FACTORS CONTRIBUTING TO INJURIES AMONG HANDBALL PLAYERS IN TERTIARY INSTITUTIONS: A CASE STUDY OF MASVINGO PROVINCE, ZIMBABWE.

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ABSTRACT

Sport injury has become an inescapable occupational menace in physical and sporting circles due to the current high entry of people into sport for competition and entertainment reasons. This inclination has seen a shift of interest from therapeutic process towards more of injury protective mechanisms with regard to players’ physical uprightness. This study aimed at identifying the main risk factors that contributed to injury occurrence during training and competition in Masvingo Province tertiary handball between 2014 and 2015. It sought to determine and examine the relationships between external and athlete-triggered risk factors, injury outcomes and their impact on player performance. This study was an epidemiological prospective cohort design with 153 college players, 18-30 years drawn from ten male and female handball teams of Masvingo Province. It was conducted with the view to recommend plausible preventive safe playing environments from the existing high cumulative injury incidences players experienced. A total of 242 incidental injuries players sustained were from contact and non-contact situations. Contact injuries were greater in matches than training in both gender but with high figures being reported in females than men. Most injuries were located in lower limb than upper limb appendages. The most vulnerable sites were the knee, ankle/foot, shoulder, wrist, fingers, elbow and hip. The principal injury mechanisms that significantly contributed to injury sustenance were plant and cutting, shooting, blocking, turning, landing and dribbling. Findings were that injury occurrence is related to the interface between externally and athlete-related risk factors implying that injury occurrence is not confined to a single inciting factor, but to a host of variables. Handball training regimes need to focus on basic proprioceptive, sensomotoric, and neuromuscular aspects to address the frequently injured body limps. Exercise-based injury prevention programs, education on injury aetiology, identification of injury trends and situational risk factors, should be
practically instituted and ingrained as correctional concerns by coaches and associations in handball.
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ABBREVIATIONS

ACL............................................................. Anterior Cruciate Ligament
BMI............................................................. Body Mass Index
CI............................................................. Confidence Interval
EHF............................................................. European Handball Federation
EMG............................................................. Electromyographic
HR............................................................. Heart Rate
IR............................................................. Incidence Rate
LES............................................................. Life Event Stress
NAIRS......................................................... National Athletics Injury Report System
NLES........................................................... Negative Life Event Stress
NMT............................................................. Neuromuscular Training
OA............................................................. Osteoarthritis
OR............................................................. Odds Ratio
ROM............................................................. Range Of Motion
RR............................................................. Relative Risk
SD............................................................. Standard Deviation
ZHF............................................................. Zimbabwe Handball Federation
ZITCOSA.....................................................Zimbabwe Teachers’ Colleges Sports Association
CHAPTER ONE
INTRODUCTION

1.1 Background to the study

The current study aimed at determining and examining how internal and external risk factors contribute to injury among handball players in tertiary institutions of Masvingo Province. It further describes how sports injuries can affect the performance of players during match and training situations.

Injury prevention, as a concept, dates back to 1905 when Roosevelt the then President of the United States of America, challenged American Colleges to make a re-look at existing football rules to eliminate the prevailing risks (Renstrom, 1994). In spite of this, not much in-depth epidemiological injury research was carried out to alleviate the problem in this area. Coaches and medics had much to do with the existing treatment and rehabilitation of injured athletes (Reeser et al., 2010). To date, many clinicians and researchers have shifted their focus from curative towards preventive management of sports injuries as a key topical issue (Bailasha et al., 2015; Luig and Henke, 2013; Clarsen, 2015; Moller et al., 2012; Meeuwisse et al., 2007; Myklebust, 2014; Bjorneboe et al., 2014). These developments brought new insights and re-birth of a new era that necessitated the adjustments of rules, equipment/facilities and officiating standards in a number of sports codes to address the issue of injury burden on players (Eustice, 2013). Available literature and anecdotal evidence has shown high prevalence injury rates to have a strong correlation with training rigors, recreational needs for personal fitness gains and sport as a major source of income all of which have become pull factors to this industry (Bailasha et al., 2014). This storming of people into sport for competition and individual recreational desires provides the need for a post-mortem of
documentary evidence into injury patterns, vulnerable body appendages and associated risks of participating in any sport code (Bailasha et al., 2014). Information of this nature greatly assists in the formulation of plausible preventive measures prior to injury occurrence.

With regards to the pattern and prevalence of handball injuries in practice, various authorities agree their occurrence to be linked to the specific characteristics of the sport with the upper and lower appendages being the most affected areas (Estriga, 2008; Clarsen, 2014; Bjorneboe et al., 2014). Consequently, the frequency of multiple injuries in handball has been viewed as an alarmingly increasing inevitable catastrophe on their causes, severity and effects by most sports studies (Estriga, 2008).

Despite the importance of this information for coaches who are responsible for promoting safety and physical integrity of the players, Estriga (2008), however, has lamented on the lack of provision of practical lasting solutions to avert injury and re-injury prevalence in training and competitions. Inherent from the foregoing views is that injury cannot be completely ruled out of sport but has become a bud in the node whose nature, cause, mechanism and severity should be established and understood so that safe playing conditions could be created. Hence this study seeks to explore such causes among tertiary handball players in Masvingo Province so as to reduce its effects on player performance during training and competitions.

Handball popularity, as a unisex game, has been seen to develop at all levels of play and practice from recreational, amateurism through to professionalism and remains massively popular, not just in Africa, but throughout the world for all age ranges (Koren, 2010;
This tendency is also present in Zimbabwe with more clubs and competitions sprouting in schools, tertiary institutions and at recreational level over the past ten years (Magiya et al., 2010). This was partly due to the Ministry’s policy to introduce new games in schools and tertiary institutions in the country as well as the inception of the sport in 1995 during the All Africa Games hosted by Zimbabwe.

The game calls for great speed, contact and versatile fast actions that are very demanding and place the players at higher risk of sustaining injuries at all levels of participation (Junge et al., 2006; Langevoort et al., 2007; Myklebust et al., 2013; Clarsen, 2014). Consequently, the game characteristics, intensity and aggressiveness should be highly understood (Meeuwisse et al., 2007) because the contemporary game of handball is significantly dependent upon the fitness components of speed and power of competitors (Bere et al., 2014). Thus, as the sport grows in terms of number, participants and intensity, so does the number of injuries (Clarsen, 2014; Bailasha et al., 2014). Intrinsic from these assertions is the need for a player to have conditioned fitness that suits the characteristics of the game as premature fatigue might have adverse effects on the player. This study intended to explore the interactions of athlete-triggered and environmentally triggered risk factors in producing injury during play among tertiary handball players in Masvingo Province.

While a large body of research has been conducted regarding the nature and prevalence of handball injuries internationally (Bahr and Holme, 2005), very little has been done in Zimbabwe or on the African continent (Assembo and Wekesa, 1995; Gitonga and Akpata,
1997; Chapweteka, 2008; Bailasha et al., 2014) to assess the status of injuries incurred at professional or amateur levels, even though researchers believe that the injury prevalence in Africa could be the same or higher than the cases observed in the developed countries. The reason behind may be due to financial factors.

Data pertaining to incidence, mechanism, nature of severity and prevalence of injuries within specific sports codes have been collected by many researchers and clinicians (Myklebust, 2007; Murphy et al., 2007; Meeuwisse, 2007; Bailasha, 2013; 2014) with the motive of providing a guide for injury prevention and improve sport safety. Murphy et al. (2007) expressed their concern that an increase in frequency, intensity and duration of injury, also leads to the need to increase the prevalence of treatments as well as preventive measures. It, therefore, implies that increase in duration of injury may lead to absence from sporting activities in most cases which might be related to injury severity.

Several studies have confirmed the prevalence of injuries among players during competition and training (Van Mechelen and Verhagen, 2009) some of which are of multi-factorial origin (Holme and Bahr, 2003). Injury incidence and mechanisms are a result of an inter-play of internal and external risk factors as demonstrated by Meeuwisse (2007); Meeusen et al. (2007); Langevoort, (2007); Koren, (2010); Luig and Henke, (2011) and these can have detrimental effects to player performance and participation. A study by Assembo and Wekesa (1995) during Kenya’s East and Central African Senior club championship has shown an incidence rate of 2.74 % injuries/match and 0.9 % injuries/player during the nineteen matches of championships. Similar results were also recorded in prospective studies by Myklebust et al., (1997; 1998) and Olsen et al. (2009) in the Norwegian league from 2008-2009 in which
the incidence of acute and over-use injury incidences were 15.2 % and 3.9 %/1000 match hours respectively.

A one year cohort prospective study by Bailasha et al. (2014) during the 2014 Kenyan national handball league of 196 male and 98 female players also confirmed higher injury incidence rates of 2.8 and 2.5 in males and females respectively. Leidinger et al. s’ (2002) studies had a similar trend, accounting for 96% of Germany’s senior players sustaining knee injuries (26.9%), ankle (20.3%) and rotator-cuff problems (17.1%) while 11.9% were over-use injuries, all of which were attributed to internal (athlete-related) and external (environmentally-related) factors.

