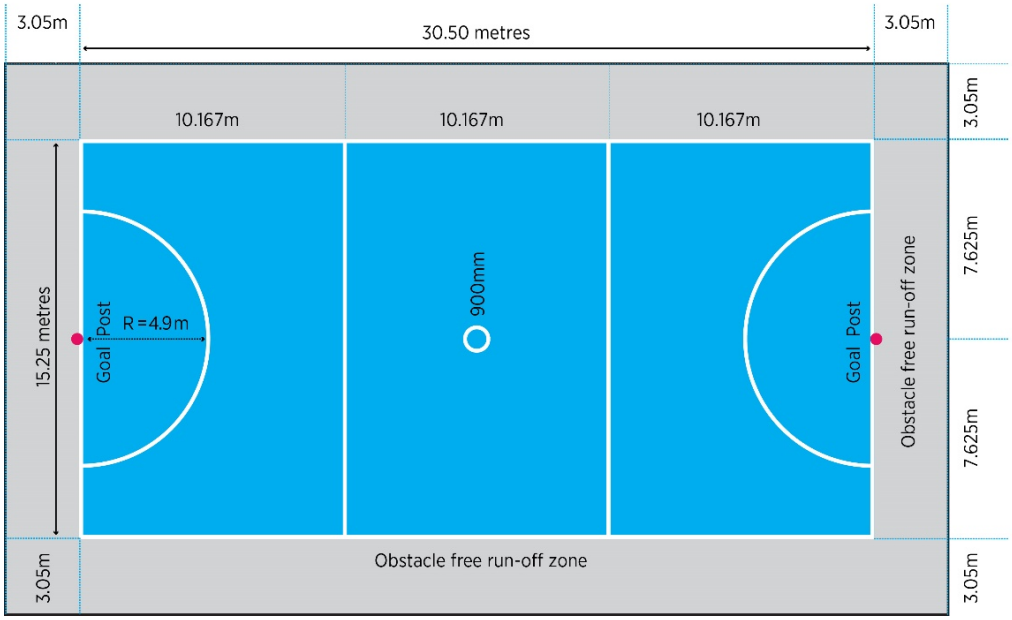

Figure 2: Court layout and design (Department of Local Government Sport and Cultural Industries, 2018)

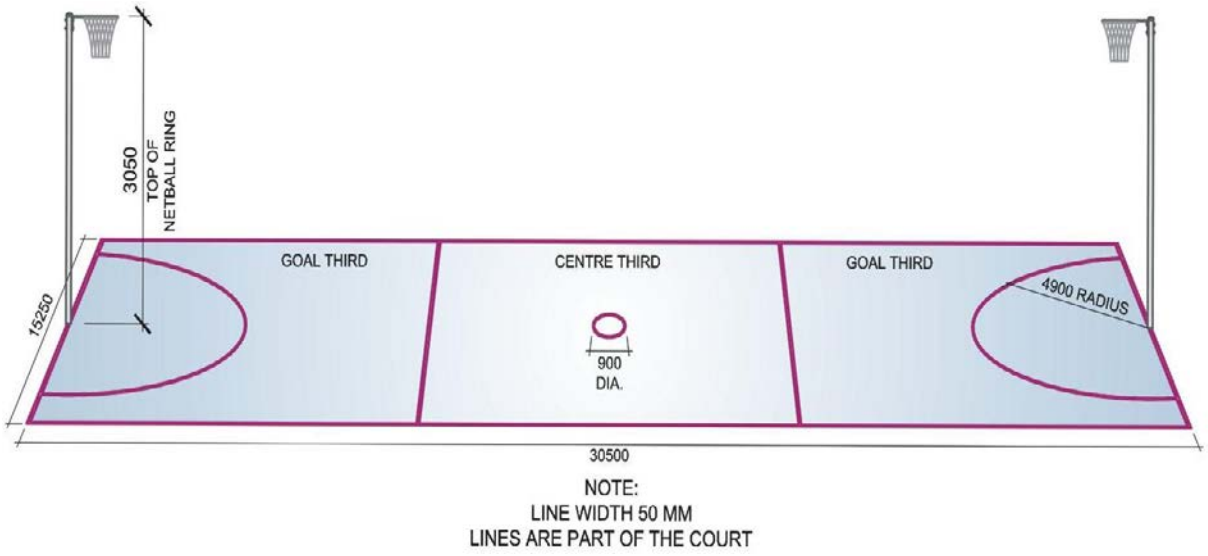

Figure 3: Court dimensions (Play Hard Sports, 2016)

Wilcox (2011:42) explains that each team is allowed to have seven players on the court during match play. Each player is assigned a certain position and areas in which she is allowed to move on the court. This restricts each player to a certain area of the court during play, and players are not allowed outside their designated area. If they fail to stay within the given area, they are immediately penalised, and the ball is given to the opponent. This is known as offside (see Table 3).

Table 3: Player position and designated court areas (Wilcox, 2011:42)

Player position	**Abbreviation**	**Designated area**
Goal Shoot	GS	Allowed anywhere in the attacking third1

[1] GS and GA are the only players allowed to score a goal from the goal circle in order to score points for their team.

Goal Attack	GA	Allowed anywhere in the attacking third, and in the centre third2
Wing Attack	WA	Allowed into the attacking third, but not in the goal circle, and are also allowed in the centre third
Centre	C	Allowed on the whole court, except the two goal circles
Wing Defence	WD	Allowed in the defensive and middle thirds, but not in the goal circle
Goal Defence	GD	Can go anywhere in the defensive third

2.2.4. Physical Demands of Netball

Competitive netball consists of different aspects which stress the physiological structures of players as mentioned in Chapter Two. This stress can be too high, especially on the immature structures of the adolescent player. Therefore, it is necessary to implement an intervention programme or injury-prevention protocol in order to establish the correct ratio

[2] GS and GA are the only players allowed to score a goal from the goal circle in order to score points for their team.

between exercise and rest, as well as between the session durations of different important modalities. The literature on the physical demands of netball is widely available, and uses a time-motion analysis to determine the different demands on the different player positions during the game (Chandler, 2014:2733; Fox, Spittle & Saunders, 2013:1588; McManus *et al.,* 2007:119; Shaw, 2018:19; Van Gogh, Wallace & Coutts, 2017:1).

Chandler (2014:2732) further suggests that time-motion analysis is often used to determine the physical stress on athletes during team sports. This gives researchers insight into the physical demands of a specific sport and enables coaches, sport scientists and allied health professionals working with the relevant sporting code to improve and adapt their conditioning programmes to further benefit and protect their players from the risks of injury. This is only beneficial when taking into consideration the type and amount of stress placed on their bodies. In practice, these experts should attempt to prepare the physiological structures of the athletes to adapt and become accustomed to the demands of the game, both internally and externally (Gabbett & Whiteley, 2017:52)

A recent study by Shaw (2018:19) investigated the physiological demands on u/19 netball players. This time-motion analysis study used advanced GPS technology to determine the physical demands placed on junior netball players. In addition, the researcher analysed the demands on each player position. This can help to determine whether there is a correlation between the demands and injuries of each playing position. The literature on junior players is also limited. Therefore, the latter study is in line with the population group of this study. Similar literature, which focuses on senior players, will also be examined in order to determine whether the demands of netball are consistent throughout the different age groups.

2.2.4.1. Distances covered on court for each playing position

According to the research, different player positions cover a variety of average distances per minute (Davidson & Treartha, 2008:329; Yong, Wylde, Choong & Lim-Prasad, 2015:707; Shaw, 2018:102). Some researchers only considered a few of the positions in netball while

others took all the positions into account. Table 4 provides a summary of the literature which analysed the distances covered during a netball match.

Table 4: Distances covered for each player position

Author	GS	GA	WA	C	WD	GD	GK
Davidson et al. (2008)	4.2 km (70 m/min)			8 km (133 m/min)			4.2 km (71 m/min)
Yong et al. (2015)	35 m/min	35 m/min	35 m/min	37.7 m/min	36 m/min	36 m/min	36 m/min
Shaw (2018)	1.6 km	2.9 km	2.8 km	3.3 km	2.6 km	2.6 km	1.4 km

2.2.4.2. Cardiovascular demands on different player positions

Netball teams consist of seven players each. Each player has a designated area on the court in which she is allowed to move, as mentioned above. Various studies have attempted to measure the physiological demands of netball on players. The methodological approach of these studies was based on both subjective and objective measurements of the internal load on the players, using the rate of perceived exertion (RPE) and GPS technology, heart rate (HR) and accelerometers (Fox *et al*., 2013:1588; Chandler *et al.*, 2014:2733; Van Gogh *et al*., 2017:1, McManus *et al*., 2006:120; Shaw, 2018: 54).

Studies using the heart rate response of players in order to establish the physical demands and intensity thereof as a physiological response showed that various positions require different types of physical effort. Shaw (2017:98) concludes that the GS had a significantly lower maximum HR than the rest of the players. The mean maximum HR of the WD appeared to be higher than that of the C, which is surprising as the C is allowed a greater surface of play, which suggests that she is active during a large part of the playing time.

The most recent study on the positional demands (also on youth netball players) found that the these demands HRmaxranged between 70% and 62.6% in terms of the proportion of

time spent in the high HR max zone (>85%). This indicates a significant difference between the demands placed on various player positions. The researcher found that the C and the GA had the largest number of cardiovascular demands placed on them in terms of their time spent in the maximum HR zone. Similar to Shaw's (2018:98) findings, it was found that the GS and GK had significantly lower cardiovascular demands placed on them and spent more time in the low zone (<70% HR max) yet the GS and GK showed more time spent catching and passing than the defending players (Van Gogh, 2018:1).

Steel (cited in Chandler *et al*., 2014:2733) compares the demands placed on netball players during skills training sessions and those placed on them during competitions and found that HR zones during competitions varied between 75% and 85% HR max whereas training loads were far less than 75% HR max. However, Chandler (2014:2733) states that training programmes in netball do not optimally prepare the athlete for the demands of the game, which can lead to fatigue and the risk of sustaining injuries.

2.2.4.3. Physical demands on each player position

Fox *et al*. (2013:1593) used a different methodological approach which also focused on the positional physical demands in elite netball by analysing video footage in order to determine variables, such as the work-to-rest ratio of each position as well as the time spent on different activities, such as walking, jogging, shuffling, running, jumping and sprinting. Upon examination of the work-to-rest ratio, it was evident that the defensive court positions exhibited a higher percentage of work compared to the amount of rest. It was found that jogging, running and sprinting were mostly performed by mid-court positions, such as GD, WD, C, WA and GA.

The amount of jumping was relatively consistent throughout the playing positions. Although the defensive court positions all showed a greater work period, the intensity thereof differed greatly. Therefore, it is of the utmost importance that position-specific training programmes are incorporated in order to prepare each player for her position-imposed demands. This can also be considered when examining the different training modalities that form part of the

training programmes used in this study. During training, it is important to consider not only the demands of the sport, but also the demands of the various playing positions in order to reduce fatigue and the risk of injury, which are the main aims of the present study.

Considering the positional demands as well as the incidence of injury related to each playing position will help to establish the needs of a simulated training programme for netball players, which will have the benefit of reducing the risk of injury due to effective preparation for the task at hand. Fox *et al*. (2013:1594) assert that these demands are also closely related to the court restrictions of netball as discussed earlier in this chapter. It would be of great value to use the demands of netball and the incidence of injury to design and implement an evidence-based, sport- and position-specific training protocol for netball players.

2.3. EPIDEMIOLOGICAL STUDIES

Pearce (2012:393) defines epidemiological studies as research that is based on a specific population followed within a particular timeframe and adds that these studies should distinguish between incidence and prevalence. In the present study, this entails differentiating between injury incidence and injury prevalence.

2.3.1. Incidence Rate Studies

Caine, Maffulli and Caine (2008:19) define ‘incidence study’ as a basic expression of risks of injury whereas ‘further incidence’ is defined as “the number of injury cases in a defined population during a set period of time”. ‘Incidence rate’, on the other hand, is a characteristic for the risk of injuries whereby the observed number of injuries is divided by the total time during which the participants are exposed to the risk (often called person-time). In the current study, the researcher used incidence rate as per the latter definition.

The incidence rate is determined by using the number of injuries divided by the total match time of participants (the person time), and this rate is expressed per 1 000 playing hours.

Caine *et al*. (2008:19) further mention that this type of reporting is commonly used and provides an important foundation for injury predictability and the effectiveness of injury-prevention measures, which is exactly what the researcher established.

2.3.2. Relevance of Epidemiological Studies

Knowing the incidence of injuries in these netball players can be of assistance in designing programmes with appropriate training modalities (Langeveld *et al*., 2012:89), thus limiting further injuries and reducing the serious effects thereof in young players.

A four-step model was proposed by Van Mechelen *et al*. (1992:84) (see Figure 4) for sports-injury surveillance. The first step emphasises the fact that it is critical to determine the extent of the injury. In the second phase, the aetiology and mechanisms of sports injury are examined. The third stage concerns the introduction of preventive and therapeutic measures, which are then assessed in terms of their efficiency by repeating Step 1. Therefore, this study can make a significant contribution by determining the incidence and frequency of injuries in junior netball players in South Africa (the first two steps of the model). Furthermore, the present study will make it possible for sports and exercise science professionals to make relevant, scientific and evidence-based recommendations for injury-prevention programmes (Steps 3 and 4) in the target population, which are currently lacking due to the limited research available on this topic.

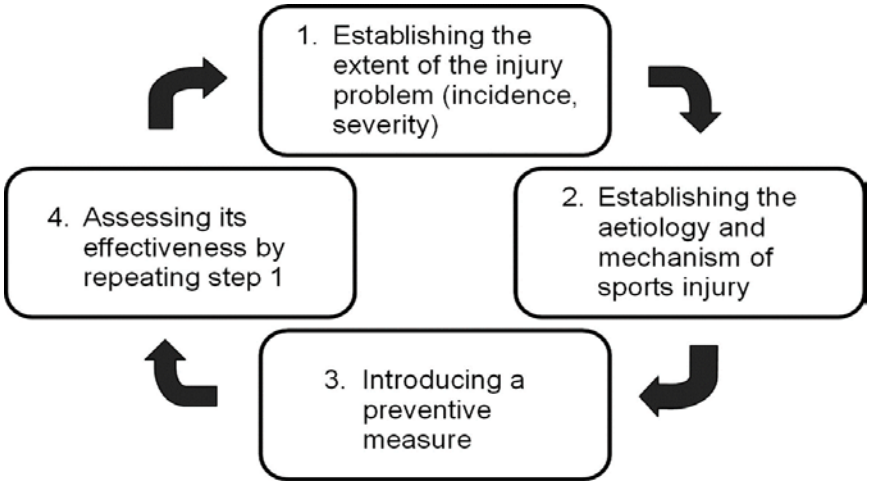

Figure 4: Four-step model (Van Mechelen *et al*., 1992:84)

A position statement of the National Athletic Trainers' Association on the prevention of paediatric overuse injuries (McLeod, 2011) states that researchers should place a great deal of focus on improving understanding with regard to the incidence and prevalence of overuse injuries among the youth athletic population as well as the financial implications thereof. The NATA suggests that such results will help researchers to focus on introducing preventive measures (Step 3 in the proposed model of Van Mechelen *et al.,* 1992:84*)*.

2.4. NETBALL INJURIES

Research on the incidence of netball injuries focuses mainly on senior netball players or elite, professional players. A small amount of evidence exists on the incidence of injuries among junior netball players, which could be due to the fact that funding opportunities for research at professional level are more readily available. Nevertheless, by including the literature on senior netball players, the researcher can provide an overall indication of the incidence of injuries. Therefore, the researcher used the available literature on junior and senior players to examine the evidence in order to establish a framework according to which the findings of this study could be objectively measured, analysed and compared to draw further conclusions and make recommendations regarding the incidence of injuries in netball. This, in turn, can be provided to regulatory bodies involved in the decision-making processes related to netball.

The incidence of injuries in netball is of great concern. Hopper *et al*. (1995:223) conducted a five-year study on the epidemiology of netball injuries (N=11 228) and reported a total of 5.4%. Although there is no significance regarding this percentage, the incidence of injuries (606 reported cases in a period of 14 weeks) should be of concern to players and coaches. In this study, the participants were divided into a junior group (ages 12-15) and seniors (16 years and older). The incidence of injury among the junior group was 5.1% (a total of 45 injuries). In accordance with the latter statistics, another study done by Hopper (1986:232), also over a 14-week period, reported a total of 5.2% injuries, adding up to 162 injuries among

3 108 players. A South African study on the epidemiology of injuries among elite netball players reported a significant injury rate of 32.8 injuries per 1 000 playing hours (Langeveld *et al*., 2012:83). This total is rather high compared to a study conducted in Australia, where 14 injuries per 1 000 playing hours were reported (McManus *et al*., 2006:119). The significant difference in injuries per playing hours may be due to the different methodological approaches adopted in the studies compared. However, Langeveld *et al*. (2012:83) aimed to determine the injuries among elite netball players during a competitive tournament whereas McManus *et al*. (2006:119) focused on community level participants in a two-year study. This is in accordance with the results of McManus *et al*. (2006:119) and McLaughlin *et al*. (2004:15), who found a total number of 11.3 injuries per playing hours during a competitive netball season (n=78).

In another study, conducted during the financial year of 2002- 2003, the Australian Government Institute of Health and Welfare National Injury Surveillance Unit on hospitalised basketball and netball injuries reported 1 129 netball-related hospitalisation. This study only documented injuries that were severe enough to require admission into a medical facility (Flood & Harrison, 2006:16). A more recent study by Attenborough and Hiller (2017:31) recorded a total of 6.75 injuries during match time among participants at the University of Sydney, with a mean age of 21.5 ±6.3 years.

Nevertheless, Hopper *et al*. (1995:223) conclude that netball may be regarded as a safe game. Still, considering the incidence of injuries and the effects thereof should be viewed as a sensitive yet critical topic in the implementation of injury-prevention programmes in order for netball players to subsequently reduce the risk of injury. In a more recent study by Hopper, Haff, Barley, Joyce, Lloyd and Haff (2017:1165), it was confirmed that netball is often associated with lower limb injuries and is seen as one of the top five sports contributing to sports-related injuries among children in Australia. Accordingly, Frisch, Croisier, Urhausen, Seil and Theisen (2009:95) recommends that critical factors and modalities, such as the duration of sessions and the training programme content should be taken into consideration, as well as frequency and the compliance of the player. Limited literature on the incidence of injuries in junior South African netball players could be found. Therefore,

this study may be of great value in improving the level of professionalism of South African netball.

2.4.1. Anatomical Sites of Netball Injuries

Previous researchers (Hopper *et al.,* 1995:16; McLaughlin *et al.,* 2004:16*;* Langeveld *et al.,* 2012:83; Pillay & Frantz, 2012:7) found that the most frequently injured anatomical sites are the knee and ankle joints. Although the literature differs in terms of the number of knee and ankle injuries respectively, it is evident that these two joints are more prone to injury during a netball game, compared to other anatomical structures. Apart from injuries in these areas, the wrist, hand and fingers are also often a site of injury during netball matches. A summary of the most relevant authors' findings is presented in Table 5 below.

Table 5: Comparison of the literature on the anatomical sites of injuries

Author	Population (years)	Highest (%)	Second Highest (%)	Third Highest (%)
Langeveld *et al.* (2012)	u/19, u/21 and Seniors	Ankle = 34	Knee = 18	Finger, hand or Wrist = 15
Hopper *et al*. (1995)	Mean age 18 (±5.6)	Ankle = 84	Knee = 8.3	
McMillan *et al*. (2004)	u/15; u/17 and Seniors	Ankle = 23	Knee = 21	Lower back and Finger = 11
Pillay and Frantz (2012)	Mean age 23-24 years	Ankle = 37.5	Knee = 28.6	-
Hume & Steele (2000)	Mean age 18.4 (±4.4)	Torso/Pelvis =19	Ankle and Knee = 14	Fingers = 9
McManus *et al.* (2006)	16-30	Ankle = 32	Knee = 17	Hand/Wrist = 15
Best and Gledhill (2017)	Senior	Ankle = 25.6	-	-

Furthermore, researchers have divided injuries into structural categories, and various studies have confirmed that ligamentous injuries are highly prevalent among netball injuries (Hopper *et al.,* 1995:16; McMillan *et al.,* 2004:1; Langeveld *et al.,* 2012:83; Pillay & Frantz, 2012:17). Although these studies rarely distinguish between the type of ligaments injured in the ankle and knee, respectively, during a netball game, other evidence suggests that the anterior cruciate ligament (ACL) is commonly injured in netball due to the nature of jumping and landing, as well as twisting and pivot movements during sudden, quick changes of direction which allows the tibia to translate anteriorly, and is mostly accepted as the mechanism of injury during an ACL injury (Langeveld *et al.,* 2012:83).

2.4.2. Chronic Effects of Acute Injuries among Adolescents

Caine, Purcell and Mafulli (2014:1) suggest that the incidence of children participating in competitive sports should raise concern in terms of the risks of sports injuries. Growth-related abnormalities or restrictions can occur on the immature skeletal structures of the adolescent due to repetitive micro trauma and training overload. Sever's disease, Osgood Schlatter, epiphyseal injuries and stress fractures are examples of such injuries. These abnormalities and disturbances in growth mechanisms can occur in sedentary individuals as well but are more often reported by active individuals (Shanmugam & Maffulli, 2008:33).

As previously mentioned, netball is seen as a popular sport with high physical demands and forms part of most South African schools' extramural programmes. Consequently, girls as young as six years old are exposed to these high demands. According to Shanmugam and Mafulli (2008:35), a contributing factor towards adolescents' susceptibility to injuries is an imbalance between strength and flexibility during this growth and developmental phase (Caine & Mafulli, 2006:501; Caine & Mafulli, 2008:20; Caine & Maffulli, 2014:1; Popovic, Bukva, Mafulli & Caine, 2017:975).

Injuries among junior athletes are complicated due to the anatomical and physiological growth that take place during this developmental stage. Growth-related injuries are of great concern and usually affect the epiphyseal plates and epiphyses. Injuries to these structures

can impede natural healing and therefore lead to growth restriction or disability. These injuries are mostly the result of constant compression and repeated stress, tension and/or traction on these structures. A combination of repetitive micro trauma, insufficient rest and inadequate injury-prevention training modalities within training programmes will most probably lead to an overuse or chronic injury (Attenborough & Hiller, 2017:31; Gabbett & Whiteley 2017:51; Shanmugam & Maffulli 2008:33) .

Considering that injuries among young athletes may have tremendous long-term effects on growth mechanisms, preventative measurements must be put in place (Caine, Caine & Maffulli, 2006:501). Training programmes should focus on injury-prevention strategies and must include age-appropriate exercises. Shanmugam and Maffulli (2008:33) state that coaches must also consider the players' physical immaturity rather than only their chronological age. Knowing the incidence of injuries in these netball players can be of assistance in designing programmes with appropriate training modalities (Langeveld *et al*., 2012:89), thus limiting further injuries and reducing the serious effects thereof in young players.

Another concern is the number of overuse injuries in youth sports. According to McLeod (2011), 50% of youth patients report to sports medicine clinics as a result of chronic injuries. This not only has a tremendous economic effect due to the costs involved in hospitalisation, doctors' consultations and additional medical costs in order to stabilise the injury, but often players are forced (or choose to) stop their participation in sports due to the psychological effects or in an attempt to prevent further harm to their existing injury, thus increasing the percentage of sedentary adolescents which is already very high. This negatively influences these patients' wellbeing and shifts the health concern to another paradigm.

Nevertheless, the effects of injuries on children cannot be ignored. It is therefore critical to quantify the severity and incidence of injuries among junior players in order to design and implement evidence-based intervention programmes for netball in schools (Caine *et al*., 2006:500).

2.5. INTERVENTION STRATEGIES

Undoubtedly, intervention strategies are needed, considering the incidence of injuries reflected in the literature reviewed earlier in this chapter. The greatest challenge is not to compile a scientific injury prevention programme, but rather the implementation thereof to bridge the gap in attitudes and beliefs regarding injury-prevention modalities among conditioning coaches and the players themselves (Mckay, Steffen, Romiti, Finch & Emery, 2014:1281). This argument is supported by Gabbett and Whiteley (2017:51) who add that in order to effectively implement intervention strategies, it is of the utmost importance that conditioning coaches and medical staff work in collaboration with, rather than against, one another in terms of their own motivations, either winning at any cost or reducing and preventing injuries. In the latter study, it was suggested that when the staff, irrespective of their position, work synergistically towards match performance as a primary goal, the intervention and conditioning will be more effective. Furthermore, the over-emphasis on injury prevention rather than on performance contributes to the fact that players are constantly trained away from their optimal threshold, which further predicts that these players will not develop and enhance the physical qualities that will allow them to perform optimally in their sport, similarly to when coaches focus purely on performance.

2.5.1. The Feasibility of Implementing Intervention Strategies

In an attempt to reduce the number of injuries and their related chronic effects it is of the utmost importance to implement an effective and safe intervention programme. This can only be effective once the researcher establishes the feasibility of such a programme. McLeod (2011) adds that repetitive physical stress on the limbs and musculoskeletal structure of any athlete in various age groups without proper preparation and rest will most likely result in chronic or overuse injuries. Due to the fact that children and adolescents are still in a growth and developmental phase, as mentioned in the introduction, they are exposed to the risk of an inimitable set of injuries or damage to physiological and anatomical structures.

To conclude, it is clear from the literature review that the number of injuries among netball players is significantly high. In an attempt to reduce the number of injuries and lower the risk for injuries and re-injuries, it can be hypothesised that a safe and effective intervention programme will be beneficial to junior netball players in South Africa. The researcher will use an evidence-based approach in order to apply the four-step model of Van Mechelen *et al.* (1992:84) (see Figure 4).

2.5.2. Evidence-Based Modalities as Intervention to Reduce the Risk of Injury

A cluster, randomised, controlled trail among adolescent athletes showed that a structured warm-up as part of their training programme could help to prevent and reduce the number of knee and ankle injuries in young athletes. A significant reduction of 50% in acute ankle and knee injuries was recorded whereas with more severe injuries, an even higher reduction in injury rates was observed (Olsen, Myklebust, Engebretsen, Holme & Bahr, 2005:1). O'Brien, Young and Finch (2017:26) assessed professional youth soccer teams with a modification of the well-known FIFA 11+ programme. Exercises were modified in an attempt to continuously develop and improve the programme. In the latter study, the researcher emphasises the fact that modifications to the programme must be implemented in a strategic-sports and movement-specific manner in order to be beneficial. The FIFA 11+ programme is based on strength, balance, core stability and plyometrics. This programme has been recognised and implemented by different sports teams across the world and is highly recommended as an injury-prevention programme. The programme's effectiveness lies greatly in the degree of specific adaptation to imposed demands (SAID) per sporting code or age group.

In accordance with the above-mentioned study, DeMers, Hicks and Delp (2017:17) also contributed to an effective injury-prevention strategy focusing on co-activation of the ankle muscles to prevent ankle inversion injuries. In this study, the researcher focused on muscle co-activation strategies in order to have a safe and correct landing pattern during sport to prevent ankle inversion injuries, which are of great concern among junior netball players

since this is the main reason for ankle injuries and one of the highest incidence injuries during netball matches.

Finch and White (2017:1734) add that behavioural factors and beliefs are important predictors of the adoption of injury-prevention modalities. In this study, the researcher emphasises the fact that players should have positive attitudes and behaviours and understand why injury prevention is an integral part of optimising their capabilities without being restricted by injuries. In order to maximise the results of an intervention strategy such as correct landing technique, it is important to explain the benefits of executing this in the correct manner. Involving significant others or role models will help to motivate young players to adopt a positive attitude towards, and to buy into, intervention programmes.

2.5.2.1. Predictors of injury

- ***Ankle mobility***

Attenborough and Hiller (2017:31) recorded the number of ankle injuries in one netball season together with a variety of pre-season testing modalities in order to see whether a low score in some of the pre-season testing modalities could predict a risk for ankle sprains during the season. The participants consisted of 94 players with a mean age of 21.5 ±6.3 years. Eleven participants sustained an ankle injury throughout the season. During this study, the test battery consisted of five components: (i) muscular power; (ii) ankle joint laxity; (iii) perceived ankle instability; (iv) previous sprains; and (v) static and dynamic balance. According to the results, a predictor of an ankle injury is a posterior-medial reach <77% of the player's leg length, pointing to a better degree of ankle mobility.

- ***Playing surface***

Researchers agreed that the type of playing surface could also significantly predict the risk of injury (Van Jaarsveld, 2015:36). Epidemiological studies compared the incidence of injuries sustained on a concrete surface to those sustained on a synthetic surface, which

allows for a softer landing than on concrete. Langeveld *et al.* (2012:89) also conclude that synthetic surfaces are safer than those made of concrete. In this study, all the matches were played on concrete surfaces. Therefore, this variable was not taken into consideration while investigating the injury incidence rate.

- ***Previous injury***

Research has established that the greatest predictor of an injury is a previous injury (Bahr *et al.,* 2017:165). The injury can be a re-injury of the same structure due to the fact that the injury did not heal properly or because rehabilitation was not efficient. Compensatory patterns exist due to a fear of avoidance or to avoid pain provocation, leading to a limp which influences the entire kinetic chain and leaves the athlete prone to a secondary injury.

- ***Age, gender and hormonal changes***

Popovic *et al.* (2017:974) agree that participation in sports at a young age has countless benefits. However, like any physical activity, it does not exclude the risk of sustaining an injury. As a young athlete, the player may be susceptible to sports injuries due to the process of growth, both physically and physiologically. According to science, the musculoskeletal system is different from a mature skeletal structure. Therefore, the responses to injury are significantly different. The adolescent growth spurt is also to be taken into consideration with adolescent athletes. Increased risk is also associated with the underdevelopment of the athlete's coordination, perception and skills compared to those of the mature athlete. Furthermore, Popovic *et al.* (2017:975) indicate that normal participation levels should not be a concern, but that increased intensity and frequency of training and competition currently create an environment in which the young athlete is vulnerable to the risk of injury (Caine & Mafulli, 2006:501; Caine & Mafulli, 2008:20; Caine & Maffulli, 2014:1; Popovic *et al.,* 2017:975).