The above studies had a similar bearing on the current situation of injury incidence rates in Masvingo tertiary institutions (73%-81% injuries, 2010-2011 season and 73%-85% injuries, 2012-2013 seasons) where competitions are held on annual bases and the likelihood of injury increase and sustenance is inevitable. Figures portray unfavourable and prevailing conditions athletes were exposed to in training and match situations. This precipitated injuries in players with implicated medical costs being incurred in injury management for players’ welfare. This study sought to address this gap so that injury prevalence and severity could be reduced in Masvingo Province tertiary institutes.

In most studies various methodologies in injury research have been adopted depending on the problem under study but to some extent, authorities seem not to agree on the one that is most appropriate. Bahr and Holme (2003; 2005) in a re-evaluation of methodological approaches to explore risk factors for sports injuries, proposed the use of the multivariate approach as most appropriate in data collection. Meeusen et al. (2007), Van Mechelen (2009), Koren
Luig and Henke (2013) admit that the use of a multi-factorial approach is most suitable since it allows gathering of data as much as possible from a substantial number of sources. Despite variations in approaches that may be suggested, the purpose of this study is to prospectively explore the prevalence and mechanisms of injuries in handball and determine how a host of factors might contribute to injury incidences and outcomes using the multi-factorial and multivariate approaches. The study also sought to assess whether there are any associations between external and internal risk factors and injury outcomes during handball training and competitions. This might assist in generating quantitative data for qualitative analysis so that preventive and injury management approaches can be provided for safe practice and participation in handball.

1.2 Statement of the problem

The game of handball has gained much popularity in Zimbabwe from recreational, amateurism through to professionalism. However, there has been lack of research in this area with regards to injury prevalence, to date. Although this popularity has had a great impact in the greater part of the society, there has been a growing cause of concern as injury occurrence and non-adherence to safety measures during training and competition have become unpleasant, common features among tertiary handball players. Despite the competitiveness, enjoyment, excitement and satisfaction brought forth to members inclined in handball, players have lost pride and interest in the game due to an alarming, cumulative seasonal rise in injury rates which still remain unattended. Therefore, it is essential to probe into factors contributing to injury manifestation in tertiary institutes of Masvingo Province through a prospective cohort study over two consecutive seasons with the view to recommend safe playing environments.
1.3 Purpose of the study

This study sought to examine and determine the inter-relationships and interaction between internal and external risk factors, injury incidences with injury outcomes among handball players during competition and training in tertiary institutions in Masvingo province over two consecutive seasons. The major purpose of this study was to identify the main risk factors that contributed to injury occurrence during training and competitions among tertiary handball players in Masvingo Province between 2014 and 2015 seasons.

1.4 Objectives of the study

The research sought to address the following objectives:

1. To examine the intrinsic risk factors associated with the injuries players sustained during collegiate handball in Masvingo Province;
2. To determine the relationship between extrinsic risk factors with injury incidence during collegiate handball in Masvingo tertiary institutes;
3. To assess the impact of risk factors on player performance in Masvingo collegiate handball;
4. To identify common sites for injuries sustained among tertiary handball players in Masvingo Province; and
5. To recommend measures to reduce injury occurrence among handball players in Masvingo tertiary institutes.
1.5 Main Research question

The prevalence of injury occurrence in Masvingo collegiate handball has not been established, hence this study aimed at answering the following question:

What are the main risk factors contributing to high prevalence rates of collegiate handball injuries among players during training and competition in tertiary institutions of Masvingo Province?

1.6 Sub-research questions

The following sub-research questions guided this study:

1. To what extent do internal and external risk factors contribute to injury prevalence during tertiary handball training and competition?
2. What significant associations exist between internal risk factors and injury outcomes during tertiary handball training and competition?
3. What impact do internal and external risk factors have on player performance during training and competition?

1.7 Significance of the study

This study highlighted the current state of injuries among Masvingo handball players in tertiary institutes. This may help players and other stakeholders in the sport to be aware of the risk factors and monitor injury trends for safe participation and reduction in extra costs incurred in injury management. Findings of this study might assist in the basic physical and skill preparation for players with regard to handball specific components through structured
and supervised conditioning programs that include individually adapted endurance, dynamic mobilization and agility drills. By revealing potential risk factors and injury mechanisms in players during competition and training, results of the study might contribute significantly in assisting coaches, players and sports directors in the formulation of structured physical conditioning routines as well as basic and advanced training techniques that might ensure safe participation of players in handball. Appropriate measures might be accepted and adopted to ensure conformity to the long term, thereby increasing the chances of successful and sustainable inclusion of injury prevention and management measures during competition and training programs. Findings of the study may also assist the aforesaid stakeholders in identifying situational risk factors and to monitor injury trends and their characteristics so that implementation of appropriate strategies for reducing injuries in number and severity of their outcome could be done. Understanding of situational risk factors, injury trends and preventive measures might pave the way for various stakeholders to adopt pro-active approaches as safety promotion ambassadors that might contribute to the positive image of the game and organizations involved. This might help in motivating members already inclined into the sport towards attracting new members as well as create good health habits and safe practice conditions for players.

1.8 Assumptions

The major assumptions of the study were that handball players in tertiary institutions were exposed to a host of internal and external risk factors which predisposed them to injuries during training and competitions. The study also assumed that the pattern of injuries between and within genders would not be significantly different.
1.9 Delimitation of the study

This study was carried out in five tertiary institutions of Masvingo Province, namely Morgenster Teachers’ College, Bondolfi Teachers’ College, Masvingo Teachers’ College, Mutare Teachers’ College and Mary Mount Teachers’ College. The study did not include all the tertiary institutions in the country. Only, ten teams, five for females and five for males with a total of 160 players and 15 officials constituted the study population. Triangulation of sources was done from injured and non-injured players who were the sample that was used in this study. The study focused on environmentally (extrinsic) and athlete-triggered (intrinsic) risk factors that subjected players to multiple injuries during handball training and competition. The focal point was on the upper and lower body appendages (sites) that were susceptible to different mechanisms of injury as a result of their exposure to training and match intensities. In terms of conceptual delimitation of this study, injury was defined as any physical complaint incurred during match or training that received medical attention from the team physician or doctor regardless of the consequences with respect to absence from match or training.

1.10 Limitations of the study

The following were the limitations of this dissertation. Financial constraints due to costs of data collection from the research sites affected the quantity and generalisability of data collected as this research was self-sponsored. Another militating factor was the change of key variables during the course of the study. The adaptation of the validated instrument (the questionnaire) also impacted negatively on the quality of findings, generalizations and conclusions. In other cases, players’ technical hitches to accurately describe the diagnosis made by medical professionals, in relation to use of technical terms, proved to be a possible
source of data contamination. To minimise these limitations, the researcher organised meetings with team designates and players at research sites to explain and clarify these technical issues every month. Coaches were asked to consistently provide the necessary assistance in completion of the self-injury report schedule, particularly in the case of novice players with regard to technical knowledge on medical terms that were used.

In addition, some injury report forms got lost/were not returned, deflating the real injury incidence as was the case of one female team where data for seven players got lost towards the end of the second season. Detection was done and properly considered in the statistics. Information on exposure time (number and duration of training sessions and matches) was provided by coaches on a collective basis as it could have been difficult to obtain accurate exposure time of each single player. Arrangements to meet respondents were done by e-mail or phone prior to visits at research sites upon the consent of the responsible authorities, an important ethical issue that should be done when undertaking any research endeavours. This created good inter-personal networks between and among participants, the researcher and responsible authorities which made collection of intended data less cumbersome and more precise.

1.11 Ethical and legal considerations

Ethical issues are a “fundamental” part of the research planning and implementation (Mertens, 1998: 23). One of the purposes of research, especially in the theoretical perspective, is to build up understandings that are trustworthy and which are arrived at in an ethical way (Merrian, 1998). In this regard, the major issues considered in this study were the
seclusion and well being of participants, and the necessity to give a clear outline of the study to participants so that their involvement were undertaken on a voluntary basis (Mertens, 1998; Schumcher and McMillan, 1993). Associated considerations will be the necessity to obtain the required clearances from the appropriate authorities to undertake the study, including gaining authority of the participants’ employer. To comply with these ethical considerations, application was done on appropriate forms and with the necessary accompanying documentation to tertiary institutions in Masvingo Province where the study was conducted. These requests for approval set out the details of the study and included, the title of the study, the researcher’s name and contact details, supervisor of the research and contact, background to the study, aim of research, purpose of the research and information regarding the confidentiality of the research. These were explained to relevant administrative bodies and players. Also in relation to the privacy issues, details of the storage and disposal of materials gathered during the study were outlined.

1.12 Definition of terms:

**Risk Factor:** any variable that has the potential to cause an injurious situation or susceptibility of players to any form or type of injury in handball (Bahr and Holme, 2005).

**Circumstance:** a situation or case in which a nasty experience is noticed that negatively impacts on the body mechanics during play or practice (van Mechelen et al., 2003).

**Injury Incidence:** the number of or rate at which injuries occur per match or training (Langevoort et al., 2007).

**Multi-factorial:** a situation that encompasses a multiple of factors that is of various origins (Meeuwisse, 2007).
**Multivariate Approach:** a statistical approach used in sports injury risk factor studies to record the inter-play and baseline assessments of several potential factors in sport injury (Bahr and Holme, 2003).

**Team Handball:** is defined as a high intensity sport with frequent physical contact between the players (Langevoort et al., 2007).

**Sports Injury:** can be defined as any physical complaint incurred during the match that receives medical attention from the team physician regardless of the consequences with respect to absence from the match or training (Langevoort et al., 2007).

**Prospective Cohort Study:** a study design where all data are collected in a standardized manner, prospectively in time, with the aim to measure potential risk factors before injuries occur after which new cases and exposure are reported during a period of follow up (Bahr and Holme, 2003).

**Mechanism of injury:** Injury caused as a result of multiple intrinsic and extrinsic factors during training or competition that may require an athlete to seek medical attention often leading to a player not further participating or temporarily stopping in partaking the activity (van Mechelen et al., 2005).

### 1.13 Organisation of the study

Chapter One described the basis of the present study. This included the background of handball at international level, statement of the problem, objectives of the study, research questions, assumptions, and definition of terms. The problem under study was described in relation to internal and external risk factors. Finally, the chapter outlined the organisation of the thesis and ended with a summary of the chapter. Chapter Two looks at review of related
literature that has a bearing towards the problem under study. It also highlights essential issues that need to receive attention. These include internal and external risk factors, prevalence and handball injury types as well as mechanisms, nature and severity. The conceptual framework, within which this study will be confined, is discussed in relation to contemporary study of sport injuries. This implies reviewing the basis, nature and importance attached to epidemiological research in sports injuries. The costs and long term effects of handball injuries will also be highlighted. The Chapter further discusses possible political preventive measures or strategies to subdue environments that might aggravate precipitation of handball injuries during matches and training sessions. Chapter Three makes an attempt to explain the methodological issues of the study, including the adopted research design, population and sampling method, data collection methods and procedure of the study. It also describes the research setting and composition of Zimbabwe Teachers’ Colleges Sports Association (ZITCOSA) with reference to tertiary institutes of Zimbabwe. An injury report system will be used in data generation having piloted the instrument on a smaller related population to ensure its reliability and validity before administering it to the intended population. The procedure used to conduct the pilot study will be described. The Chi-Square type of statistic will be used in quantitative data analysis. Gathered data will be analysed inferentially. The Chapter finally concludes with issues of ethical considerations that were adhered to during the course of the study. Chapter Four presents the description of the main findings stemming from this study. It reports on the demographic characteristics of handball players. Injury prevalence in handball, anatomical sites prone to injury, mechanisms and nature of injuries, are further presented in order to determine if there might be any significant correlations between different sets of variables. In Chapter Four, the results of this study are interpreted and discussed in relation to similar studies conducted earlier. An attempt to suggest plausible solutions to problems related to this study will be provided. The Chapter
ends by outlining its summary highlights. The final chapter (five), entitled “Summary, Conclusions and Recommendations”, provides a summary and draws important conclusions from the research and gives suggestions for future work or research.
CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction:

This Chapter is a review of the available related literature on intrinsic and extrinsic risk factors that contribute to injuries in handball. Focus is on the general characteristics and attributes of the game of handball; injury incidence, severity and its mechanisms in handball. Some common anatomical locations of injury in handball, the influence of external and internal risk factors in sport performance and how an array of variables can jointly affect player performance in sport, were also alluded to. The Chapter also highlights the theoretical and conceptual frameworks of the study as well as Empirical Reviews conducted on epidemiological research on the aetiology (biomechanical issues) of injury in sport and preventive measures. In addition, it highlights gaps in the literature regarding extrinsic and intrinsic risk factors and preventive measures of injury in sports.

2.2 Conceptual framework

This research outlined some methodological issues that are pertinent to risk factors on sport injuries as well as the conceptual framework within which this research was confined. As outlined in most studies, epidemiological research on the aetiology of sports injuries need to account for the multi factorial nature by including as many risk factors as possible (Bahr and Holme, 2003, 2005; Van Mechelen et al., 2005; Luig and Henke, 2013; Clarsen, 2015) as illustrated by the diagram below adapted from Meeuwisse’s (1994; 2007) dynamic multi-factorial model. Since the focus of this study was on risk factors (internal and external) that
make players susceptible to injury, this model was key to exploring whether there are any significant associations and inter-relationships between internal risk factors (such as age, gender, stress, prior injury, self confidence, body weight, trait anxiety) and external risk factors (such as opponent, playing position, match schedule, facility, training quality with injury occurrence.

According to this model, injury outcomes (mechanism, incidence, nature, and severity dependent variables) are dependent upon an array of internal and external factors (independent variables) which predispose the player to multiple injuries during training and competition. As well, inciting events can significantly contribute to injury cause. The presence of both internal and external variables renders the player more susceptible to injury though mere presence of this is usually not sufficient to produce injury. Summation of risk factors and the resultant degree of interface between them are key elements responsible for the athlete’s susceptibility to injury occurrence in a particular situation (Bahr and Holme, 2003; Meeuwisse, 1994; Van Mechelen, et. al., 2005).

As illustrated on the diagram, the inciting event is the final link in the chain that causes an injury. As such, it is a necessary cause that is regularly and directly connected with the onset of injury (Bahr and Holme, 2003, Luig and Henke, 2013). What is key and intrinsic to this diagram is the gradual metamorphosis on the chain of links, folding into each other systematically and eventually leading to mishaps that are multi-factorial in nature. A further look at the diagram indicates the necessity to expand the traditional approach to describing the event. Firstly, the term ‘injury mechanism’ is often used to describe an inciting event in biological terms only. For example, ankle sprain could be described as resulting from an
inversion injury or ACL injury from valgus trauma to the knee. The key elements to the description of injury mechanism should take cognisance of the resultant events leading to the situation performed by the player, for instance, dive shot and jump shot (Bahr and Holme, 2003).

The intrinsic idea that can be drawn from the above discussion involves the interface between biomechanical and kinematic issues that closely align to athletes’ dynamism in their action-packed environment of operation. For an enhanced understanding of the inciting event, this research will not only focus on the place of injury occurrence like playing situation in the field (for instance, pivot player), playing relations, (for instance, pulling, contact/non-contact), or skill to describe injury type as contact for meaningful information, but will establish patterns in the event leading to injury situations. Some information can be potentially important and easier to apply to prevent injuries than an exact biomechanical description of joint motion at the point of injury. To this end, the researcher, therefore, based his study within the confines and pillars of this conceptual framework in order to provide answers to pre-stated research objectives, research questions and preconceived assumptions at the end of this research (See figure 2.1 below).
Risk factors for injury mechanism, incidence, severity and nature.

(Distance from outcome) Independent variables → Dependent variables (Proximal to outcome)

**INTERNAL RISK FACTOR** → **PREDISPOSED ATHLETE** → **SUSCEPTIBLE ATHLETE** → **INJURY**

- Gender
- Age
- Prior injury
- Stress
- Self confidence
- Competitive trait anxiety
- Skill level
  (Sport specific technique)
- Body weight

**EXPOSURE TO EXTERNAL RISK FACTORS**
- Facility
- Equipment
- Opponents
- Playing position
- Match schedule
- Officiating quality
- Coaching style
- Training quality
- Month of season
- Weather

**INCITING EVENT**
- Match schedule
- Training quality

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**Figure 2.1: A dynamic multi-factorial model of sports injury aetiology (Meeuwisse, 1994)**

**2.2.1 Characteristics of the game**

Team handball is a complex sport game that is determined by the individual performance of each player as well as tactical components and interaction of the team. As an Olympic sport game, it is characterised by fast pace defensive and offensive action during the game with the objective of scoring goals (Povas et al., 2012). To score goals, the offensive players (6 players and one goalkeeper) attempt to establish an optimal position for the throwing player
by fast evasive movements over short distances performing powerful changes in direction (with and without the ball), one-on-one action against defensive players and passing the ball using different offensive tactics (Magiya et al., 2010). Since the game is complex and multifactorial, players have to synchronize their dynamic engagements well for running, jumping, pushing, directional changes and team handball specific movements of passing, catching, throwing, checking and blocking (Wagner et al., 2014). Intensities during the game always change between standing and walking, jogging and moderate running, sprinting and fast forward, sideward and backward movements and evasive actions (Michalsik et al., 2012; Povas et al., 2012; Wagner et al., 2014), and, therefore, specific high level of endurance is important to keep high level of play during the entire game (2 x 30 minutes). Equally, team handball is strongly influenced by the tactical concepts, social factors as well as cognitive aspects. Like any other team sport, illness, injuries as well as internal and external influences of materials, individual state of condition and environmental conditions, could negatively impact on player performance in team- handball (Michalsik et al., 2012).