Non-linear growth patterns of different body segments occur and cause inconsistency in body segment proportions, which directly impact the movement of the athlete. Moreover,

the adolescent is in a non-linear growth stage that places his/her kinetic chain under greater stress when participating in physical activity that may increase the chances of an overuse injury. Gender differences may also be considered when investigating the incidence of injuries since girls mature more quickly than boys (Caine & Mafulli, 2006:501; Caine & Mafulli, 2008:20; Caine & Maffulli, 2014:1; Popovic *et al.,* 2017:975).

- ***Participation in injury-prevention modalities***

"An ounce of prevention is worth a pound of cure."
(Benjamin Franklin, 1706-1790)

Recent research focuses more on injury-prevention strategies than on cure or treatment. The prevention or pre-rehabilitation of injuries has an inverse correlation with the incidence of injuries or the risk thereof.

According to Bahr *et al.* (2017:165), athletes can gain significantly from the ongoing research on injury-prevention strategies. Injuries that draw attention in pre-rehabilitation strategies are mostly acute knee, ankle and hamstring injuries. Bahr *et al.* (2017:165) also refer to the four-step model of Van Mechelen (1992:84) for sufficient injury prevention which is based on evidence.

Clinical research on injury prevention protocols, including different training modalities, such as (i) neuromuscular/proprioception training; (ii) biomechanical training or landing technique training; (iii) flexibility training (stretching programmes) and sufficient warm-up protocols; and (iv) strength and conditioning programmes which are designed according to the specific needs of the sport or of the player position, showed successful results (Hopper *et al.,* 2017:1173; Lopes, Simic, Myer, Ford, Hewett & Pappas, 2018:142; DeMers *et al.,* 2017:17; Hume & Steele, 2000:406; McKay *et al.,* 2014:406).

2.6. SUMMARY

A recent study by Gabbett and Whiteley (2017:54) emphasises the fact that physical preparation should ideally adequately prepare an athlete for the appropriate demands of the competition. Furthermore, the authors suggest that athletes train for the average demands of the game and that, as a result, they are undertrained and only prepared for half of the demands, thus increasing their chances of sustaining an injury.

By evaluating the chronic effects of an acute injury on an adolescent player, it can be concluded that the injuries are sustained as a result of overuse. It can be hypothesised that the injuries occur due to players engaging in training programmes with higher intensities and volume, which goes against their internal capacity to handle these demands. In contrast, the conclusion drawn by Gabbett and Whiteley (2017:54) suggests that players may be insufficiently prepared and underconditioned compared to the demands of the game, which also increases the risk for injury. Nevertheless, it is equally important to determine how to establish whether athletes are at risk of injury.

CHAPTER 3:

RESEARCH DESIGN AND METHODOLOGY

CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

3.1. INTRODUCTION

This chapter describes the research design and methodology used in this study in order to objectively determine the incidence of injuries during local tournaments among South African youth netball players participating in competitive netball at school level and who were between the ages of fifteen and nineteen years. A further aim of this chapter is to evaluate the training modalities in the existing training programmes of these players.

In preparation for this study, literature was collected from electronic databases, such as Kovsiekat, Pubmed, EbscoHost and ScienceDirect, as well as relevant academic journals and textbooks, all of which were used to inform the methodological considerations. A questionnaire/survey was used to collect data pertaining to all the injuries sustained by the netball players, as well as information on their training programme format at the tournament. The data collection process forms an integral part of the research methodology. Creswell, Hanson, Clark Plano and Morales (2007:4) describe the research methodology as the complete process followed in conducting the study. This chapter provides a thorough description of the research procedure employed in this study and how the data were gathered during the tournament, and elaborates on the quantitative nature of this research. Therefore, the research design and approach, as well as the way in which these were applied in this study are described in detail in this chapter.

3.2. RESEARCH DESIGN

An appropriate research design is an important aspect of any research process. The research design forms the 'blueprint' of the study and determines the methodology used to obtain sources of information, such as participants, elements and units of analyses, to collect and analyse the data, and interpret the results (Brink *et al*., 2012). To conclude, Zikmund, Babin and Griffin (2013:21) describe a research design as "a masterplan" that explains and specifies, in detail, the methods and procedures used for collecting and analysing all the information and data needed for the research project.

A quantitative, cross-sectional research design was used to determine the incidence of injuries among junior u/15-u/19 netball players in South Africa during match time.

3.2.1. Definitions

An injury is defined as any physical complaint from the player during a netball match or practice session which forces the player to receive medical attention. Exposure is defined as the amount of match time before the injury occurred. These definitions are similar to those presented in the consensus statements for epidemiological studies in rugby and football injuries (Fuller *et al*., 2006; Fuller *et al*., 2007).

3.2.2. Participants

Thomas, Nelson and Silverman (2015: 101) define a population as a larger group (for example, junior netball players) from which a sample is taken. Alternatively, it refers to the entire group of people, events, or things of interest that the researcher wishes to investigate. The current study made use of a convenience sample. This was done once permission to conduct the research was obtained from Netball South Africa (see Appendix K), as well as from the coordinators of the tournaments and the Department of Education. Permission was also obtained from the head coaches of all the netball teams that participated in the local tournaments, and assent was sought from the injured players. The study aimed to determine

the incidence of injuries during local tournaments among South African youth netball players participating in competitive netball at school level and who were between the ages of 15 and 19 years. A further aim of this study was to evaluate the training modalities in the existing training programmes of these players.

A total of 560 players were included in the study. These included 220 u/15 players, 220 u/16 players and 120 u/19 players. The u/15 and u/16 players played a total of 71 games per age group whereas the u/19 players played a total of 36 games. A total of 178 games were played among the three age groups, comprising 560 participants. Only injured players completed the questionnaire. Therefore, the incidence of injury per playing hours could be determined. The teams that were approached in the study included:

School Teams:

- Diamantveld High School Netball Team (u/14-u/19);
- AHMS High School Netball Team (u/14-u/19);
- Waterkloof High School Netball Team (u/14-u/19);
- Wilderklawer Invitational Netball Team (u/14-u/19);
- Sentraal High School Netball Team (u/14-u/19);
- Potch Gymnasium High School Netball Team (u/14-u/19);
- Ben Vorster High School Netball Team (u/14-u/19);
- Rustenburg High School Netball Team (u/14-u/19);
- Stellenberg High School Netball Team (u/14-u/19);
- Paarl Gimnasium High School Netball Team (u/14-u/19);
- Paarl Girls High Netball Team (u/14-u/19);
- HTS Middelburg Netball Team (u/14-u/19); and
- Menlopark High School Netball Team (u/14-u/19).

Provincial Teams:

- Gauteng Provincial Netball Team (u/14-u/19);
- Western Cape Provincial Netball Team (u/14-u/19);
- Free State Provincial Netball Team (u/14-u/19);
- Kwazulu-Natal Provincial Netball Team (u/14-u/19);
- Western Cape Provincial Netball Team (u/14-u/19);
- Namibia National Netball Team (u/14-u/19);
- North West Provincial Netball Team (u/14-u/19);
- Northern Cape Provincial Netball Team (u/14-u/19);
- Mpumalanga Provincial Netball Team (u/14-u/19);
- Eastern Cape Provincial Netball Team (u/14-u/19); and
- Limpopo Provincial Netball Team (u/14-u/19).

3.2.2.1. Inclusion criteria

The participants had to be between 15 and 18 years of age and had to participate in competitive school tournaments. In order to complete the questionnaire, the participants had to have sustained an injury during a match of the tournament and which required medical assistance. The participants also had to be able to speak Afrikaans or English.

3.2.2.2. Exclusion criteria

Participants who were not between the ages of 15 and 18 were excluded from the study. In addition, potential participants who had sustained an injury and needed medical attention during an activity other than a netball match were also not included. Players injured during practices or cooldown were also excluded from the study.

3.2.2.3. Withdrawal of participants

Prior to participating in the study, each participant was asked to read an information sheet (see Appendix B) and to sign an assent form (see Appendix C). The researcher also explained to the participants that they would not be penalised in any way if they did not participate in the study. The subjects were informed of their right to voluntarily give consent to participate, as well as their right to withdraw participation at any time.

3.3. DATA COLLECTION

A questionnaire/survey was used to collect data pertaining to all injuries and to collect information on the format of the participants' training programme during the tournament. After examining various injury surveillance questionnaires and definitions of injuries, the questionnaire was designed based on the questionnaire of the Rugby Injury Consensus Group which is used to monitor the epidemiology of rugby injuries (Orchard, Newman, Stretch, Frost, Mansingh & Leipus, 2005:22; Fuller *et al*., 2006:193; Fuller *et al*., 2007:328; Pluim *et al*., 2009:893). The questionnaire was adapted by the researcher to address the aims of this study and to standardise the definition of injury.

A section on training history was also included to examine the use of evidence-based preventative training modalities. This section consisted of five training modalities, namely core stability, flexibility, proprioceptive exercises, neuro-muscular control, and biomechanics (improved landing technique). Each player was asked to indicate the number and duration of sessions per week spent on these training modalities. Coaches and medical staff received instructions on how to complete the questionnaire and completed questionnaires were gathered at the end of each day at the tournament. A summary of the number of sessions was then compiled. The applicable terminology and definitions of training sessions are explained below:

- **Core session:** the ability to control the position and motion of the lumbo-pelvic hip complex to allow optimum production, transfer and control of force and motion to the

terminal segment in integrated kinetic chain activities (Kibler, Press & Sciascia, 2006:191; Prentice, 2015:125).

- **Plyometric (jumping and landing) session:** quick, powerful movements involving pre-stretching muscle and activating stretch-shortening cycle for stronger concentric contraction; a combination of speed and strength (topendsports.com).

- **Flexibility session:** the capacity of a joint or muscle to move through its full non-restricted pain-free range of motion (topendsports.com).

- **Proprioception and balance:** the ability to sense stimuli arising within the body regarding position, motion, and equilibrium (medicinenet.com). The objective of these activities is to re-focus the players' awareness of peripheral sensations and process these signals into more coordinated motor strategies.

- **Biomechanics (improve landing technique):** the science that applies laws of physics and mechanics to human movement and performance. Biomechanical knowledge enhances performance by using movement science in athletic preparation. Biomechanical knowledge is obtained by observation, measurement and simulation studies (Wood, 2010).

Permission was granted by the coordinators of the tournaments, Netball South Africa and the Department of Education before the research was conducted. Ethical clearance was also obtained from the Ethics Committee of the University of the Free State before the study commenced (HSREC 115/2016).

The first part of the questionnaire asked about personal and demographic information while the second part asked about the specific details of the injury. Questions were only posed to injured players. Team managers, coaches and medical staff were instructed on how to complete the questionnaire to enable illiterate participants and those who were uncomfortable with the chosen language of the questionnaires to complete the survey

without discrimination or lack of understanding. According to Neuman (2012:195), discrimination and lack of understanding yield answers that are meaningless which, in turn, negatively influence the validity and reliability of the study. Team managers and medical staff were also responsible for ensuring that each injured player answered the questions on the questionnaire and were assisted by the primary researcher. The primary questionnaire supervisor of each team was trained by the primary researcher to ensure that they and the injured players understood the meaning of each question. In the event of uncertainty, the primary researcher was called for assistance.

The completed questionnaires were collected daily at a scheduled meeting for managers at the adjournment of each day's play. In this way, reasonable measures were put in place to ensure that all data on injuries sustained at these tournaments were collected in accordance with the accepted method of data collection specified by Langeveld *et al*. (2012:89), Hopper (1986) and Hopper *et al*. (1995). Players were asked to complete the questionnaire directly after the injury had been treated to avoid a low response rate which often occurs when questionnaires are handed out to participants who are expected to hand these in afterwards (Neuman, 2012:195). Figure 5 below provides a schematic illustration of the data collection process.

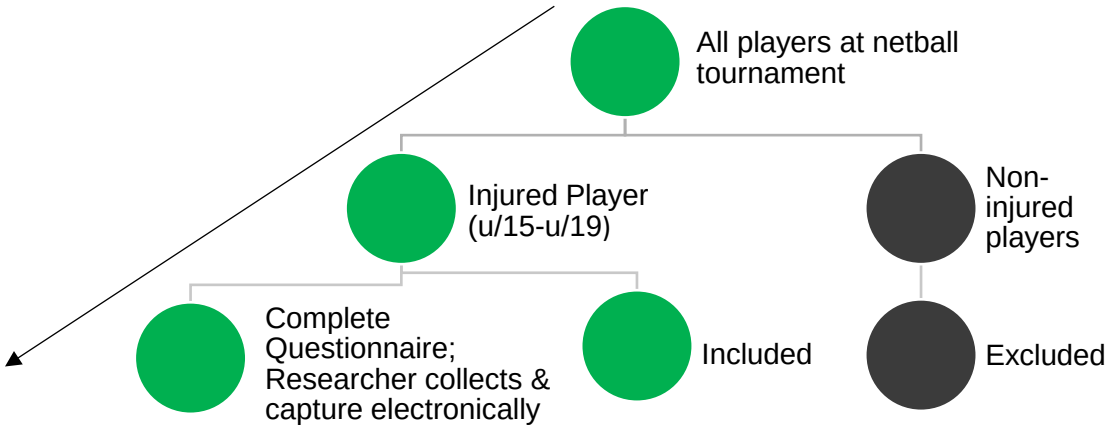

Figure 5: Schematic representation of the data collection procedure

As outlined in the inclusion and exclusion criteria used in the study, only injured players completed the questionnaire pertaining to the event of injury.

3.4. RELIABILITY AND VALIDITY

Bless, Higson-Smith and Sithole (2013:222) define reliability as "the degree to which the instrument produces equivalent results for repeated trials". As previously mentioned, to improve reliability, the inclusion criteria stated that participants had to be able to speak Afrikaans or English. Furthermore, reliability is improved by formulating and explaining the questions in a language that is easily understood. The questionnaire was also based on an in-depth literature review as well as questionnaires used in previous, similar studies (Orchard *et al*., 2005:22; Fuller *et al*., 2006:193; Fuller *et al*., 2007:328; Pluim *et al*., 2009:893, Langeveld *et al*., 2012:89). To further improve the validity of the main study, a pilot study was also conducted.

3.5. PILOT STUDY

According to Thomas, Nelson and Silverman (2011:278), it is critical to conduct a pilot study when using a survey. The pilot study included netball players, competing in the high school league competition. The study was conducted at two school league matches in the Northern Cape region. These matches included four different local netball teams, each of which consisted of ten team members. Players only participated in the study if they had sustained an injury during these matches.

The aim of the pilot study was explained to the participants and none of the results were included in the main study. This gave the researcher insight into practical aspects regarding the study, for example whether there were any general questions or uncertainties pertaining to the questionnaire, and the amount of time needed by the players to complete the questionnaire. This was done to ensure effective time management during the actual study.

3.6. METHODOLOGICAL ERRORS

The researcher attempted to minimise the methodological errors of this study by providing the participants with a standardised description and explanation of the questionnaire and how to complete it. The researcher then collected and filed all the completed questionnaires. Subsequently, the data were recorded on a standardised Excel Spreadsheet at the end of each day.