2.2.2 Contemporary trends in injury research

Much literature has been produced identifying and analyzing predictor risk factors of injuries during training and competitions. Epidemiological studies on the aetiology of sports injuries have demonstrated prevention and intervention as focal points for researchers and clinicians, which, prior to take off, the risk factors of injuries must be clearly recognized (Murphy et al., 2003; Bahr and Holme, 2003, 2005; Luig and Henke, 2013). These have been classified as internal/intrinsic (athlete- related factors) and external/extrinsic (environmentally related factors) (Van Mechelen et al., 1992). Extrinsic risk factors include, playing surface, environmental conditions, equipment and training quality while intrinsic risk factors would
take into account previous injury, age, gender, skill level, sport experience, stress and anxiety. However, merely to establish the internal and external risk factors for sports injuries is not enough. Bahr and Holme (2005) assert that to establish a more complete understanding of the causes, the mechanisms by which they occur must also be identified. Meeuwisse (1994), Bahr and Holme, (2005), Rasuli et al. (2012) as well as Luig and Henke (2013) argue that injury occurrence or onset cannot always be confined to a single event or cause, but may result from a multifaceted interface between risk factors that are athlete and environmentally-triggered. The presence and computation of these risk factors and their ‘degree of interaction’ provides fertile ground for the athlete to incur an injury in a given situation (Luig and Henke, 2013).

In view of this assertion, an injury outcome (mechanism, incidence, nature and severity) is, therefore, dependent upon an array of internal and external predictor variables (independent) such as age, gender, prior injury, and equipment. The protection of the athletes’ health by preventing injuries is an important task for the national and international sports federations as well as the International Olympic Committee. Commenting on this issue, Junge et al. (2008) and Church et al. (2001) argue that standardized assessments of sports injuries provides not only important epidemiological information, but also necessary guidelines for injury prevention, which becomes the ‘launch pad’ for monitoring long-term changes in the incidence and circumstances of injury. Finch et al. (1996) see the importance of adhering to injury surveillance during sporting events to be a part of the duty of care to be ingrained by the participants so as to provide safer platforms for future events. For these reasons, most research work has focused on injury surveillance and preventive measures on identified potential risk factors during training and competition in handball so that injury could be reduced in severity.
2.3 Theoretical Framework

In this section, model theoretical backgrounds and directions of the actual approaches in sport injury research are presented. It is within the context of theories and models through which a systematic view for researchers to explain and predict human behaviour is mirrored to guide peoples’ understandings and how actions can specifically be influenced (Clement, 2008; Deroche et al., 2007; Levy et al., 2008; Finch et al., 2002). One of the most common cited theoretical models of sports injury prevention over the past decade has been that initially articulated by Van Mechelen et al. (1992). The theory presented a version of the standard public health prevention model (Robertson, 1992) to the sports injury context. In its approach, four stages to sports injury prevention have been outlined, which involved establishing the extend of the problem, its aetiology and mechanisms of injury, then introducing preventive measures, culminating into the last stage that makes an assessment of the effectiveness of pre-stated preventive measures (Van Mechelen et al., 1992).

Over the past decade, this four stage model has importantly been adopted as a valuable instrument in guiding epidemiological injury research in sporting circles (Finch, 2008). From a research point of view, it clearly outlines the direction of required evidence about sports injuries and their casual factors. More so, its acceptance to a broad risk management/epidemiological control model, addressing the problem similar to those proposed for general injury control, has had its impact being felt in the field of injury research (Anderson and Menkel, 1995; Lett et al., 2002). In spite of its renowned strengths, however, the model lacks vivid clarity to sufficiently describe the directions required for research that leads to direct inquiry prevention once prevention measures have been proven (Finch, 2008).
Another theoretical framework developed on the aetiology of injury research is the dynamic model which has been developed by Meeuwisse (1994). The dynamic model accounts for the multi-factorial nature of sports injuries and, in addition, takes the sequence of events eventually leading to an injury account (Bahr and Krosshaug, 2005). The model describes how multiple factors interact to produce injury and, as such, can be used to explore the inter-relationships between risk factors and their contribution to injury occurrence (Bahr and Holme, 2003).

Meeuwisse (1994) classified the internal risk factors as predisposing factors that act from within, and that may be necessary, but seldom sufficient to produce injury. In this theoretical model, external risk factors act on the predisposed athlete from outside, hence are classified as enabling factors in facilitating injury manifestation. The presence of both internal and external risk factors renders the athlete susceptible to injury as a result of their interaction. The model proposes the inciting event to be the last link in the chain that causes an injury, which is a necessary cause. Meeuwisse (1994) argues that such an inciting event is usually directly associated with the onset of injury. Similarly, Macintosh (2005), Murphy et al. (2003), Bahr and Krosshaug (2005), Bahr and Holme (2005) as well as Luig and Henke (2013) also developed theoretical models in which they all concur that risk factors of injuries must be clearly established and be the focal points for prevention and interventions.

Finch (2006) further developed a related six-stage research framework ‘The Translation Research into Injury Prevention Practice-TRIPP’ The framework recognises a complete evidence base for prevention of injuries which requires a comprehensive understanding of the aetiology of injuries; and the development of interventions to directly address the identified
injury mechanisms. The next stage involves formal testing of intervention measures under controlled conditions (that is, efficacy, research). Next, is understanding of the sporting and individual athlete behaviour context in which the interventions are to be confined. This is followed by potential adaption of intercession to take this implementation context into account (Finch, 2006). Then assessment of potential factors associated with the real world into measures and application of safety measures and development of implementation strategies to accompany the real world “roll out” of the intervention is carried out. In the last stage, formal evaluation of the effectiveness of injury prevention measures within the implementation context is done (Finch, 2006).

Although an appreciation on the need to consider the implementation context has been recognised in models of general injury control since the 1990s, Finch (2006) admits that this is the first time these concepts have been formally applied to a framework for sports injury research. Particular implementation challenges also exist in the sport injury context (Eime et al., 2004), compared to other injury settings such as road trauma or firearms use, that justify a context-specific framework.

This study adopted Meeuwisse (1994) theoretical framework of injury research for its suitability in identifying and establishing the significance of understanding the interaction between external and internal risk factors that subject players to multiple injuries in tertiary handball. The framework uses a multi-factorial approach since injury cause cannot be attributed to a single inciting cause or event. The framework identifies a number of athlete and environmentally-triggered variables whose interaction during training and competition may result in injury occurrence. At the same time, the model allows for testing of pre-stated
hypothesis to measure the degree of severity; injury pattern and prevalence rate so that corrective, preventive measures could be provided. The model permits a methodical tracking of the chosen cohorts’ exposure (players) to identified extrinsic risk factors of intent prospectively so that the degree of casualty could be arrived at. The use of this model permitted the researcher to work with a large sample size at one time from which large amounts of data was collected and quantified for inferential analysis. It allowed full complete evaluation of athletes’ physical and psychological integrities for easy tracking of events as they occurred than it being done in retrospective. The dynamism of this framework, in practice, suits contemporary injury research methodologies while it can also be applied to multi-disciplinary sport. Hence it was strongly aligned to the quantitative approach used in this study. A vivid description of the adapted conceptual framework from Meeuwisse (1994) was diagrammatically presented in section 2.2 above.

2.4 Empirical reviews/findings

2.4.1 Impact of risk factors on player performance

Numerous injuries have been reported in handball each year, resulting in decreased physical activity and work time lost, in addition to substantial medical costs. Available literature from a report by Egger (1990) on Australian Health Promotion Research Centre has shown a high estimate of $1 billion annually channelled towards sports injury rehabilitation world-wide, handball included. A similar trend was also noted in Kraus and Conroy’s (1984) report on mortality and morbidity from injuries in sport, whose estimates stood at 3-5 million injuries annually in the United States alone. Surveillance by the National Collegiate Athletic Association Injury Surveillance System for 2000-2001 indicates that the most vulnerable injury appendages during collegiate handball and basketball were ankle, knee and lower leg.
This is possible as these sport codes share similar skills and dominant limbs used during the activities all related to different environmental conditions and athlete related factors. Challenges of this nature are also similar to collegiate handball in Masvingo tertiary institutes as indicated by high cumulative percentage rates of (73%-85%) between 2010-2013 seasons, hence a cause of concern to the associations and the health ministry.

This international problem, saw several organizations engaging in the development and implementation of seasonal injury report systems and preventive measures such as the Canadian Inter-Collegiate Sport Injury Registry (CISIR) (Sevim, et al. 2002); the Australian Centre for Research into Injury in Sport and its Prevention (ACRISP), Sports Injury Research Centre (Canada), Clinical Sports and Exercise Medicine Centre (South Africa) and Oslo Sports Trauma Research Centre (Norway) (IOC report, 2009). All are currently operating under the auspices of IOC dealing in epidemiological research in sports injuries. However, no handball publication on local issues in Zimbabwe has been claimed through these organizations to date.

This lack of documentation implies that the high manifestation rate of handball injuries among tertiary institutes in the country, and Masvingo Province in particular, require urgent attention. A report by F-MARC (2009) indicates that a total of 478 injuries were reported in handball from six international tournaments. This corresponds to an incidence rate of 108 injuries per 1000 player hours or 1.5 injuries per match, but varied between tournaments. It was the lowest in the 2002 European cup of women and highest in the 2004 Olympic Games. Similarly, local tertiary tournaments and games also seem to be experiencing problems of this nature but are not addressed.
Several studies confirm injuries which are multi-factorial in nature during matches. In a study conducted in Turkey league on 50 handball players by Kirisci et al., (2010), 80% of the players reported an injury. A similar study by Dirx and Geus (1992) of 130 handball players in Netherlands indicated that 35.4% suffered dislocations, 25.4% sprains, 5.4% to crushing and 13.8% ligamental tears. In a study of 108 handball players in Switzerland by Langevoort et al. (2007), 42% of total injuries were located in the lower extremities and 8% were sprains while 18% of injuries were reported in the upper extremities, 14% in the head. In an IOC report of 2008, handball injuries during competition stood at 65% while 35% was recorded during training with strains and contusions being the most common (Junge et al., 2013).

Kenya seems to have experienced similar threats. A study by Assembo and Wekesa (1995) during the African International men’s championships in Kenya, revealed an injury rate of 56% with similar results being announced by Langevoort et al. (2007) who recorded 28% and 32% from the 2003 World Cup and 2004 Olympic games respectively. On the same issue, Oehlert et al. (2004) confirmed 34% injury record, with Koren (2010) attributing these injuries to a combination of internal and external factors.

A study by Seil (1998) in Germany handball league indicated that match injuries ranged between 56% - 98% (acute) and 2% - 44% (overuse). According to Hawkins et al. (2001), most injuries occur in pre-season matches and at the start of the season which they have attributed to insufficient physiological and psychological fitness of players to participate in the strenuous activity of playing handball. This signifies the importance of players being physically fit during matches because, in most cases, players have an increased desire to win.
matches, thus they are under pressure themselves to perform at higher levels than they are capable of.

Although most research studies (Langevoort, 2007; Myklebust, 2013; Koren, 2010; Meeuwisse, 1994; Murphy et al., 2007) have proposed guidelines for identification of risk factors, proper management and prevention of handball injuries, it is not always the case that recommendations are adhered to. This lack of adherence seems to be common even in both European and African countries, possibly as a result of increased competition demands, popularity and the aggressive nature of the game. A similar tendency seems to have also rocked Zimbabwean tertiary handball, particularly in Masvingo Province. Despite this abundance in literature on handball injuries, most studies have only been conducted in European countries that have different political and background settings than Zimbabwe. As well, there is lack of research work in Southern Africa in handball circles than in any other sporting disciplines. To date, not much at all in terms of research literature documentation on causes and preventive measures in handball in the Zimbabwean context has been studied.

This research was thus guided by other research studies carried out elsewhere, as this situation is heavily impacting on the good image of the game. Because the long term consequences of injury are serious and team handball is a high risk sport, there was a felt need to carry out an injury epidemiological research study in handball, hopefully to restore the seemingly lost pride and interest in Provincial tertiary handball. The researcher intended to determine and assess whether the same factors (external and internal) posed a similar bearing and replication for Masvingo tertiary institutes just like in any other country through a prospective cohort study over two consecutive seasons. This research examined the extent
and association to which internal and external factors interact in predisposing players to multiple injuries during competition and training with the ultimate goal to recommend and document plausible safe participation environments delved to address the situation in Masvingo Province collegiate handball.

2.4.2 General incidence of injury in team handball

Injury incidence rate in handball is believed to be in the region of 2 injuries per 1000 hours playing or training time. Professional athletes show notable higher incidence rates than semi professionals or amateurs (Luig and Henke, 2010). Despite there being no significant differences in injury occurrence rates between men and women, available literature indicates women as having more clearly vulnerable cases than their counterparts (Langevoort et al., 2007; Luig and Henke, 2010). A number of authorities tend to agree that 95% of women have a significant higher risk to anterior cruciate ligament than their male counterparts whose record stands at 95% (Myklebust et al., 1997; 1998; Lephart et al., 2002b; Meyer et al., 2004a; Zazulak et al., 2005). The possible explanation to this might be related to hormonal and morphological issues of players which might also be a similar reason for high percentage injury rates among female tertiary handball players in Masvingo Province.

Injury incidence in team handball has been reported by several studies. In a retrospective study by Strand et al. (1990) from 1979-1989 in Norway, an incidence rate of 0.31 ACL injuries/1000 hours at the top three division teams was reported. A similar study by Myklebust and associates (1997) on Norwegian elite handball players (1989-1990 and 1990-1991) reported a high incidence rate of 0.54 injuries/1000 match hours and 2.2% of the
players suffered an ACL per season. The second highest level recorded 0.84 injuries/match hours with 2.0% having suffered ACL injuries.

Myklebust et al.’s (1998) prospective study of ACL injuries in elite Norwegian handball players (1993-1994 and 1995-1996 seasons), further reported a total of 5 ACL injuries among men with an incidence rate standing at 0.06, 0.03 injuries/ 1000 match hours. The study results were a 5 fold higher risk among women than men. Koren (2010) has hypothesised this to have a strong link with intrinsic and extrinsic risk factors in his attempt to explain the differences in results. These works have been supported by Olsen et al. (2003) who prospectively carried out a 7 season study on ACL injuries developing on Myklebust 1997, 1998 and 2003 studies from 1989-2000. A record of 9 ACL injuries occurred during regular matches for men, giving an incidence of 0.24- 0.09 injuries /1000 hours.

Apparent from this discussion is that injury prevalence is common among players during matches or training and is a result of an inter-play of different variables (Van Mechelen and Verhagen, 2009) some of which are of multi-factorial in origin (Bahr and Holme, 2003). Injury incidence and mechanism are, thus, an interaction of external and internal risk factors as demonstrated by Meeuwisse (1994), Muessen, et al. (2007); Langevoort 2007., Luig and Henke (2013) and Clarsen (2015) and their-interlink has a strong correlation with injury incidence, mechanism, nature and severity. This information seems to relate more to the current situation of high injury occurrence in Masvingo tertiary handball which this study investigated to establish the real cause so that injury might be reduced in number and severity.
Injury incidence and mechanism have been seen to have a positive association with match schedule. A study by Langevoort et al. (2007) reported that the incidence and mechanism of injury varied during the course of the match. The general tendency indicated that injury incidence increased towards the middle of each half and decreased towards the end with a similar pattern sustenance being reported in all six tournaments of the World Cup, Olympics and European Cup and slightly more pronounced in the second half. A figure of 45% of all the injuries were reported in the middle 10 minutes of both halves (minutes - 11-20 and 41-50) with 58% noncontact injuries (40 out of 69) being incurred. Injury incidence variations were related to types of tournaments with a low figure of 92% being reported in the 2002 women Olympic Games and a high of 97% being noted in the 2004 Women Olympics Games. Overally, no significant differences in injury incidence rates were noted between men and women (112 and 103 injuries/ 1000 player hours respectively). Furthermore, the location and type of injuries during the match revealed a similar pattern in their occurrence in men and women. The establishment made from these tournaments was that women incur significantly more non-contact injuries than men (20% and 12% respectively). These findings, therefore, are indicative of the strong associations that exist between extrinsic and intrinsic risk factors with injury incidence during training and competitions in handball regardless of level of competition. Similar findings were also noted in Masvingo Province collegiate handball which this study addressed in order to provide safe environments during training or competitions.

More researches have been carried out to prove injury incidences during match tournaments and leagues. Assembo and Wekesa’s (1995) study during Kenya’s East and Central African Senior Club Championship in handball, has shown an incidence rate of 2.74% injuries/match and 0.9% injuries/player during the nineteen matches of championships. Leidinger et al.
(2000) studies had similar trends accounting for 96% of Germany’s senior players sustaining knee injuries (26.9%), ankle (20.3%) and rotator cuff problems (17.1%) while (11.9%) were overuse injuries.

In a similar study conducted by Bailasha et al. (2014) for the Kenyan handball league, results indicated high injury incidence rates with more cases being reported among males (2.8) than females (2.5) in one season. The foregoing studies posed a similar threat to tertiary institutions of Masvingo Province where competitions are held annually, with players who are amateurs, and the likelihood of injury sustenance was inevitable.

Ekstrand et al. (2009) carried out a study in professional football of the UEFA injury study in which an incidence record of 27.5 injuries/match hour was noted. This was less than Langevoort et al. (2007) who reported 89 out of 129 injuries/1000 match hour from international handball, but more than Gundersen and Myklebust’s (2009) study of 15.2 injuries/ match hour found in Norwegian club handball. Moller et al. s’ (2012) study on Danish handball players reported 23.5 and 15.1 injury incidences during match and training schedules respectively. A study by Junge et al. (2004) during the 2004 Olympic Games in football, basketball and volleyball (32 matches) revealed an incidence of 2.4 injuries per match (football), 109 (85-133) per 1000 player matches and 73 (57-89) per 1000 playing hours. This indicates more injuries per match, but share a similarity with handball as reported by Koren (2010), despite a lower incidence rate from basketball and volleyball than was reported for handball. This means the nature of the game of handball, compared to other disciplines, predisposes players to multiple injuries hence a lot of precautionary measures should be considered to create safe environments in players during matches and training.
sessions. This might also explain why a high injury rate exists in tertiary institutions of Masvingo which this study investigated.