Random methodological errors that could occur included players not completing all the relative questions, which influenced the quantity of a certain variable in the analysis of the data. However, the researcher was experienced in the field of practice as a biokineticist and coach.

3.7. STATISTICAL ANALYSIS AND INTERPRETATION OF THE DATA

All data were captured electronically using Microsoft Excel 2007. The SAS version 9.1.3 statistical software was used for further analysis of the data. Numerical data were summarises using descriptive statistics (mean, standard deviations, medians, minimum, maximum). Frequencies and percentages were calculated for categorical data.
The following incidence rate for injuries were calculated per age group:

- Injuries/(playing hour)=(number of injuries)/[0.75*(number of games)x14]
- Injuries/(1000 playing hours)=1000 x Injuries/(playing hour)

3.8. ETHICAL CONSIDERATIONS

Marczyk, DeMatteo and Festiger (2005:65) explain that all studies involving human participants entail some degree of risk. The risks can range from minor discomfort to embarrassment. The researcher took these risks into consideration in order to prevent an ethical dilemma from arising as a result of placing the participants at risk in the name of

scientific progress.

Ethical clearance was obtained from the Ethics Committee of the Faculty of Health Sciences at the University of the Free State (see Appendix E). Additional permission was obtained from the South African School Netball Association and the Department of Education. Conducting research requires responsibility, honesty and integrity in order to protect the rights of the participants. To render the study ethical, the rights to self-determination, anonymity, confidentiality and informed consent were observed. Therefore, the information provided by the participants was handled with strict confidentiality. The primary researcher assisted the players in completing the questionnaires and immediately filed these in order to keep all documentation safe. The questionnaires were also coded to ensure anonymity and confidentiality.

The participants signed an agreement to participate voluntarily in the study. The details and information pertaining to the study were explained to them and their parents in an information sheet in the language of their choice (see Appendix B). The participants used in this study were minors and were therefore required to complete the informed consent form together with their parents (see Appendix C). It was explained to the participants that they would not be penalised in any way if they did not participate in the study. The subjects were informed of their right to give voluntary consent to participate, as well as of their right to withdraw participation at any time.

The letter of informed consent explained what the research entailed, what the participants could expect and the responsibilities of the researcher, in addition to providing them with her contact details.

CHAPTER 4

RESULTS

CHAPTER 4

RESULTS

4.1. INTRODUCTION

Frisch *et al*. (2009:95) mention that sports injuries among the youth is a big problem and health issue not only in South Africa but globally as well, and add that effective preventions by the health professions must be implemented.

4.2. DEMOGRAPHIC INFORMATION OF PARTICIPANTS

The study included participants between the ages of 15 and 19, participating in two of the top-rated tournaments in South Africa. Players from various provinces, as outlined in Chapter 3, participated in the study. This helped to enhance the validity and reliability of the data seeing that the selected sample represented the larger population.

4.2.1. Number of Participants and Games Analysed

The study included 560 players. This total comprised 220 u/15 players, 220 u/16 players and 120 u/19 players. The u/15 and u/16 players played a total of 71 games per age group, while the u/19 players played a total of 36 games. A total of 178 games were played among the three age groups.

4.3. INCIDENCE OF INJURIES

A total of 560 players were included in the study and consisted of 220 u/15 players, 220 u/16 players and 120 u/19 players. The u/15 and u/16 players played a total of 71 games per age group, and the u/19 players a total of 36 games. A total of 178 games were played among the three age groups. A total of 46 injuries were reported at the two tournaments. Seventeen (17; 37%) of the injuries were reported by the u/15 group, 20 (43%) by the u/16 group and 9 (20%) by the u/19 group. Of the 46 reported injuries, 42 (91%) occurred during the match and only 4 (9%) during practice sessions. Fifty seven percent 26 (57%) of the injuries were acute injuries and 20 (43%) happened to be re-injuries. Of these injuries, 27 (59%) incidences occurred due to contact with another player whereas 19 (41%) were non-contact injuries. The injury rate for the u/15 players was calculated at 23 injuries per 1 000 playing hours, 27 for the u/16s and 24 for the u/19s.

4.4. INCIDENCE RATES

To compare the available literature on the incidence of injuries, the data were analysed and converted to the number of injuries per 1 000 playing hours. The results showed an injury rate of 23 injuries per 1 000 playing hours in the u/15 age group, 27 injuries per 1 000 playing hours in the u/16 age group and 24 injuries per 1 000 playing hours among the u/19s.

4.5. ANATOMICAL SITE OF INJURIES

Figure 6 shows the proportion of injuries by anatomical site for the total sample (all three age groups combined). Most of the injuries were knee injuries (14; 30.4%), followed by the ankle joint (13; 28.3%), lower leg (4; 8.7%), and wrist, lower back and posterior thigh, with 3; 6.5% respectively. The incidence of injuries sustained to the elbow, hand, fingers, groin, feet and ribs were the lowest, with 1; 2.2% respectively.

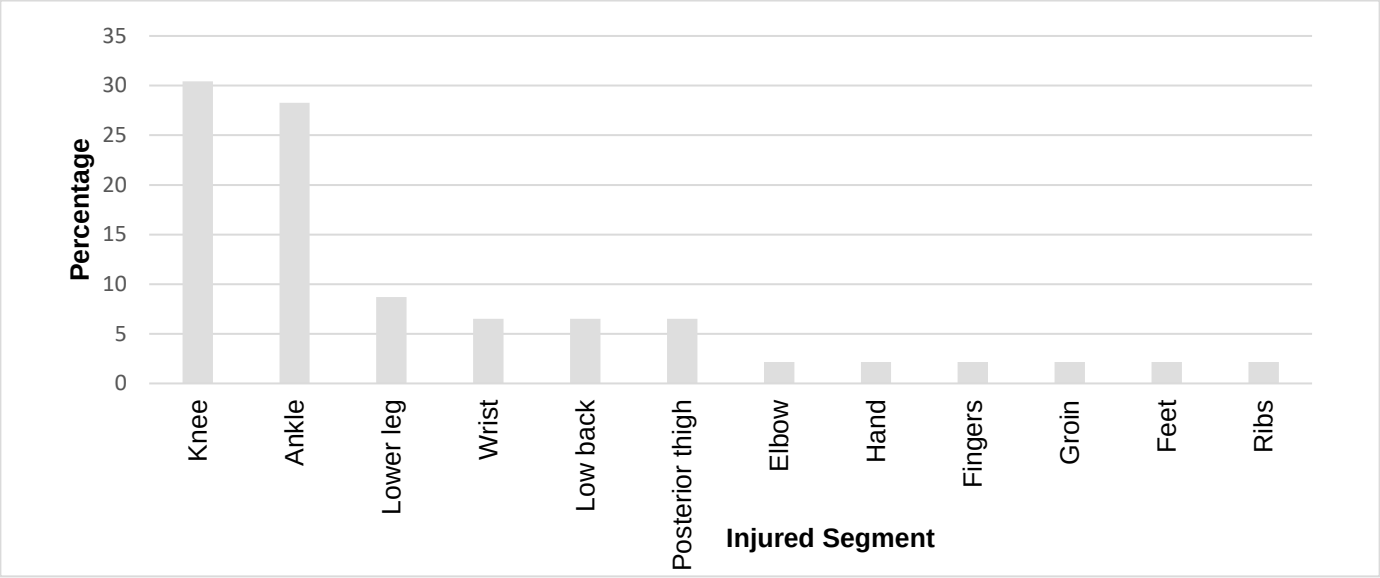

Figure 6: Anatomical site of injuries in junior netball players in South Africa

Similar, to Figure 6, Figure 7 shows the proportion of injuries by anatomical site, but now separately for the three age groups, namely u/15, u/16 and u/19. For the u/15s, the most-injured segment was the ankle (6; 35.3%), followed by the knee (3; 17.7%), wrist (2; 11.8%) and lower leg (2; 11.8%). In contrast, the u/16 players showed a higher incidence of injuries of the knee (7; 35%), followed by the ankle (4; 20%), lower back, posterior thigh and lower leg, with an equally reported incidence of 2; 10%. Only a few injuries of the wrist, elbow and groin (1; 5%) were reported. Again, in the u/19 players, the knee (4; 44.4%) was the most-injured anatomical site, followed by the ankle (3; 33.3%). Lastly, the incidence of injury to the posterior thigh and an unexpected case of injuries to the ribs (1; 11.1%) of these players were also reported.

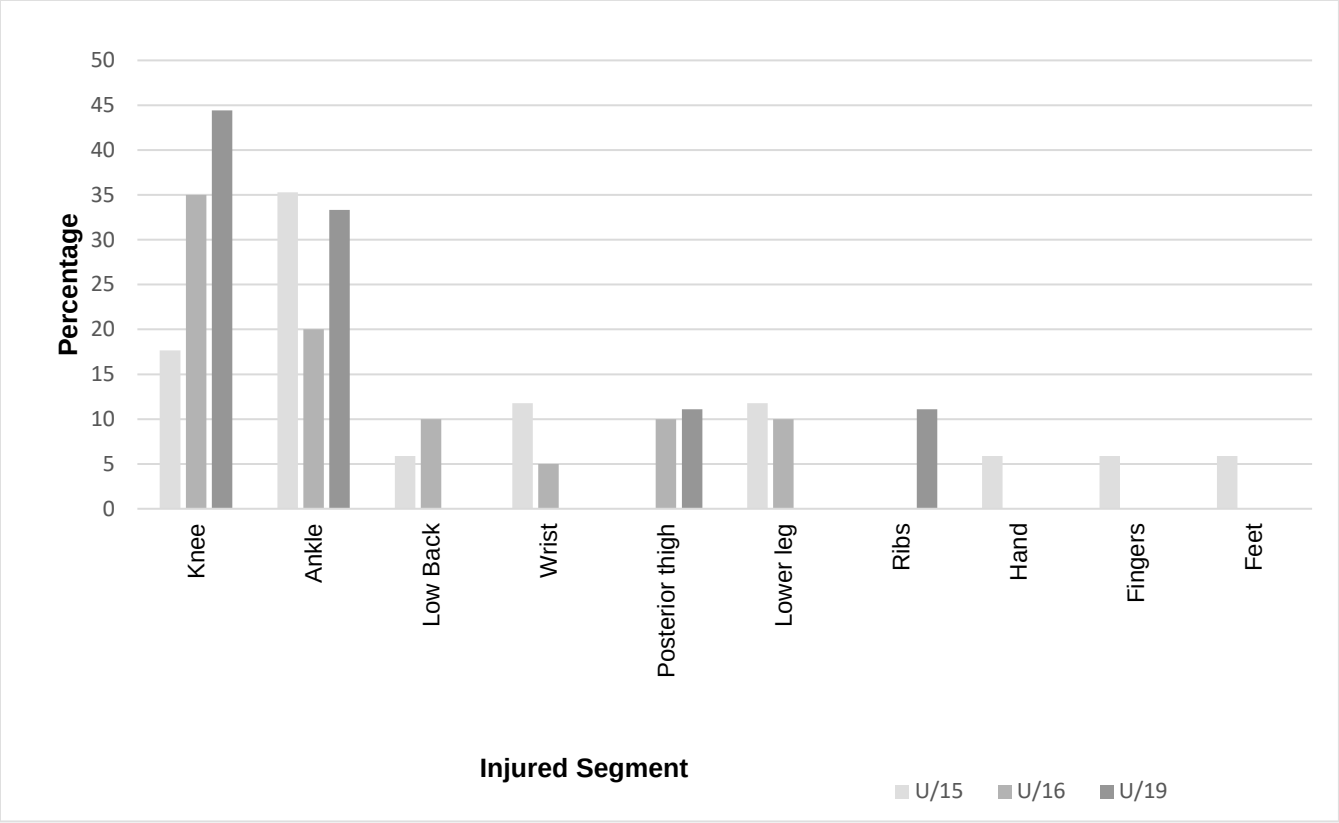

Figure 7: Anatomical site of injury per age group

4.6. INJURY TYPE

The types of injuries by age group are shown in Figure 8. For both the u/15 and u/19 groups, the most prevalent injuries were classified as ligamentous injuries whereas the u/16 group reported a higher incidence of injuries to muscular structures than secondary musculature structures. Muscle injuries, lacerations and other types of injuries not specified were the second-most prevalent type of injury among the u/15s. Lacerations, tendon injury and meniscus/cartilage injuries were equally reported in incidence after ligamentous injuries in the u/19 players. Dislocations were only reported by the u/15s.

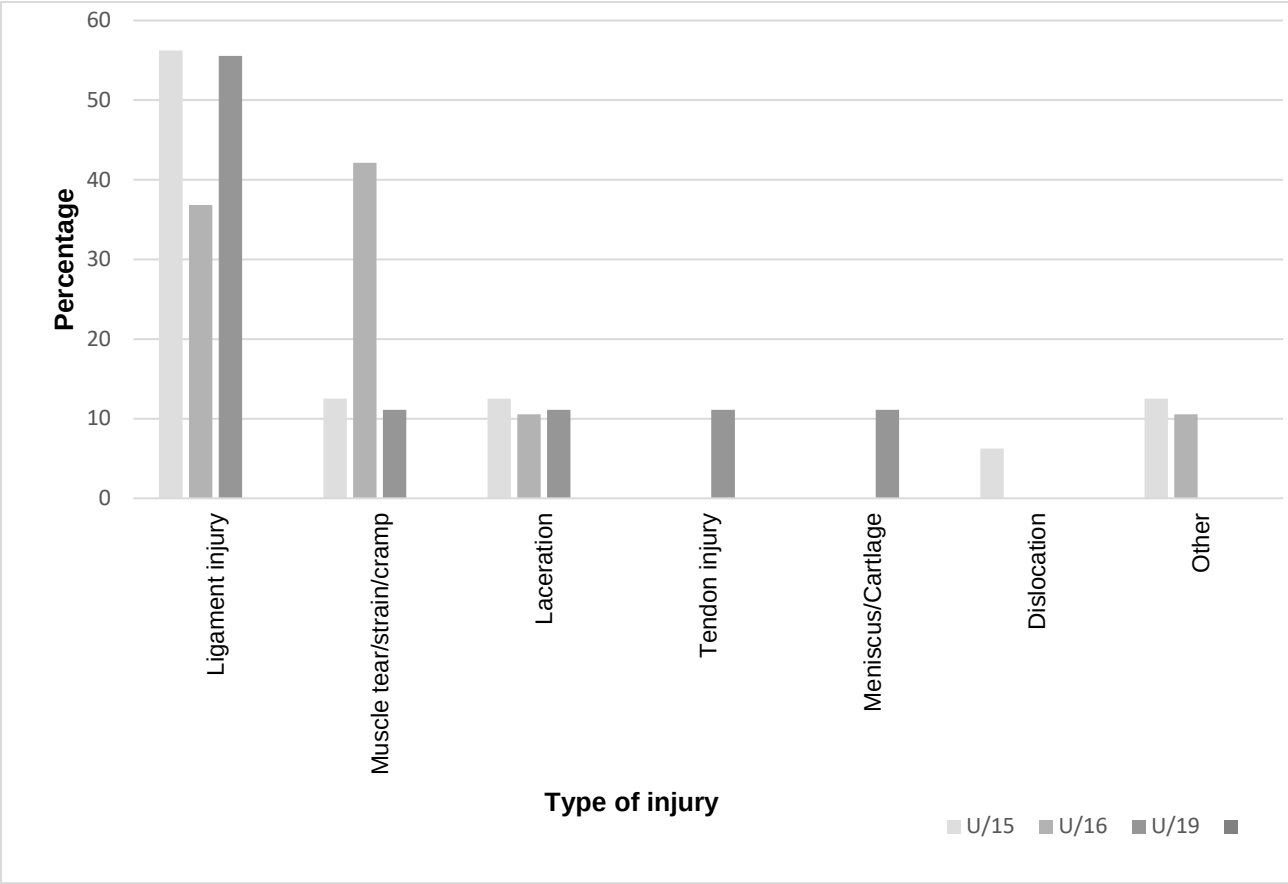

Figure 8: Most common structure injured

4.7. PLAYER POSITION

Figure 9 shows the proportion of injuries by player position. There was an overall higher incidence of injuries sustained by the GA (11; 25%), followed by the WA and GD (8; 18.2%), compared to those reported by the GS, C and WD players (5; 11.4%). It is evident from Figure 9 that in this study, the GKs (2; 4.6%) were the least affected by injury, and that their probability of sustaining an injury is significantly lower compared to that of the GA, WA and GD.