2.4.3 Prevalence of injuries in sport

A number of authorities have suggested different definitions of the term sport injury due to the diverse nature and design of areas under exploration. In general, sport injury has been commonly defined as any physical or medical condition resulting in the player having to miss participating in sport (Hassan, 2008; F-MARC in Clarsen, 2015). Turner et al. (2012), Timpka et al. (2014a) and Clarsen (2015) proposed “all physical complaints” to be the most common consensus-recommended surveillance definition despite there being relatively few examples for its use in its true form (that is, registration of all medical problems, including those that do not lead to medical attention. Hodgson et al. (2007) believe the reporting of medical-attention incidents should be recommended in consensus injury statements as this is likely to capture a far greater number of conditions than time-loss alone. The argument being laid is the need to establish a more complete picture of the true load of injury and illness that players are subjected to so that appropriate management can be arrived at. However, in practice, time-loss injury definition should be commonly considered particularly in longer-term surveillance programs in team sports (Ekstrand et al., 2011; Bjorneboe et al., 2014).

All definitions seem to hold water and their key elements should be intertwined if at all the main purpose is to provide best preventive measures in injury occurrence in any sport. The duration of the injury differs from one injury to another depending on the severity and condition (Orchard and Seward, 2002). According to Augustsson et al. (2006), Bahr and
Reeser, (2003) and McKay et al. (2001) injury is any incident that occurs during warm up or competition that requires medical attention and causes the player to be absent from sport participation in either training session or match. If a player receives medical attention, injuries are referred to as “medical attention injury”, whereas an injury that causes a player to miss at least a full part in future training or match play is constituted as “time-loss injury” (Fuller et al., 2006; 2007a; 2010). Bahr (2009) points out that time loss definition is probably the most commonly used, as it, at least covers the most relevant injuries. Caine et al. (1996) lament the lack of agreement on a sound definition of sports injury from researchers, yet an array of known factors about sports injuries from the medical and sports medicine literature exist. A working common definition should, therefore, be provided for meaningful sport injury research.

Research findings by Abernethy and Bleakley (2007) revealed that 8% of adolescents drop out of recreational sporting activities annually due to injury. A high rate of injuries occurs during sports though most of these are not very severe but rehabilitation delay may lead to more severe injury development. This delay, in many cases, can be attributed to economical, social and diagnostic challenges of the rehabilitation and treatment process. Intrinsic to the foregoing assertion is that the nature and cause of injury in sport can heavily be influenced by the interaction of intrinsic and extrinsic risk factors. This interplay, in turn, could determine injury mechanism severity and circumstances surrounding injury occurrence during training and competition.
2.4.4 Injury severity

Fuller et al. (2010) views the definition of severity of an injury as the number of days the athletes will not be able to undertake their normal training programme or competition. Clarsen (2015) defined injury severity as the number of days that have elapsed from the date of injury to the date of the players’ return to full participation in team training and availability for team selection. Injury severity can be classified as minor (1–7 days, or 1–3 days or 4–7 days), moderate (8–28 days), severe (> 28 days) and carrier ending injuries (F-MARC, 2007). All injuries that result in the athlete being unable to undertake his or her normal training programme or being unable to compete at least the day after injury are classified as time-loss injuries (Junge et al., 2008).

Other literature state different durations and classifications, like Orchard and Seward (2002) who categorized severity of injuries according to the number of games missed due to the sustained injury. Caine et al. (1996) classified injuries into four levels: first, injury with no time lost and no effect towards the sport and fitness activities. Second, injuries with time lost and modifying the duration or intensity of sport and fitness activities. Thirdly, injuries with time lost and causing a player to miss part or all of any sport and fitness activity. Fourth, injury with time lost causing a player to miss part or all of any sport and fitness activity and in alterations in daily life such as crutches.

Generally, the above authorities tend to agree that injuries should be grouped and that there is a close alignment with the nature of sport, circumstances and current environment and situation in which it is being conducted. This, tied together with intrinsic and extrinsic risk
factors, would greatly influence injury mechanism and severity outcomes which a well informed coach should be aware of so that injury risk during matches and competitions could be effectively reduced.

2.5 Relationship between Intrinsic and Extrinsic risk factors

There is a general agreement by most epidemiologists that sport injuries can be classified into traumatic incident/acute and chronic/overuse injuries (Henke and Luig, 2010; Watson 1995), though variations in classification may differ. Traumatic incident injuries result from a specific, identifiable event (such as facility, equipment, etc) whereas chronic overuse injuries are caused by repeated micro trauma without unique identifiable event responsible for the injury (Luig and Henke, 2010). Traumatic incidence (acute) injuries are most common in sports requiring long periods of training such as running, jumping, turning and throwing (Bird et al., 2004). This tendency is also similar to handball which requires sharp body manoeuvres and conditioned fitness, lack of which may lead to injury sustenance in players during matches or training sessions. Sports injuries have also been classified by their nature (distortion, sprain, strain, ligamental raptures, wounds), location (foot, ankle, wrist, hands, trunk, elbow etc) (intrinsic factors) and direct causes (extrinsic factors) (Dirx et al., 1992; Langevoort, 2007; Koren, 2010). It, therefore, implies that an understanding of various situations in which injuries may occur and their causes is critical in order to prevent and apply plausible rehabilitation methods.
2.5.1 Injury mechanism in sport

In injury research, it is common that epidemiological and biomechanical models are used to explain the interaction between different causative risk factors as well as description of the inciting event which Henke and Luig (2013) have termed “the trigger event”. Information of such kind is critical as it becomes the ‘launch-pad’ to develop specific measures that address sport-specific types of injury (Bahr and Krosshaug, 2005). With regard to this, a genesis of classification of injury mechanisms has been proposed by various authors. The Committee on Trauma Research, as cited by Bahr and Krosshaug (2005), classifies casual mechanisms into crushing deformation, impulsive impact, skeletal acceleration, and energy absorption and extent rate of tissue deformation.

On the other hand, Seering et al. (1980) have proposed seven basic mechanisms of injury ranging from contact of impact, dynamic overload, overuse, structural vulnerability, inflexibility, muscle imbalance and rapid growth. However, Bahr and Krosshaug (2005) bemoan that, although the foregoing definitions may make sense as they might appear from a mechanical perspective, and be helpful in other areas of research, they might be insignificant if the objective is to identify modifiable causes with a potential for intervention in sport injuries.

For instance, a situation in which a handball player sustained shoulder tendonitis during a dive shot and push from an opponent shows aspects of a playing situation and related skill when injury occurred. Additional explanation could be that the incident occurred to a powerful attacker who was pushed just as he/she was trying to pass the opponent in a
maximal effort which included aspects of an athlete’s characteristics and behaviour as well as an opponent’s behaviour. More so, this can be accompanied by a more detailed biomechanical description that the injury was as a result of large external valgus and rotation moment combined with a translator shift of the tibia relative to the femur (Bahr and Krosshaug, 2005). Bahr and Krosshaug (2005) insist on the need for the description also to include information ranging from the playing situation, player and opponent behaviour to a more or less detailed biomechanical description of joint motion and loads.

It is apparent from this discussion that epidemiological injury research should take a multifactorial approach in order to gain a full understanding of the relationship and association that exists between different variables (external and internal) and how they may impact on players’ performances during training and competition. In the case of this study, injury cause cannot be divorced from biomechanical and kinematic issues as they relate to loads imposed on the player during dynamic actions and how such loads can be detrimental to injury cause. This might assist in the establishment of the cause and effect so that suitable preventive measures could be provided.

There is a general trend from literature on sports injuries and how the term “injury mechanism” has been used to understand the mechanisms for ACL injuries. To date, biomechanically oriented descriptions dominate, although to a different level of detail (Bahr and Krosshaug, 2005). Simple features such as “contact/none contact injuries” (Arendt and Dick, 1995; Silvers and Mandelbaum, 2007) or jumping/non jumping injuries (Paul et al., 1990) have often been used to describe injury mechanism in sport. Terms like “side-stepping manoeuvres”, “tackle” or “long short” (Strand et al., 1990), “spiking or blocking” (Ferretti
et al., 1992), phantom foot mechanism (Ettilinger et al., 1995), descriptions that are sport specific to handball, basketball, volleyball and alpine skiing respectively have also been frequently used. This clearly indicates that various studies use different biomechanical descriptors to explain mechanisms of injury but with variations in the level of detail. Borden et al. (2000) prefer “deceleration injury” to describe whole body acceleration, while for McLean et al. (2004) “valgus torque” refers to knee kinetics. Anterior drawer describes the relative translation between femur and tibia (Geyer and Wirth, 2004), quadriceps drawer describes the relative translation between femur and tibias as a result of quadriceps activation (DeMorat et al., 2004) and “intercondylar lift off” is a description of the result from either a valgus or a varus load (Hewett et al., 1996). Despite variations alluded to above, they all have in common the effects that internal and external forces have upon the body during dynamic activities, application of which may result in negative or positive impact on player performance (injury/no injury).

Over two thirds (70%) of all reported ACL injuries are believed to be non – contact in origin and the remainder, (30%), involving contact from an outside force such as opponent or other objects on the court/field (Silvers and Mandelbum, 2007). The mechanism of non contact ACL injury in court sports commonly involves a one step/stop deceleration, cutting movements, sudden change of direction, landing from a jump with inadequate knee and hip flexion (at or near full extension), or a lapse of concentration (resulting from an unanticipated change in the direction of play) (Mandelbum, 2007). This is especially true with handball which may precipitate injuries in players. Research indicates that non contact ACL naturally occurs during a deceleration manoeuvre combined with a change of direction while the foot is in a closed chain position. While the foot is in a closed chain position and pronated, the tibia is internally rotated, and the knee is at or near full extension (0 – 20 degrees of flexion). If the
athlete attempts to change direction, the result is an excessive torsional force that can potentially strain or rapture the ACL. This can be caused by the type of surface whose coefficient of friction is too much making the foot to stick and be unable to provide the correct manoeuvres as intended. This might also be the case of high injury rates among tertiary handball players in Masvingo Province which this study explored.

Bahr and Krosshaug (2005) insist that factors ultimately causing a joint injury emanate from the loads that act on the joint (contact forces, ligament forces and muscle forces), which are results of the interface between external and internal forces acting on the body and moments acting within the body. Bahr and Krosshaug (2005) further stress that a detailed biomechanical description of these factors should take primacy as this information is more significant than a description of the playing situation despite the necessity to expand the traditional biomechanical approach to describing the inciting event if the objective is to prevent injuries. To justify this, the description of an ankle sprain in football could result from an inversion injury, a combined supination – internal rotation moment in plantar flexion that causes overload stress to weight bearing structures of the anterior talofibular and calcaneofibular ligaments (Bahr et al., 1998). Similar actions can also be seen in handball in the wrist action during the extension phase when passing the ball. In this case, the combination of supination and pronation actions produces an internal rotation that can make the hand joints more prone to injuries, worse still if the hand is blocked by an opponent when executing a jump shot.

Bahr and Krosshaug (2005) suggest that a full description of the mechanisms for a particular injury type that is sport specific should include information on different levels. They suggest
that the delineation of a provocative event be grouped into four categories to depict injury mechanism in relation to sport specific playing situation point of view, athlete and opponent behaviour. This relates to a qualitative description of the athlete’s exploits and contact with the opponent, gross biomechanical features and body joint analysis. Bahr and Krosshaug (2005) feel an injury mechanism description should rest within the precincts of injury analysis tools that take cognisance of explicit terms, definitions and inherent analytical methods applicable in the explanation of sport performance. Knowledge and understanding on risk factors and injury mechanisms is critical to develop effective preventive measures for sports injuries. To this end, a multi-factorial approach should, therefore, be adopted as the most suitable accounting tool for all trigger events and how they interconnect in pre-disposing athletes to numerous injuries during match and training situations (Bahr and Krosshaug, 2005; Henke and Luig, 2013).

2.5.2 Biomechanical description of inciting event: Risk factor associations

According to Bahr and Krosshaug (2005), a precise description of the inciting event is a key component to understanding the causes of any particular injury in sports. The term “injury mechanism” has been acceptably used in medical literature to describe the inciting event in biomechanical terms but whose meaning is not well defined. According to Whiting and Zerniche (1998), the term can be taken to mean the basic physical development responsible for a given exploit, response or outcome. In another biomechanical perspective, injury is related to improper functioning of an appliance or structure (Fung, 1993).
McIntosh (2005) and Fung, (1993) assert that a biomechanical model that embeds tissue properties and load features into account, injury occurrence usually results from a transfer of energy to the tissue due to forces produced within the elastic series components. These mechanical properties of human tissue and load intensity placed upon them, determine the body's capacity to tolerate physical loads. These differences in mechanical properties sorely depends upon the nature and type of load; intensity and frequency of maximal load repetitions, the degree of energy transfer; and athlete-related factors such as age, sex and physical condition (Bahr and Krosshaug, 2005).

According to Meeuwisse (1994), the epidemiological model of injury aetiology and its central tenets (internal and external risk factors, trigger events) variedly influence load and load tolerance during maximal and sub-maximal training. Although the three elements influence load, Bahr and Krosshaug (2005) believe that athlete-triggered risk factors play the most critical role in determining the body’s load tolerance capacity. They attribute load tolerance to tissue material properties and ligament size (degree of elasticity and force output) which are influenced by physiological capacities such as cardiovascular fitness, age (internal factor), sex, body size and training background (external factor). The same factors can also influence load as can be the case of a hypertrophied anaerobic sprinter with fast-twitch glycolytic muscles than an aerobic long distance runner whose slow-twitch muscles suit well with the event demands. It also means this same relationship can be realised among handball players as similar demands are also shown when performing forward and side body cuttings and landings in maximal training and match situations which, no doubt, make the player more prone to different forms of injury.
In addition, the external environment, as a causative risk factor on load influence, cannot be underestimated. Training on hard surface increases load and in the same way the inciting event determines this load (Bahr and Holme, 2005). What is intrinsic from the above discussion is that internal and external factors are determinant variables to injury outcomes such as mechanism, nature, incidence and severity. In addition, overloading during training and competition may also place a lot of stress on the weight bearing structures (lower body appendages) which may damage tendons and ligaments and precipitate multiple forms of injury. For instance, development of knee tendonitis during landing and cutting manoeuvres (faking skills), rotator-cuff problems from overuse of the dominant throwing hand when executing a jump shot or pass in handball, eventually leading to chronic injuries.

McIntosh (2005) has recently described a more complex biomechanically focused injury causation to account for additional factors that may positively or negatively impact on the interplay between load and load tolerance. These include player attitudes/ behaviour (psychological), training, skills, equipment, coaching, other competitors and the environment of operation (McIntosh, 2005). This builds on to the work of Van Mechelen et al. (1992), Meeuwisse, (1994), Hewett et al. (2005), Bahr et al. (2003, 2005), Luig and Henke (2013) and Clarsen (2014) as pointed earlier on. The above authorities tend to agree on the need to use the multi-factorial approach when determining and examining the influence and association of external and internal factors when conducting epidemiological research in injury aetiology. They commonly perceive the importance of using a biomechanical approach as it also takes into cognisance factors that are athlete-related and how they inter-relate with each other and external factors to influence injury outcome during training and match situations in handball. More importantly, the level of proficiency in terms of skills might positively or negatively impact on player performance during competition or training which
can predispose the player to injury. More so, psychological factors such as fear, anxiety, inexperience and arousal in relation to the level of competition, might be induced in the players and precipitate injury. Equipped with these, preventive methods can be mapped out.

One of the keynote address in McIntosh’s (2005) model is to describe how load and load tolerance, hence injury risks, can change as a result of changes in such factors through interventions. McIntosh (2005) specifies that knee guards can attenuate impact energy that, in turn, reduces the impact of forces on the knee when falling while correct skills training may assist in maintaining their stability over the weight bearing knee, hence reducing knee loads in the frontal and transverse places. The effects of improved training on knee material properties have been seen to have a positive impact, though this may result in higher forces being applied to the tissue, subsequently causing an injury (Bahr and Krosshaug, 2005; Bahr and Holme, 2003). If a handball player, through strength, fitness or skills training develops a faster (pass) jump shot, this can result in a higher load on the shoulder (shoulder tendonitis) as well as the opponent during the block. Thus, the greater the application of force, the greater the chances of sustaining an injury during training or competition due to the inter-play of external and internal body moments of force. Consequently, knowledge on risk factors and injury mechanisms is necessary to develop effective preventive measures for sports injuries (Bahr and Krosshaug, 2005; Bahr and Holme, 2005) which was the main reason for conducting this study.
2.5.3 Types and conditions of playing surface

Increased ground friction limit and resist the movement of players, increasing the likelihood of ACL injuries. Dry ground surfaces have been seen to increase co-efficient of friction between the shoes sole and ground surface than damp ground and this subject player to ACL injuries more easily on dry surface than over damp surfaces (Scranton et al., 1997). A lot of debate has been raised on whether artificial surface are more or less harmful than natural surfaces. Based on this issue, Meters and Barnhill’s (2004) study on American soccer players afflicted with ACL injuries at collegiate level, demonstrated a 50% non conduct injury occurrence on natural grass than on artificial turf.

In a related study, Orchard and Powell (2003) observed that natural grass was less harmful than artificial turf while artificial indoor floors were reported to be less favourable ground surface than natural wood floors despite there being no gender discrepancy in terms of ACL injury occurrence. In spite of insignificant differences in ACL injury occurrences between the two types of surfaces noted in males from the above discussion, Olsen et al. (2003) reported more Anterior Cruciate Ligament injury occurrence to be more frequent in artificial indoor floors than natural wood floors in females.

A study by McGuine et al. (2006) on surface condition has demonstrated that natural grass uniquely causes non contact epidermal and muscle-related trauma, whereas head and ligament injuries are common on field turf. According to Bahr and Krosshaug (2005), training on hard surfaces is a risk factor of injury influencing an athlete’s performance through increasing a biomechanical load. In a systematic review of risk factors by McGuine
et al. (2006), in child and adolescent sports, the author reported that the type and/condition of playing surface was identified as a potentially modifiable risk factor that influence child and adolescent sport players (Emery, 2003). It is apparent from this assertion that some risk factors identified in this study can be modified as a protective measure to better player performance which might also reduce injury burden in Masvingo collegiate handball.

Playing surface and shoes must be considered when determining whether or not these factors can independently increase the rate of non-contact ACL injuries in women (Silvers and Mandelbum, 2007). A recent study of the incidence of ACL injury in European team handball found that injury rates on wooden floors (parquet), which generally have lower friction, are lower than those on artificial floors, which generally have higher friction. According to Silvers and Mandelbum (2007), a total of 174 ACL injuries were incurred over 11 seasons with nine occurring in men and 44 in women. A figure of 4 was reported for men to have occurred on wooden floors and 5 on artificial floors while for women a record of eight occurred on wooden floors with 36 being on artificial floors. This indicates that the risk of ACL injury for woman is higher than for men on artificial floors than on wooden floors.