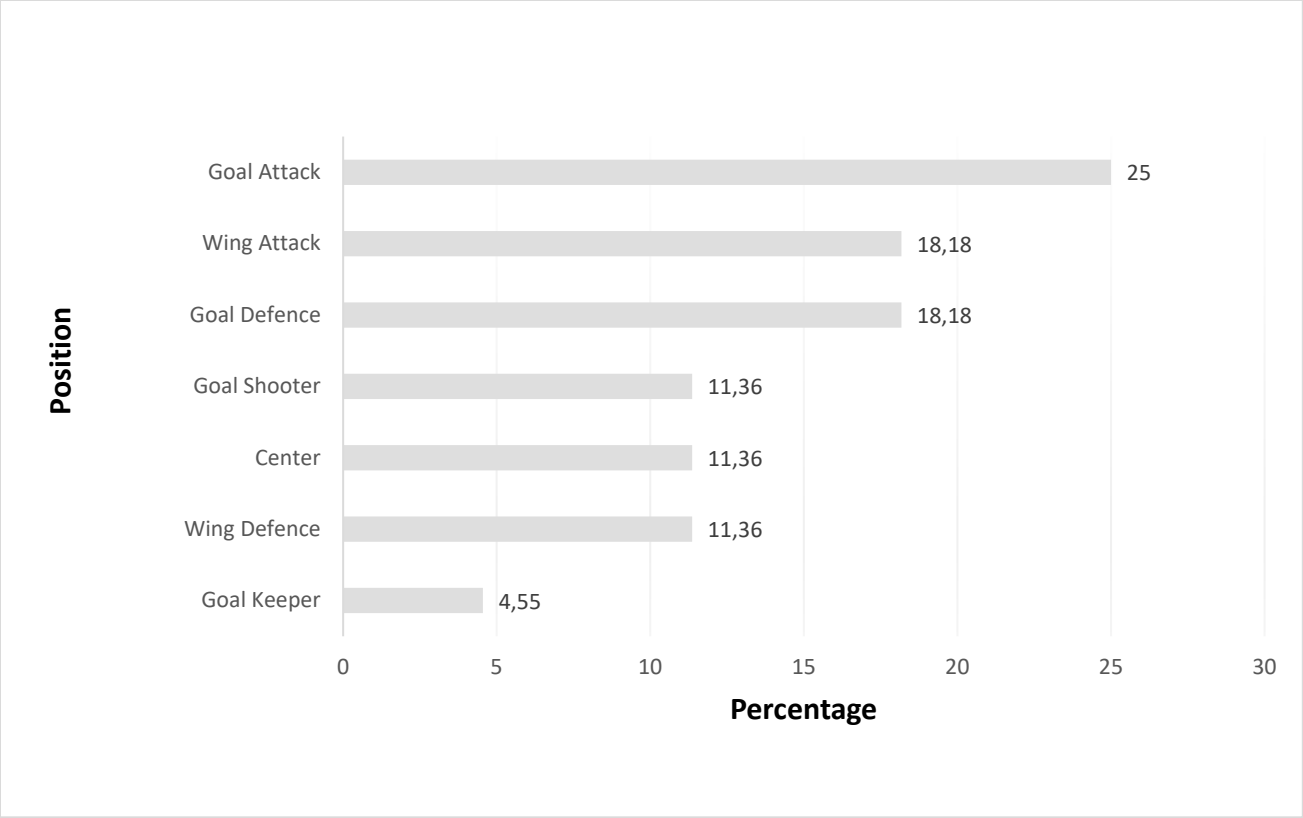

Figure 9: Injuries according to player position

4.8. TIME OF PLAY

In order to evaluate whether fatigue during a match was a possible cause of injury, the time of play was noted, as illustrated in Figure 10. The majority of the injuries sustained by the u/15 and u/16 players occurred within the first 30 minutes of play. A high incidence within the first ten minutes was reported respectively (7; 46.7% & 8; 50%), with a decline in the second quarter, and reaching a peak in the third quarter of the match amongst the u/15 group (8; 53.3%).

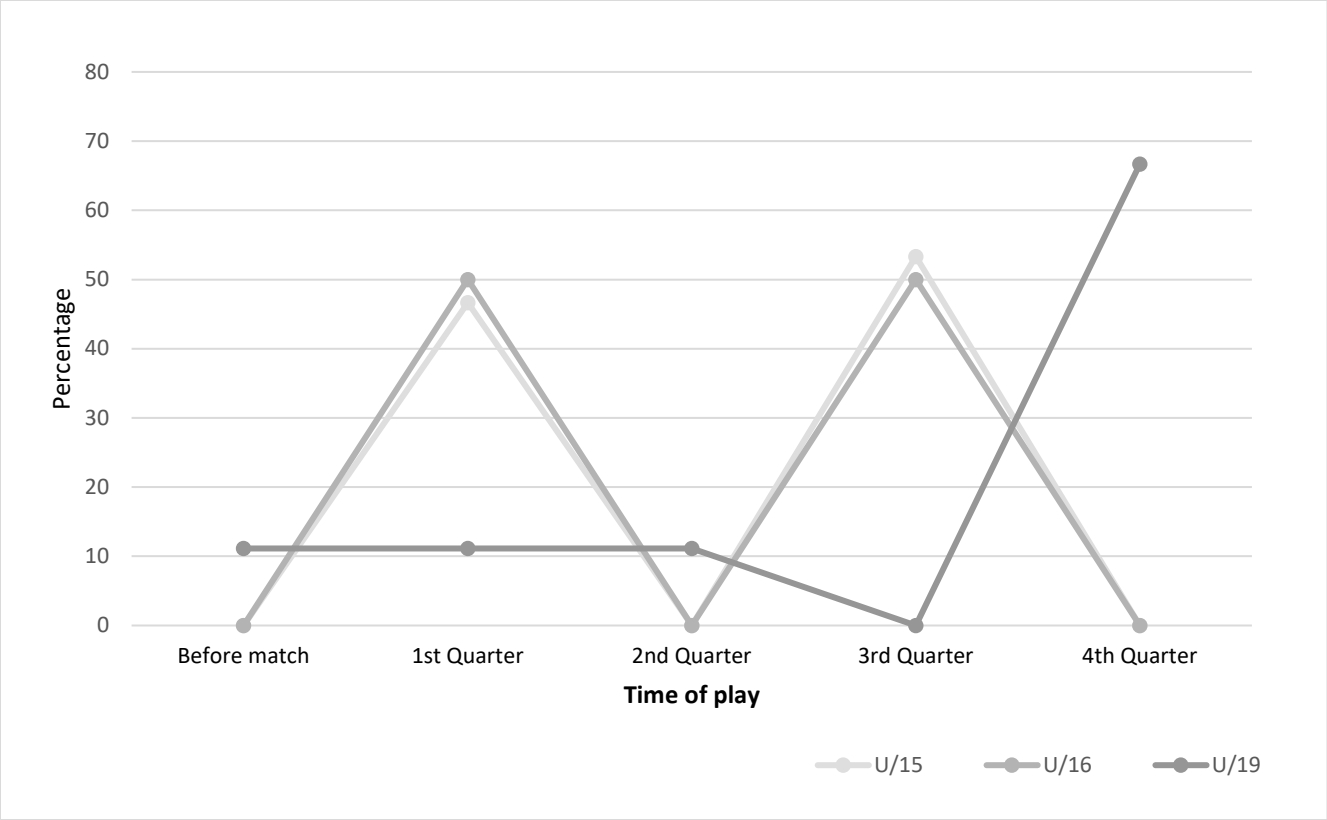

Figure 10: Time of injury

4.9. TRAINING HABITS OF NETBALL PLAYERS

Finally, the research set out to provide possible answers to the questions pertaining to the efficiency and validity of the existing training programmes of junior netball teams in South Africa. In order to achieve the last objective of the study, namely evaluating the existing training programmes of these players, the information provided by the players is summarised in Table 6 below. Table 6 indicates the average number of sessions per week and the average duration of the different training modalities, which are critical to the prevention of injuries.

Table 6: Average number of sessions spent on injury-prevention training modalities per week

Training Modality	Average number of sessions per week	Average duration per session
Biomechanics	2	24 minutes
Core	2	32 minutes
Flexibility	4	23 minutes
Proprioception	2	19 minutes

CHAPTER 5:

DISCUSSION OF RESULTS

CHAPTER 5
DISCUSSION OF RESULTS

5.1. INTRODUCTION

A total of 560 players were included in this study and consisted of 220 u/15 players, 220 u/16 players, and 120 u/19 players. The u/15 and u/16 players played a total of 71 games per age group, while the u/19 players played a total of 36 games. A total of 178 games were played among the three age groups.

5.2. THE INCIDENCE OF INJURIES IN JUNIOR PLAYERS

A total of 46 injuries were reported at the two tournaments. 17 (37%) of the injuries were reported by the u/15 group, 20 (43%) by the u/16 group and 9 (20%) by the u/19 group. Of the 46 reported injuries, 42 (91%) occurred during the match, and 4 (9%) during practice sessions. Twenty six (26; 57%) of the injuries were acute injuries, and 20 (43%) incidences were noted to be re-injuries. Of these injuries, 27 (59%) occurred due to contact with another player whereas 19 (41%) were non-contact injuries.

Furthermore, to compare the available literature on the incidence of injuries, the data were analysed and converted to the number of injuries per 1 000 playing hours. The results showed an injury rate of 23 injuries per 1 000 playing hours in the u/15 age group, 27 injuries per 1 000 playing hours in the u/16 age group and 24 injuries per 1 000 playing hours among the u/19s.

It must be noted that the u/15 and u/16 players played a total of 71 games per age group while the u/19 players played a total of 36 games. A total of 178 games were played by the three age groups, collectively consisting of a total of 560 participants. A total of 46 injuries

were reported at the two tournaments where 37% of the injuries were reported by the u/15 group, 43% by the u/16 group and 20% by the u/19 group, respectively.

The injury rate of the u/15, u/16 and u/19 age groups is notably higher than that reported in the study conducted by McLaughlin *et al.* (2004:15), who reported 11.3 injuries per 1 000 playing hours. Comparable to the results of this study, Hume and Steele (2000:406) recorded a total of 23.8 injuries per 1 000 playing hours in a population with a mean age of 18.4 ±4.4 years, also rendered at a three-day competitive tournament. Thus, the study by Hume and Steele (2000:406) is more relevant to the findings of the present study, particularly since McLaughlin *et al*. (2004:15) focused on an entire competitive season that included injuries sustained during practice rather than only those occurring during match time at tournaments.

Subsequently, it can be hypothesised that to compare the findings of the present study with those documented in the relevant literature, it is critical to reproduce a standard methodological approach to determining the incidence of injuries to make valid and reliable comparisons. Most of the research available on the epidemiology of injuries in South African netball focuses on elite and senior participants or uses a methodological approach to evaluate injury occurrence in an entire netball season. Consequently, this affects the results compared to those obtained by means of a methodological approach which only records the incidence of injuries during match time and competitive play.

On an amateur level of play in the UK, a total of 5.72 injuries per 1 000 hours were reported by Partner, Upsall and Francis (2018). This injury rate is significantly lower than that reported in this study. Again, this could be due to the difference in the sample used as the researcher focused on junior, competitive players. Consequently, increasing the level of competitiveness increases the physical demands and load on the body on an immature skeletal structure. If this is true, this could explain the higher occurrence of injuries reported in another South African study on the epidemiology of injuries in elite netball players, which reported a significant injury rate of 32.8 injuries per 1 000 playing hours (Langeveld *et al.,* 2012:83). Conversely, a study conducted in Australia reported only 14 injuries per 1 000

playing hours (Pillay & Frantz, 2012:7). Both McManus *et al.* (2006:119) and McLaughlin *et al*. (2004:16) also found a total number of 14 injuries per 1000 playing hours during a competitive netball season.

A more recent study by Attenborough and Hiller (2017:31) recorded a total of 6.75 injuries during match time among participants at the University of Sydney, Australia with a mean age of 21.5 +-6.3 years. This study showed a much lower incidence of injuries compared to those above.

The difference in injuries per playing hours may be due to the different methodological approaches in the studies compared but can also reflect the level of professionalism and differences in training programmes as Australia invests a great deal of time in evidence-based prevention and rehabilitation programmes in netball. The difference in socio-economic status of the countries compared could also have a significant impact because of the limited finances in developing countries such as South Africa. This could affect not only the hiring of qualified and experienced coaching staff, but could also have financial implications for players seeking effective medical treatment for injuries. Furthermore, this may have an impact on the limitation and prevention of re-injuries. Hence, there is an insufficient amount of available research with similar methodological approaches and related age groups to make a reliable comparison with regard to the methodology and inclusion criteria.

The aim of the study was achieved by determining the incidence of injuries in junior netball players in competitive tournaments. The results showed a total of 24.7 injuries per 1 000 playing hours. While research using a similar methodology and population is limited, the results of this study are in line with those of other, similar studies, as previously discussed. Although this research adds value to this specific field of research, further studies are of critical importance in terms of increasing the quantity of data, therefore improving the quality and value of recommendations regarding training programmes for junior netball players. It is recommended that future research focus on junior netball players during competitive play to make valuable and useful evidence-based recommendations regarding preventative and

therapeutic measures to be implemented in the training programmes of these players. Although the design of this study did not allow the researcher to evaluate the perceptions of coaches regarding the different training modalities, it does provide valuable information that can be used to assess their knowledge on injury-prevention programmes. The evaluation of existing programmes is not significant, resulting in a gap in the literature. Therefore, it is recommended that future research focus on this aspect. Of the 46 reported injuries, 91% occurred during match time whereas only 9% happened during practice or warm-up sessions. Acute injuries accumulated to 57% and it is important to note that 43% of the reported injuries were re-injuries.

There is no significant difference between the number of contact injuries (59%) versus non-contact injuries (41%). Although this difference is unsubstantial, the number of injuries due to contact is unexpectedly high when referring to the rules of netball, one of which stipulates that contact with another player is prohibited:

> Contact: No player may accidentally or deliberately physically contact an opponent if it hinders that person's play. Like the obstruction call, if a player is called for contact, they must stand down while the penalty pass (or shot) is taken (Wilcox, 2011).

5.3. ANATOMICAL SITE OF INJURIES

The prevalence of the anatomical site of the average sustained injuries among the three age groups as outlined in Figure 6 shows that most injuries were knee injuries (30.4%), followed by the ankle joint (28.3%), lower leg (8.7%), and wrist, lower back and posterior thigh with 6.5%, respectively. The incidence of injuries sustained to the elbow, hand, fingers, groin, feet, and ribs was the lowest, with 2.2%, respectively.

Despite the inconsistency of findings in previous research on the less prevalent injured segments, the majority of the research reported a significantly high incidence of knee and ankle injuries, which were rated as either the highest or second-highest injured anatomical

sites (Hopper *et al.,* 1995:16; McLaughlin *et al.,* 2004:16; Langeveld *et al.,* 2012:83; Pillay & Frantz, 2012:7).

Furthermore, the results pertaining to the anatomical sites injured in the three age groups in this study, namely u/15, u/16 and u/19 were as follows: The u/15 players' most-injured segment was the ankle (35.3%), followed by the knee (17.7%), wrist (11.8%) and lower leg (11.8%). On the contrary, the u/16 players showed a higher incidence of injuries of the knee (35%), followed by the ankle (20%), lower back, posterior thigh and lower leg with an equally-reported incidence (10%), whereas a lower incidence of injuries in the wrist, elbow, and groin (5%) were reported. Conversely, the u/19 players reported that the knee (44.4%) was the most-injured anatomical site, followed by the ankle (33.3%). Lastly, the incidence of injury to the posterior thigh and an unexpected case of injuries to the ribs (11.1%) of these players were reported (see Figure 6).

In accordance with the majority of the literature, this research also found that injury to the knee contributed to the highest number of injuries during match time, which accumulated to a total of 30.4% of all injuries recorded, followed by the ankle joint with a total of 28.3% of all injuries. Although knee and ankle injuries were significantly high compared to other injuries reported, the lower leg contributed to 8.7% of the injuries, while the wrist, lower back, and posterior thigh represented 6.5% of reported injuries. The incidence of injuries sustained to the elbow, hand, fingers, groin, feet, and ribs was the lowest, with 2.2%, respectively.

To conclude, the ankle and knee joints are the most commonly injured segments. Therefore, research should focus on preventative modalities that target the knee and ankle in injury-prevention programmes. Training programmes must be implemented to address the shortcomings of players that could be possible risk factors for sustaining an injury.

5.4. INJURED STRUCTURES

The types of injuries sustained by participants are categorised according to age group in Figure 7. For both the u/15 and u/19 groups, the most prevalent injuries were classified as

ligamentous injuries, whereas the u/16 group reported a higher incidence of injuries to muscular structures than to secondary musculature structures. Muscle injuries, lacerations and other types of injuries not specified were the second-most prevalent types of injury among the u/15s. Equal numbers of lacerations, tendon injuries and meniscus/cartilage injuries were reported after ligamentous injuries in the u/19 players. Interestingly, dislocations were only reported by the u/15 players. A limited number of studies provide information on the specific structures injured, and focus, instead, on the overall anatomical structures.

5.5. THE INCIDENCE OF INJURIES FOR EACH PLAYER POSITION

Figure 9 indicates that overall there was a higher incidence of injuries sustained by the GA (25%), followed by the WA and GD (18.2%), compared to those reported by the GS, C and WD players (11.4%). It is evident from Figure 9 that in this study, GKs were the least affected by injury and that the probability of sustaining an injury is significantly lower than that of the GA, WA and GD.

An evaluation of the physical demands associated with each player position shows that the GA is subjected to the highest cardiovascular demands, when referring to the time spent in the maximum HR zone (Caine *et al*., 2014:1). Furthermore, Fox *et al.* (2013:1588) conclude that midcourt positions, which include the GA, WA and GD, among others, such as the WD and the C, mostly engage in jogging, running and sprinting, which further increase their work-to-rest ratio. Increased physical demands and active rest could further increase the risk of injury. Shanmugam and Mffulli (2008:33) found that the amount of jumping was more or less consistent throughout the team. If this is true, the players who spent more time jogging, running and sprinting engage in jumping activities in fast-moving patterns. Consequently, this increases their risk of injury when attempting a jump seeing that this is the most reported cause of injury compared to players who jump from a static position.

However, when comparing the incidence of injuries associated with each player position to the demands of the various positions, it becomes evident that the higher the requirements,

the higher the risk of injury. Therefore, it can be confirmed that training programmes should focus on the individualised demands of the different playing positions.

5.6. TIME OF PLAY WHEN THE INJURY OCCURRED

As illustrated in Figure 9, the time of play was noted to evaluate whether fatigue during a match could be a possible mechanism of injury. Most of the injuries among the u/15 and u/16 players occurred within the first 30 minutes of the game. A high incidence of injuries was reported within the first ten minutes, with a decline in the second quarter and reaching a peak in the third quarter of the match. The latter is consistent with the findings of Langeveld *et al.* (2012:83). Conversely, the majority of injuries in the u/19 group were reported in the last ten minutes of the game.

Further investigation into fatigue towards the end of the game or the lack of sufficient warm-up structures could explain this phenomenon. Injuries during the last third could also be attributed to higher intensity brought about by a stronger motivation to win by attacking or defending. Although this has not been established scientifically, it can only be hypothesised. Few literature studies indicate the time of, and reasons for, injury during play.

5.7. TRAINING HABITS OF NETBALL PLAYERS

The research set out to provide possible answers to the questions pertaining to the efficiency and validity of the existing training programmes of junior netball teams in South Africa. To achieve the final objective of the study, namely to evaluate the existing training programmes of these players, the average number of sessions per week as well as the average duration of the various training modalities, which are considered critical to injury prevention, were determined (see Table 5).

Considering that injuries among young athletes may have tremendous long-term effects on growth mechanisms, preventative measurements must be put in place (Caine *et al*., 2006:501). Training programmes should focus on injury-prevention strategies and must

include age-appropriate exercises. Shanmugam and Maffulli (2008:33) state that coaches must also consider the players' physical immaturity rather than only their chronological age.

Although the main aim of this study was to determine the incidence of injuries, future research is needed to determine the effects of training modalities and appropriate sessions and duration for junior netball players since no research on an effective training programme could be found.

The feasibility of educating coaches on effective injury-prevention modalities can be determined. If coaches understand the importance of the training modalities mentioned above in preventing injuries and reducing the risk thereof, players can benefit from optimal training introduced by their coaches. The researcher recommends that future research focus on this aspect.

Limited research exists on the incidence of injuries in junior netball players in South Africa. The main finding of this study is consistent with those of previous studies which show that the highest incidence of injuries in netball players occur in the knee and ankle joints. In conclusion, the incidence of injuries in junior athletes is of great concern due to the longstanding effects on their musculoskeletal growth and development, especially in the adolescent phase. This study succeeded in highlighting the importance of the implementation and evaluation of intervention strategies, as illustrated in Figure 1, to reduce the risk and incidence of injuries in junior netball players. Furthermore, this could have a significant effect on the wellbeing of young netball players in South Africa.

5.8. LACK OF INJURY-PREVENTION MODALITIES IN CURRENT TRAINING PROGRAMMES

The researcher conducted a comprehensive analysis of the literature to further evaluate the training programmes in terms of the suggested evidence-based modalities. Firstly, a recent study by Gabbett and Whiteley (2017:50) concludes that conditioning coaches and staff responsible for the team's physical conditioning and healthcare practice in isolation does

not reflect a welcoming response and attitude regarding the prescribed training-load. These authors also observe that a reduction in injuries is closely linked to appropriate chronic load management. Research suggests that there is a fine line between too much and too little chronic loads, and that it is often difficult to determine. Therefore, a scientific analysis of the needs of the sport and athlete is required.

The information on the existing training programmes of the injured players was assessed to obtain possible answers to the questions concerning the proficiency and cogency of these training programmes of junior netball players in South Africa (see Table 6). Table 6 indicates the average sessions per week as well as the average duration of the different training modalities which are critical to the prevention of injuries. In addition, the literature reported on the use of mechanotherapy and therapeutic intervention to determine the effect of different training modalities on the reduction and prevention of netball injuries. A summary of this modality and the impact thereof follows.

- ***Neuromuscular training:***

Several studies have investigated the effect of neuromuscular training on physical performance and as an injury-prevention modality. A recent survey by Hopper *et al*. (2017:1165) confirms this. According to this study, neuromuscular training follows a holistic approach which addresses different training modalities, such as resistance and plyometric training to improve dynamic joint stability in athletes. According to various researchers (McLean, Huang & Van Den Bogert, 2005:863; Powers, 2007:1; Langeveld *et al*., 2012:89; Hoppers *et al*., 2017:1165), it is of the utmost importance for female adolescent athletes to incorporate neuromuscular training as an integral part of their training programme due to the fact that these athletes show continuous decreases in their strength and power performance, which makes them vulnerable to the risk of any injury.

The average time spent on neuromuscular training or proprioception was 19 minutes, completed in an average of two sessions per week. Nevertheless, it is critical to establish whether this is sufficient. Hopper *et al*. (2017:1165) used a six-week NMT intervention, each

week consisting of three non-consecutive days comprising of a total duration of 60 minutes per session, which showed a significant improvement in performance and which subsequently reduced the risk of injuries among these players. Similarly, balance training (NMC) proved to reduce the number of ankle injuries, especially in players with a history of this type of injury. Deficits should be addressed by means of an individualised approach to have an optimal effect on all players (Hiller & Grayson, 2017:31).

To conclude, various authors (Stasinopoulos, 2004:182; Verhagen, Van Der Beek, Twisk, Bouter, Bahr & Van Mechelen, 2004:1385; Emery, Casidy, Klassen, Rosychuk & Rowe, 2005:749; Langeveld *et al*., 2012:89; Hitler & Grayson, 2017:31; Hopper *et al.*, 2017:1165) emphasise the value of neuromuscular and proprioceptive exercise as part of the training programme since it has been proven to limit injuries to the lower extremities, especially to the ankle.

- ***Biomechanical training:***

Hopper *et al*. (1995:223) determined that improper landing techniques contribute significantly to the risk of ankle and knee injuries. To improve the landing technique of netball players, this study presented injured players with questions pertaining to the frequency and duration of their biomechanical training and technique, and specifically mentioned the preparation and correction of landing patterns.

It was found in the current study that the average amount of time spent on biomechanical training accumulated to 24 minutes per session and an average of two sessions per week. When comparing this to the average amount of time spent jumping and landing during a game, the question as to whether this training is sufficient to prepare the athlete for the imposed demands during the game arises. However, there is growing evidence that improvements in neuromuscular control (NMC) and biomechanics (improved landing technique) contribute to injury prevention (Hopper *et al*., 1995:223; McLean *et al*., 2005:863; Powers, 2007:1; Langeveld *et al*., 2012:90).

Since the focus of this research was to determine the incidence of injuries, the answer to this question could only be established by means of an in-depth analysis on whether existing training programmes focus on efficient preparation to comply with the demands of the sport during match time. There is, without a doubt, a gap in the literature, which can be closed by means of future research which could be conducted with the aim of providing valuable insight into this aspect.

Considering that injuries among young athletes may have tremendous long-term effects on growth mechanisms, preventative measurements must be put in place (Caine *et al.,* 2006:501). Training programmes should focus on injury-prevention strategies and must include age-appropriate exercises. Shanmugam and Maffulli (2008:33) state that coaches must also consider the players' physical immaturity rather than only their chronological age.

Although the main aim of this study was to determine the incidence of injuries, future research is needed to determine the effects of training modalities and appropriate sessions and duration for junior netball players since no research on an effective training programme could be found.

- ***Flexibility training:***

It must be highlighted that flexibility training is the most frequent training modality applied by coaches (four times per week, consisting of 23-minute sessions) in this study. As discussed in the literature review (Chapter 2), Attenborough and Hiller (2017:31) found that a predictor of an ankle injury is a posterior-medial reach <77% of the player's leg length, subsequently referring to a better degree of ankle mobility. Hiller and Grayson (2017:31) confirm that a decrease in the ankle dorsiflexion range of motion is said to be correlated with ankle injuries in netball players. If this is true, it is critical to implement programmes which address the mobility of the ankle. However, it is the responsibility of the coach to ensure that time is set aside to incorporate exercises that improve not only flexibility, but also core stability, NMC and biomechanics (improved landing technique), as well as proprioception in the training programme.

- ***Core training***

The literature (Kibler *et al*., 2006:189; Zazulak, Hewett, Reeves, Goldberg & Cholewicki, 2007a:1123; Zazulak, Hewett, Reeves, Goldberg & Cholewicki, 2007b:368) suggests that improvements in core stability can limit sports injuries, specifically knee injuries. As shown in Table 6, netball players only engage in two sessions lasting 32 minutes each on core training per week. This may be one of the reasons why knee injuries, in particular, are so prevalent among netball players. More core sessions could contribute to injury prevention in netball.

5.9. SUMMARY

Considering that injuries among young athletes may have tremendous long-term effects on growth mechanisms, preventative measurements must be put in place (Caine *et al*., 2006:501). Training programmes should focus on injury-prevention strategies and must include age-appropriate exercises. Shanmugam and Maffulli (2008:33) state that coaches must also take into account the players' physical immaturity rather than focusing only on their chronological age. Furthermore, as mentioned in the introduction to this study, Frisch (2009:95) concludes that certain crucial factors and modalities should be considered in the training programmes of junior players, such as the duration of sessions, training programme content, frequency and player compliance.

Hopper *et al*. (2017:1165), Langeveld *et al*. (2012:89), McLean *et al*. (2005:863), and Powers (2007:1) conclude that incorrect landing techniques are a significant contributing factor in ankle and knee injuries. To improve the landing technique of netball players, it is vital to conduct an in-depth investigation into the need for the implementation of more biomechanical (landing technique) and proprioception training.

Although the main aim of this study was to determine the incidence of injuries, future research is needed to determine the effects of training modalities, appropriate sessions and

duration for junior netball players since no research on effective training programmes could be found.

The aim of the study was achieved by determining the incidence of injuries in junior netball players in competitive tournaments. The results showed a total of 24.7 injuries per 1 000 playing hours. While research using a similar methodology and population is limited, the results of this study are in line with those of other, similar studies as previously discussed. Although this research adds significant value to this specific field of research, further studies are of critical importance in order to increase the quantity of data, therefore improving the quality and value of recommendations regarding training programmes for junior netball players. It is recommended that future research focus on junior netball players during competitive play in order to make valuable and effective evidence-based recommendations regarding preventative and therapeutic measures to be implemented in the training programmes of these players. Although the design of this study did not allow the researcher to evaluate the perceptions of coaches regarding the different training modalities, it does provide valuable information that can be used to assess their knowledge on injury prevention programmes. Therefore, there is a gap in the literature which could be closed by means of future research focusing on this aspect.

The feasibility of educating coaches on effective injury-prevention modalities can be determined. If coaches can understand the importance of the above-mentioned training modalities in preventing injuries and reducing the risk thereof, players can benefit from the introduction of optimal training by their coaches. It is recommended that future research focus on this aspect.

Limited research exists on the incidence of injuries in junior netball players in South Africa. The main finding of this study is consistent with those of previous studies in that the highest incidence of injuries in netball players are shown to be in the knee and ankle joints. In conclusion, the incidence of injuries in junior athletes is of great concern due to the longstanding effects on their musculoskeletal growth and development, especially in the adolescent phase. This study succeeded in highlighting the importance of the

implementation and evaluation of intervention strategies and measures, as illustrated in Figure 4, to reduce the risk and incidence of injuries in junior players. Furthermore, this could have a significant effect on the wellbeing of young netball players in South Africa.

CHAPTER 6:

CONCLUSION AND RECOMMENDATIONS

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1. CONCLUSIONS

The results of this study showed an injury rate of 23 injuries per 1 000 playing hours in the u/15 age group, 27 injuries per 1 000 playing hours in the u/16 age group and 24 injuries per 1 000 playing hours in the u/19 group.

Considering that injuries among young athletes may have tremendous long-term effects on growth mechanisms, preventative measurements must be put in place (Caine *et al.,* 2006:501). Shanmugam and Maffulli (2008:33) state that coaches must also take into account the players' physical immaturity rather than only their chronological age. Furthermore, as mentioned in the introduction, Frisch (2009:95) concludes that certain crucial factors and modalities should be considered in the training programmes of junior players, such as the duration of sessions, training programme content, frequency and player compliance.

Research has shown that incorrect landing techniques are a significant contributing factor in ankle and knee injuries. Seeing that these types of injuries in young athletes may have negative long-term effects on the growth and development of immature skeletal structures, the implementation of preventative measurements is critical.

To conclude, this injury surveillance study reported a high incidence of injuries among junior netball players in South Africa and reveals the factors that may be associated with them. Surprisingly, however, evidence-based preventative strategies have been found to be

underutilised. The following conclusions and recommendations are based on the results of this study:

- The majority of netball games in South Africa are played on cement surfaces as was the case in this study. Given the high injury rate on these surfaces, creative ways need to be found to reduce ground reaction forces and the resistance of footwear-surface interface. Further research in this regard may contribute greatly to the reduction of injury rates in junior netball and should be actively promoted.

- Training programmes should focus on injury-prevention strategies and must include age-appropriate exercises. In addition, coaches must consider junior netball players' physical immaturity rather than only their chronological age.

- Netball coaches must be educated on the value of improved neuro-muscular control (NMC), biomechanics, proprioception and core stability. Coaches are strategically placed to have an impact on injury rates, and to prevent recurring ankle and knee injuries.

- Future epidemiological studies will need to assess the efficacy of intervention programmes.

- If these factors are addressed and their effects monitored, a positive contribution could be made to the prevention of netball injuries.

This study reported a high incidence of injuries among junior netball players in South Africa. Furthermore, this study identified the factors associated with injuries in netball. If these factors are addressed and, most importantly, their effects monitored, a significant contribution can be made to the prevention of netball injuries in South Africa at junior level.

6.2. LIMITATIONS

A possible limitation of this study is that the exact diagnosis of the injury is unknown since a definite diagnosis could only be made once the participants had received medical care at a medical facility. Therefore, the injuries reported are a general indication of the type of injury rather than the different kinds of ligaments or specific anatomical structures.

Training programmes were evaluated subjectively based on the individual information proved by the injured players. To conduct more reliable evaluations, training programmes should, instead, be measured objectively by engaging with the conditioning coaches to obtain comprehensive and detailed information on their training programmes.

This study only focused on in-season games or match time. Therefore, the results could be different if the participants are followed for an entire season.

6.3. RECOMMENDATIONS FOR FUTURE STUDIES

Although the main aim of this study was to determine the incidence of injuries, future research is needed to determine the effects of training modalities and appropriate sessions and durations for junior netball players since no research on an effective training programme could be found.

While the population size is sufficiently large for this particular study, it is recommended that future studies make use of a larger population to increase the reliability and validity of the study.

CHAPTER 7:

REFLECTING ON THE RESEARCH PROCESS

CHAPTER 7

REFLECTING ON THE RESEARCH PROCESS

7.1. INTRODUCTION

Nelson Mandela once said that something seems impossible until it is done. However, this is something that can only be understood near the end of a journey – a journey which requires dedication and hard work; a journey that one can walk step by step to make progress towards the finish line, and in the end, this is how a marathon is finished – step by step. Although it takes an enormous amount of hard work and long hours, the personal growth and knowledge acquired in the process are worth far more than the sacrifices made.

This three-year process was most definitely a journey that I will forever be proud of and treasure. While it was most certainly a challenging experience, it was worth the effort. In the beginning, it started out as an exciting yet daunting venture. Some people were sceptical about my furthering my studies on a part-time basis. Nevertheless, I accepted the challenge which, in the end, turned out to be worthwhile. This was a challenge that became easier as a result of having had an excellent support system which served to provide understanding and motivation, and which was comprised of supportive and loving people who were able to identify areas where they could offer a helping hand to lift the weight off my shoulders.

Undoubtedly, obtaining a master's degree seemed impossible until I reached this chapter, where I can almost see the finishing line. As previously mentioned, I took this journey step by step and which was sometimes fraught with doubt and sometimes with an incredible amount of enthusiasm. Nevertheless, I would not exchange the experience or the knowledge gained for anything else. The desire to know more, learn more and read more is an attribute that was instilled in me throughout this three-year process.

7.2. THE JOURNEY TO THE TOPIC

As I am the youngest of four children, I was introduced to sports at a very young age. Since I grew up next to the sports fields, I became passionate about sports, and at only four years of age, I began to experiment with different sporting codes, such as ballet, gymnastics, hockey and netball. At the age of nine, I started gymnastics and was later included in the high-performance provincial squad, which meant long hours of blood and sweat, literally. As my coach was passionate about our team's success, we were forced to choose between gymnastics and other sports due to the risk of injury. At this stage, I could not understand the reason for this and continued playing netball at school level, where I faced a variety of injuries. These included mostly ankle and knee injuries, which influenced my performance in gymnastics.

In 2014, I became a primary school netball coach and, given my background in Sports Science, I came to realise that there is a lack of training programmes at school level despite the significant number of injuries sustained during netball games. Moreover, I recognised that the coaches, in general, had no knowledge whatsoever regarding injury-prevention modalities and periodisation of training programmes. Hence, I concluded that there is a definite absence of knowledge regarding safety-training programmes. During this time, I received a merit bursary from the University of the Free State after completing my honours degree in Sports Science, which I saw as an excellent opportunity to engage in a post-graduate study which could examine this broad statement. Firstly, I was excited about determining the incidence of school injuries and, secondly, helping to implement an intervention programme to reduce the number of injuries at this level of participation. Thus, I wanted to make a valuable contribution to South African School Netball by establishing a baseline for further research to revise existing structures and protocols in an attempt to reduce the risk of injuries and improve the quality of life in the long run for these athletes.

7.3. PEARLS OF EXPERIENCE

"The beautiful thing about learning is that no one can take it away from you."
(BB. King)

Post-graduate candidates will surely agree that the journey involved in writing a dissertation is not easy and that it does not happen quickly. It takes blood, sweat and tears and, most of all, sacrifices in all forms, especially regarding valuable time with friends and family. In view of the above quote by B.B. King, it is evident that in the end, the value of further education is immeasurable and is something that no-one can take away from you. Although it is a challenge to engage in post-graduate studies on a part-time basis, particularly in terms of achieving a balance between work and academics, many have overcome this challenge and succeeded without neglecting the one or the other. Therefore, while it is undeniably complicated, it is certainly not impossible.

The most valuable lesson I have learned during this journey is to be able to manage my time efficiently and find a balance between different aspects of my life. This, in my view, is an essential attribute that is needed in the working environment. Within the allied health profession and sports science field, it is of the utmost importance to remain up to date with the latest research and to follow an approach which is based on scientific evidence. Therefore, I have experienced personal as well as professional growth with regard to the ability not to merely read, but to achieve a deeper understanding of the literature on a post-graduate level, particularly in terms of critical analysis and the ability to scrutinise writing in a practical yet meaningful manner.

7.4. PERSONAL REMARKS

To conclude, I would like to make a few personal remarks to help upcoming students and offer advice when deciding to take on a master's dissertation.

Firstly, I would advise that one equip oneself with what is needed and expected. This is critical to learning how to read literature and critically analyse what you have read. Secondly, it is imperative to learn how to write, more specifically to write academically. The topic on which you decide should apply to a certain amount of available literature. Furthermore, it is essential to choose a question with which you are comfortable and a field in which you would like to specialise. Therefore, it is important to select an area which interests and about which you are curious. A vast amount of your time should be spent engaging with the literature pertaining to your chosen topic. For this reason, you should be intrigued by what you read and write. The process can become more difficult if the selected question is not what you had in mind.

Lastly, it is of the utmost importance to choose your support network, especially those who will be assisting and guiding you throughout the research process. With that said, I would like to give thanks to my excellent support network who have been there for me throughout the past three years, if not longer. I wish to thank Prof. Derik Coetzee for guiding me through the entire process, and for motivating me. Your input has been of immeasurable value. It is a privilege to learn and work with an expert such as yourself. Thank you for your patience and for believing in me. Thank you for the sacrifices that you have made to invest in this study. I also wish to extend my gratitude to Prof. Robert Schall, the biostatistician who contributed significantly to the effective deliverance of the data. Your help in terms of representing the data in a logical yet scientific way is greatly appreciated. It has been a privilege to work with such an expert in the field of statistics. Working with a person who is knowledgeable in their area also helps to take the load off your shoulders. Thank you for your recommendations and input regarding the efficient representation of data.

Furthermore, I am eternally grateful to my friends and family who continually motivate and provide me with new perspectives when I am feeling vulnerable. Thank you for your constant motivation, support and caring throughout.

In conclusion, nothing is impossible for those who believe and reach for the stars. It may seem impossible now, but in the end, you will look back and be proud that you have made

it. Though this may not happen immediately, a diamond is also put under enormous pressure in order to have value. With that said, I thank God for His guidance and for giving me insight while working on this product.

All the glory to my heavenly Father!

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APPENDIX A

Questionnaire

Injury Report for Netball

Personal information

1. Name:	2. Surname:

3. Date:						4. Team:
Day:		**Month:**		**Year:**		

5. Date of birth:						6. Age group:							
Day:		**Month:**		**Year:**		**u/15**		**u/16**		**u/17**		**u/18**	

7. Weight:	8. Height
kg	**cm**

9. Lateral Dominance (Left- or Right handed)

Right		Left	

Information of injury

10. Date of injury: **11. Time of injury during play (e.g. 1st quarter)**

Day:		**Month:**		**Year:**		1st		2nd		3rd		4th	

12. Total hours/ minutes of play in the tournament before injury occurred?

	Hour/s		Minutes

13. Position at time of injury:

1. Goal Shooter (GS)	
2. Goal Attack (GA)	
3. Wing Attack (WA)	
4. Center (C)	
5. Wing Defense (WD)	
6. Goal Defense (GD)	
7. Goal Keeper (GK)	

14. Injured body segment:

1. Head		8. Clavicle		15. Low back		22. Posterior thigh	
2. Face		9. Upper arm		16. Abdominal		23. Knee	
3. Neck/ C-spine		10. Elbow		17. Sacrum		24. Lower leg/ Achilles	
4. Sternum		11. Fore arm		18. Pelvis		25. Ankle	
5. Ribs		12. Wrist		19. Hip		26. Feet	
6. Upper back		13. Hand		20. Groin		27. Toes	
7. Shoulder		14. Fingers		21. Anterior thigh		28. Other	

If "other" please specify

15. Side of body that is injured:

1. Left		2. Right		3. Bilateral		4. N/A	

16. Type of injury:

1. Concussion		10. Ligament injury	
5. Structural brain injury		11. Tendon injury/tear/tendinopathy	
6. Spinal cord compression		12. Haematoma/bruising	
7. Fracture		13. Bursa	
8. Other bone injury		14. Laceration	
9. Meniscus/Cartilage		15. Nerve injury	
10. Muscle strain/tear/cramp		16. Visceral injury	
11. Dislocation		17. Tooth	
12. Subluxation		18. Other	

If "other" please specify

17. Diagnoses of injury?

18. Is it a re-injury?

1. Yes		2. No	

19. If "yes", when did you return to play before the previous injury?

20. What is the cause of the injury?

1. Trauma		2. Overuse	

21. When did the injury occur?

1. During practice		2. During match	

22. Did the injury occur because of contact with another player?

1. Yes		2. No	

23. How many exercise sessions per week do you participate in:

23.1 Core/ Stabilizers (e.g. Sit ups, planks)

0 sessions		1 session		2 sessions		3 sessions		4 sessions		5 sessions	

Average duration of session:

min

23.2 Biomechanical alignment/ jump and landing technique

0 sessions		1 session		2 sessions		3 sessions		4 sessions		5 sessions	

Average duration of session:

min

23.4 Flexibility/ Stretching

0 sessions		1 session		2 sessions		3 sessions		4 sessions		5 sessions	

Average duration of session:

min

23.5 Proprioception/ Balance

0 sessions		1 session		2 sessions		3 sessions		4 sessions		5 sessions	

Average duration of session:

min

APPENDIX B

Information Document

Injury survey of netball injuries

Research done on injuries among Elite Netball players in South Africa at a National Tournament showed that most frequent injured sites are the ankle and knee joints. Research determining the frequency and type of injuries in junior South African netball players could not be found.

The aim of the research will be to determine which injuries occur more frequently in South African players aged between 15 and 19 years, to design and implement evidence based intervention programs that limit the risk of those injuries.

Data will be captured by the completion of an injury questionnaire. The questionnaire will focus on the anatomical site and nature of the injuries. Completing the questionnaire will take approximately 5 minutes.

This information is of critical importance to determine if conditioning coaches involved in the game are making the correct recommendations for injury prevention, and to increase the awareness among team management members about this subject.

In order to conduct the research we need your permission as parent or caretaker. Your child's participation in this research project will be greatly appreciated but is voluntary. The researcher undertakes to treat all personal information confidentially.

Contact details of the researcher:
Christel Botha
078 504 9325

APPENDIX C

Informed Consent Form

INFORMED CONSENT

Injury survey of netball players

I, _____, hereby grant consent that the information about the sustained injury of my child may be used for this research project. It is my understanding that the information gathered through the completion of the questionnaire will be evaluated to determine which injuries occur most frequently in South African School Netball tournaments

The researcher will take precautions to preserve the confidentiality of the research data and that all reports of the research will be devoid of identifiers.

_____ _____

Parent signature **Date**

_____ _____

Child signature **Date**

APPENDIX D

Child Assent Form

CHILD ASSENT FORM

You are being asked to take part in a research study being done by the University of the Free State. In this study, we are interested to know more about injuries occurring in your Netball games. We have asked your parent or caregiver whether it is OK for you to participate, but now we want to see if it is OK with you.

If you decide to take part in this study, you will be given a questionnaire to fill in when you get injured during your netball game. This will take about 5 minutes to do. Also, we would like to ask your coaches about your training programs and habits. All the information we collect will be kept secret and you don't have to share any of your answers in the questionnaire with anybody else. We will not use your name so everything will remain private.

By signing this you are showing that you understand what is going to be happening and have asked any questions you may have about the research. You can also ask questions later if you cannot think of them now. Signing this form does not mean that you have to finish the study- you can pull out from the study at any time without explaining why.

_____ _____

Child signature **Date**

Contact details of the researcher:

Christel Botha

078 504 9325

APPENDIX E

Ethics Approval Letter

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

07 September 2016

CHRISTEL BOTHA
DEPT OF EXERCISE AND SPORT SCIENCE
FACULTY OF HEALTH SCIENCES
UFS

Dear Christel Botha

HSREC 115/2016
PROJECT TITLE: THE INCIDENCE OF MATCH PLAYING INJURIES IN JUNIOR NETBALL PLAYERS IN SOUTH AFRICA

1. You are hereby kindly informed that the Health Sciences Research Ethics Committee (HSREC) approved this project. This decision will be ratified at the next meeting to be held on 20 September 2016.
2. The Committee must be informed of any serious adverse event and/or termination of the study.
3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.
4. A progress report should be submitted within one year of approval and annually for long term studies.
5. A final report should be submitted at the completion of the study.
6. Kindly use the **HSREC NR** as reference in correspondence to the HSREC Secretariat.
7. The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

Yours faithfully

.....
DR SM LE GRANGE
CHAIR: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | F: +27 (0)51 444 4359 | E: ethicsfhs@ufs.ac.za
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
www.ufs.ac.za

APPENDIX F

Approval from Biostatician

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
NATURAL AND AGRICULTURAL SCIENCES
NATUUR- EN LANDBOUWETENSKAPPE

[redacted]

20 July 2016

Ethics Committee
Faculty of Health Sciences
UFS

Project title: THE EPIDEMIOLOGY OF INJURIES IN JUNIOR SOUTH AFRICAN NETBALL PLAYERS

Researcher: Ms Christel Botha
Supervisor: Prof FF Coetzee

I herewith confirm that I have reviewed the protocol for this study. I have discussed the protocol with the researcher and have provided input into the study design, procedures and methodology. After data collection I will assist the investigator with data analysis and interpretation.

Sincerely

Robert Schall
Professor: Statistical Consultation Unit

Department Mathematical Statistics and Actuarial Science
T +27(0)51 401 2299 | F: +27(0)51 401 3019
205 Nelson Mandela Drive/Rylaan | Park West/Parkwes | Bloemfontein 9301 | South Africa/Suid-Afrika
P O. Box/Posbus 339 | Bloemfontein 9300 | South Africa/Suid-Afrika | www.ufs.ac.za

APPENDIX G

Evaluation Committee Approval

BYLAE 7

SCHOOL FOR ALLIED HEALTH PROFESSIONS
SKOOL VIR AANVULLENDE GESONDHEIDSBEROEPE

VERSLAG EVALUASIEKOMITEE
REPORT EVALUATION COMMITTEE - RESEARCH

NB. Evaluation committees should be appointed & approved by the Research Committee of the SAHP* six(6) *weeks before the set date. All members should receive the protocol at least ten (10) working days before the set date.

DISSERTATION/VERHANDELING: Ph.D. ..... **Master/Magister: Full ✓ mini.....**

CANDIDATE/KANDIDAAT: C. Bills

DATUM/DATE: 1 April 2016

TITLE/TITEL: The epidemiology of injuries among adolescent netball players in South Africa

MEMBERS OF THE COMMITTEE/
LEDE VAN DIE KOMITEE

Chairman/Voorsitter: C. Kroukamp

Lid van die Dagbestuur:
Member of Executive Committee: .....

Expert/Kundige: Dr. M. Sykes

Expert/Kundige: Dr. L. Hollander

Expert/Kundige: .....

Biostatistician/Biostatistiek: Prof. Schall

Studyleader/promotor/Studieleier/
promotor: Prof. P. Cooper

Co Study Leader/promotor
Mede-Studieleier/mede promotor: .....

.....

PROCEDURE/PROSEDURE

1. **Word of Welcome/Verwelkoming**
   Al members and the candidate are welcomed by the chairperson.
2. **Agreement on handling of session and process in SAHP**
   Ooreenkoms oor die hantering van die sessie en proses in SAGB
   - The chairperson explains the procedure of discussing the protocol page/section by section.
   - Editorial corrections as indicated by the members of the committee will be given to the supervisor to be corrected under their supervision.
   - The title will be discussed at the end of the session.***(No title registration and appointment of examiners may take place before ethical approval has been granted).***

2

- Any member of the evaluation committee may request to review the protocol again after the recommended corrections have been done. After the re assessment of the corrected version of the protocol these members have to inform the chairperson in writing(by email) of their approval of the revised protocol.
- **Only** after all the approvals have been recieved by the chairperson the report will be signed off by the chairperson and **only then** the protocol can be submitted to the Ethics committee of the Faculty. The chairperson will inform the Ethics committee and studyleader of the final approval.
- The student will be excused after the discussion of the protocol.
- Members will be requested to hand in their copy of the protocol to the studyleader.
- All title registrations must be submitted to the office of the SAHP **electronically** on the correct form, for approval at the relevant committees

---

3.1 Candidate has been informed of the procedure/
Kandidaat is ingelig oor die prosedure (✓/×) ✓

4. Presentation – if applicable/

Voordrag – indien toepaslik

5. Summary of the most important recommendations on the protocol:/
Opsomming van die belangrikste aanbevelings ten opsigte van die protokol

5.1 Titlel page, Concept clarification & abbreviations //Titel bladsy, konsepklarifikasie & afkortings

[illegible] hard copy / electronic copy

[illegible] aspects such as incidence and prevalence

5.2 Introduction and Literature review/inleiding en literatuur oorsig
Contains a clear statement demonstrating the focus of the study/'n Duidelike stelling wat die fokus van die studie uitlig (✓) ✓ revision_____

Correct some language errors

clarify differences between this and previous studies

Literature is clearly related to the problem statement/Literatuur ondersteun die probleemstelling ten volle (✓) ✓ revision____

5.3 References/Verwysings(applicable for topic and recent/toepaslik vir onderwerp en resent) (✓) ✓ **revision____**

Comments/kommentaar:

[illegible] method of referencing

5.4 Problem Statement/Probleemstelling
A clear statement demonstrating that it is worthy of study/'n duidelike stelling wat demonstreer dat die onderwerp die moeite werd is om na te vors (✓)___ revision____

Comments/kommentaar:
clearly justified, please ask more information in the comments.

5.5 Aim/Doel
Described in a logical, explicit manner/beskryf in 'n logiese, eksplisiete wyse (✓)__ revision_✓
for their own debrain org.

Objectives/doelwitte(✓)__ revision___✓

5.6 Methodology/Metode:
Design/ontwerp
Appropriate for the question/toepaslik vir die navorsingsvraag (✓/x)_✓

Study population/studiepopulasie:
Described in detail/beskryf (✓)__ revision_✓
include sample size, method of sampling, population + population size.

Inclusion criteria/insluitings criteria (✓)__ revision_✓
clearly injury and place of game.

Exclusion criteria/uitsluitings criteria. (✓)__ revision___✓
include language, library, etc

Measurement/meting:
In alignment with the research question and the literature/belyn met navorsingsvraag en literatuur (✓)_✓ revision___
how data is looked at study; email from panels updated time

Explanation of data gathering and analysis/inligting oor data insameling en analise(✓)_✓ revision___

Measurement errors/Metingsfouts: Not added. - need to add

4

5.7 Pilotstudy/Loodstudie

Paticipants/deelnemers (✓)__ revision ✓

Need to specify

aim/doel (✓) ✓ revision___

5.8 Data analysis/Data verwerking (✓) ✓ revision___

6. Ethics/Etiek (✓)__ revision___

Explain in more detail how people/ questions are going to be approached.

7. Time Schedule/Tydskedule

Realistic for execution/realisties vir uitvoering(✓)___ revision ✓

Comments/kommentaar:

8. Budget/Begroting

Funds available/fondse beskikbaar (✓/) ✓ revision___

Comments/kommentaar:

9. Appendixes/Bylaes

Letters of permission(✓)___ revision ✓

Comments/kommentaar: See dietician reg. [illegible] to be revised

Informed concent/ingeligte toestemming(✓)___ revision ✓

Comments/kommentaar: See dietician reg.

Measuring instruments/meetinstrumente (✓)___ revision ✓

See Questionnaire for netball and language changes

10. **Language & technical editing/Taal & Tegniese versorging (✓)**___ revision ✓

Comments/kommentaar:.....

12. **Discussion of the protocol with reference to:/ Bespreking van die protokol deur die komitee, ten opsigte van:**

- **Feasibility of the study?/Uitvoerbaarheid van die studie?(✓/×)** ✓
- **Adhere the study to the level descriptors (NQF) (✓/×) of a Masters/Doctoral degree? Voldoen die studie aan die vlakvereistes (NKF) van die Magister of Ph.D van die graad?** ✓
- **Sal die kandidat opgewasse wees om die studie te voltooi?/ Will the candidate be able to complete the study? (✓/×)** ✓

If not - reasons?/Indien nie - redes?

.....

- **Is the title correct?/Is die titel korrek? (✓/×)** ✓
- **If no – recommend new title/ Indien nie – voorgestelde tiel**

The incidence of match playing injuries among junior netball players in SA

13. **RECOMMENDATIONS/AANBEVELINGS**

To be re-assessed/her assesseer: (✓/×) ✓
By whom/deur wie:

Ethicskom

Approved with corrections to be done onder supervision of the study leader/promotor/goedgekeur met korreksies gedoen onder leiding van die studieleier/promotor(✓/×) ✓

14. **FINAL SIGN OF AFTER RE ASSESSMENT AND APPROVAL TO SUBMIT TO ETHICS COMMITTEE/ FINALE AFTEKENING NA HER ASSESSERING EN TOESTEMMING VIR VOORLEGGING AAN ETIEK KOMITEE**

Ethicskom — 5 April 2016

CHAIRPERSON COMMITTEE/ VOORSITTER KOMITEE — **DATE/DATUM**

c:\evaluasiekomm\bo verslegvorm blanko 5.doc11-12.doc

APPENDIX H

Department of Education Letter

RE: RESEARCH PROJECT ON NETBALL INJURIES

I would like to request permission to conduct research at local Schools Netball Tournaments to be held in 2016 - 2017. The research will be done together with Prof. Derik Coetzee (The Department of Exercise and Sports Science).

Research conducted on Elite Netball players in South Africa showed that the ankle and knee joints are the most common sites for injuries in netball players. No research to determine the frequency and type of injuries among junior Netball players in South Africa could be found. According to research injuries sustained by children can have serious long term effects.

Therefor the aim of our research will be to determine which injuries occur more frequently among netball players participating in competitive schools netball in South Africa, and to design and implement intervention programs to limit the risk of these injuries in junior players.

In order to complete this research, permission is required from the governing body in order to report injury details and note data that will be collected at the daily adjournment of play. The completion of an injury questionnaire will be completed for every player that receives medical attention for an injury sustained. Players will be assisted by the researcher in order to complete the questionnaire. There is no risk for players participating in the study and no interventions are planned. All data will be handled with strict confidence and an informed consent from all the participating players will be obtained.

Your assistance in this matter will be greatly appreciated.

Contact details of the researcher:
Christel Botha (078 504 9325)

_____

Signature

APPENDIX I

Department of Education Approval

I.K Nkoane Education House

156 Barkly Road
Homestead
Kimberley 8301

Private Bag X5029
Kimberley 8300
Republic of South Africa

Tel: 053 839 6500
Fax: 053 839 6580/1
Web:ncdoe.ncpg.gov.za

DEPARTMENT OF EDUCATION

Enquiries: MR GT PHARASI
Contact No:
Reference:
Date: 6/6/2016

TO WHOM IT MAY CONCERN

APPROVAL OF RESEARCH PROJECT FOR MS CHRISTEL BOTHA

1. Approval

The Northern Cape Education Department granted permission to **Christel Botha** to conduct research at inter-school and at regional or provincial school sport gatherings as follows:

Research Topic

To determine which injuries occur more frequently among netball players participating in competitive school netball in South Africa and to design and implement intervention programs to limit the risk of these injuries in junior players

The focus will be on junior players participating in organized netball tournaments over the period 1 May 2016 – 30 April 2017.

2. Logistical procedures

- The research will be done together with Prof Derik Coetzee (Department of Exercise and Sports Science UFS). All ethical considerations for conducting research will be stringently adhered to.
- An informed consent will be obtained from all participants.
- At the adjournment of play, injury details will be reported and the data collected noted.
- All data will be handled in strict confidence.

APPENDIX J

Netball South Africa Letter

RE: RESEARCH PROJECT ON NETBALL INJURIES

I would like to request permission to conduct research at the local Netball Tournaments to be held in 2016 - 2017. The research will be done together with Prof. Derik Coetzee (The Department of Exercise and Sports Science).

Research conducted on Elite Netball players in South Africa showed that the ankle and knee joints are the most common sites for injuries in netball players. No research to determine the frequency and type of injuries among junior Netball players in South Africa could be found. According to research injuries sustained by children can have serious long term effects.

Therefor the aim of our research will be to determine which injuries occur more frequently among netball players participating in competitive schools netball in South Africa, and to design and implement intervention programs to limit the risk of these injuries in junior players.

This research study will contribute to injury prevention strategies and will be made available to Netball South Africa and will further contribute to the level of professionalism in the management of netball in South Africa.

In order to complete this research, permission is required from the governing body in order to report injury details and note data that will be collected at the daily adjournment of play. The completion of an injury questionnaire will be completed for every player that receives medical attention for an injury sustained. All data will be handled with strict confidence and an informed consent from all the participating players will be obtained.

Your assistance in this matter will be greatly appreciated.

Contact details of the researcher: _____

Christel Botha (0785049325) **Signature**

APPENDIX K

Netball South Africa Approval Letter

South African Schools

PRESIDENT:
Ms Di Woolley
Cell: 082 445 9406
Fax: 011-672 4420

SECRETARY:
Ms Ronelle Nell
Fax: (086)7324042
Cell: 083 288 9246

28 August 2016

TO WHOM IT MAY CONCERN

This serves to confirm that SASN is aware of the research project being done with Christel Botha. SASN further has no problem with the research being carried out on condition that all protocols have been followed and consent has been given by the parents of the learners participating in this research.

Should you require any further information please do not hesitate to contact me.

Yours faithfully

DPWOOLLEY

D.P.WOOLLEY(MISS)

PRESIDENT

ORIGINALITY REPORT

12%	9%	1%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	scholar.ufs.ac.za:8080 Internet Source	3%
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3	Submitted to University of the Free State Student Paper	1%
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15	Monese, PH, EAM Prinsloo, and FC Van Rooyen. "Injuries in children and adolescents seen during 2006 at the emergency department of the National District Hospital, Bloemfontein", South African Family Practice, 2011. Publication	<1%
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