Olsen et al. (2003) have demonstrated that there is an increased risk of ACL injuries on high friction floors in handball, but for female players only. This is indicative of the interaction between sex and floor friction in injury risk, which suggests there may be a difference in the characteristics of the inciting event between sexes as well. Bahr and Holme, (2003) believe that, perhaps, differences exist between male and female players in the way body manoeuvres are executed during dynamic transitions, which exposes the female knee to a more defenceless situation when shoe coefficient of friction is high. This might be similar to
women handball players in tertiary institutions of Masvingo who seem to be more vulnerable to multiple injuries.

Uneven playing surfaces have the potential to trigger ACL incidence as authenticated by Huston et al. (2001) whose study reported landing or stepping on an un-even surface (inconsistency in grass or another player) at the time of injury to cause injury. More so, the effects of wet ground/ field were seen to affect the rate of ACL injury in a study by Scranton et al., (1997) that revealed 61 non-contact ACL injuries in 22 National Handball League (NHL) teams over the course of four seasons. The variables of surface, shoe type, playing conditions and shoe spotting were identified for each ACL injury. Study results announced 40 non contact injuries to have been as a result of conventional cleated shoes on natural grass and 21 being reported on an artificial surface. The same study revealed that injury rates on game day exceeded rates in practice in which 47.5% occurred during game-day exposures despite the fact that the practice versus game day exposure was 5:1. Of these injuries, 95.2% occurred on dry field. This implies that more injuries occur during game day exposure more than on natural grass fields. An investigation by Bradley et al. (2002) reported no differences in rates of non-contact ACL injuries between natural grass and artificial surface throughout the season’s games. This is in tandem with study results from Orchard and Powell (2003) who found no increased risk of ACL sprains in natural grass compared to dome and open turf. This was in spite of an increase of 82% and 18% reported by Bradley et al. (2002) on natural and artificial surfaces respectively when taking into account practice sessions. Meyers et al. (2004) and Fuller et al.’s (2007; 2010) studies revealed no significant differences in ACL injury sustenance between artificial turf and natural grass in practice and competitive games among male handball and football players.
In a 5 year descriptive epidemiological male study in National Collegiate Athletic Association of Football, Dragoo et al. (2012) observed that increase in ACL injuries in artificial surfaces was relative to natural grass for both pre-season and in-season periods but not in the post season period. Research work by Dragoo et al. (2012) shows artificial surfaces to be potential risk factors that predispose athletes to ACL injuries in games and practice than from natural grass across all divisions with games reflecting higher risks than practice. With regard to specific type of artificial turf, third generation surface (with fill) had more risks of ACL injury compared to first and second generation surfaces (without file) (Dragoo et al., 2012).

In another study, an investigation to compare the risk of ACL injury between artificial turf and natural grass in male handball players for six teams (2 seasons) in Hong Kong and two English Premiership teams, showed no significant differences in ACL injuries between the two surfaces (Fuller, et. al. 2010). The risk of ACL injuries in male handball athletes of the 3 top divisions of Norway during 7 seasons was evaluated relative to the playing surface (wooden floors) generally with lower friction and artificial floors, generally with higher friction (Olsen et al., 2003). The authors concur that the type of floor was not a risk factor for ACL injury in male handball players. This study intended to investigate whether the same factors might also replicate the same results among handball players in Masvingo tertiary institutes. However, the study was only confined to hard, grassy and natural surfaces as no artificial surfaces exist in these tertiary institutions.
2.5.4 Effects of playing surface

In 1974, Torg et al. developed a quantitative measurement entitled “release coefficient” to describe the force/weight ratio of shoe surface interaction. This work was reinforced by Heidt et al. (1996) who found that 73% of the different types of athletic-shoes tested had an “unsafe” or “probably unsafe” rating. Considering shoe design, Silvers and Mandelbum (2007) believe it is important to remember that, although increased friction coefficient may enhance performance, it may also inadvertently increase ligamentous injury. According to a literature review on sports injuries by McGuine (2006), effects of protective equipment such as footwear with no proper grip, have been seen to precipitate injury occurrence during football. An increased friction between sports shoes and floor may produce a favourable effect on performance, through an increased force transmission, resulting in higher accelerations, useful for faking movements, side and forward manoeuvres. However, it may also increase the risk of ACL injury (Renstrom et al., 2008) as, exactly for the same reason (increased force transmission), the forces and torques acting on the lower appendages are higher.

This also implies that the type of footwear players put on across all sports codes may present the same effects, a variable which this study also explored. Preceding work by Ekstrand and Nigg (1989) indicate the need for an optional range to be incorporated into shoe design: one that will minimise rotational friction to avoid injury yet optimise transitional friction to allow peak performance in activities that incorporate cutting and decelerating manoeuvres as is the case of handball. It implies that the interaction between shoe design and surface can influence injury mechanism and severity during play and competition as some injuries players
sustained emanated from slipping on wet surfaces, loose surfaces and slippery shoe surfaces with less coefficient of friction.

2.5.5 Facility, equipment and playing surface relationship

Playing environment has been seen to have threatening effects to players’ safety during handball training and match situations. The game is played on different floor types or surfaces with varying quality regarding friction and shock absorption (Myklebust, 2014) ranging from wooden floors, artificial turfs or grass covered surfaces. Shoe-surface interaction has been studied as a risk factor for ACL injury in most sports (Myklebust, 2014) and in handball circles, it has been shown that ACL injury risk is 2.4 times when competing on artificial floors compared with wooden floors (Olsen et al., 2003). However, Myklebust (2014) in her study disputes that older synthetic and wooden floors tended to have a high friction resulting in injury causes to lower body extremities. Slippery surfaces on the other hand offer low friction and increase risk injury chances due to falling (Watson, 1995). Watson (1995) further insists that surfaces with moderate amounts of friction have the reverse effect and are safer.

Ironically, many modern indoor and outdoor surfaces with exceptionally high levels of friction have been reported to increase risk of injury through anchoring the athletes’ footwear so firmly to allow greater force to be developed and improve performance but precipitate a rise in over-use injuries, strains and sprains (Watson, 1995). Despite players adapting to new types of surfaces, alternating the surfaces makes injury risk unavoidable (Ekstrand and Vigg, 1989). In a study of American handball, Mueller and Blythe (1974) found a 31% reduction in
knee and ankle injuries as a result of improved playing surface and a reduction of 46% when both playing surfaces and boots were changed. Two similar studies in handball also attributed 25% of injuries to playing surfaces (Sullivan et al., 1980; Ekstrand and Gillquist, 1983a). As well, hard surfaces increase the likelihood of chronic injuries to the feet, legs and back while shin splints are commonly attributed to running on hard surfaces. Less hard surfaces have little effects to the body but if too soft, they absorb a significant amount of energy which reduces power output and increase fatigue which increases chances of muscle injury (Watson, 1995).

Despite the difference that exists in sports codes, the surface type can be a common factor for most facilities, even in handball, often producing deleterious effects on the athlete during training and participation. The nature of surface types has the potential to precipitate injuries of varying degrees on the athlete regardless of shoe type being used. Too high or too low a friction can increase the number of injuries and a higher risk of getting an ACL injury (Olsen et al., 2003). There seems to be little doubt that the shoe-surface playing interface is an important risk factor to consider when developing intervention strategies to reduce the rate of knee injuries (Myklebust, 2014). There are traceable degrees of associations between external (facility and floor type, footwear) and injury outcome (injury mechanism, injury severity, and its nature and incidence rate). The same factors had adverse effects on player performance among handball players in Masvingo tertiary institutes as revealed by high injury rates of contact and non-contact injuries sustained during the course of the study.

A study by Mckay et al. (2001) found a more than fourfold increase in the incidence of ankle injury among elite and recreational handball and basketball players wearing shoes with air
cells in the heels compared with those wearing shoes without air cells. In a prospective study on 3,119 high school American team sports athletes to investigate the relation between cleat design and incidence of ACL tears, Lamb et al. (2006) reported significantly more ACL in those wearing edge designs with longer irregular cleats positioned at the periphery of the shoe and smaller pointed cleats positioned interiorly. Those wearing other cleat types, including flat, screw in and pivot disk designs had less injuries.

Murphy et al. (2008) believe an increased shoe to surface positional resistance may have contributed to the increased risk of ACL tears in athletes wearing the edge cleat design. However, Marquez et al. (2012) advise that before using a specific type of shoe, athletes should know the structural morphology of their feet that can adapt to specific characteristics that complement and correct potential foot dysmorphia. The same factor could also contribute to a substantial number of injuries among handball players in Masvingo tertiary institutes due to insufficient knowledge which this study intended to explore.

On the contrary, Milgrom et al. (1991) and Barrett et al. (1993) found no association between shoe type and injury, though more research needs to be carried out to establish any association with injury incidence. Apart from the external support and traction that shoes provide, Barrett and Bilisko (1995) feel that other athlete-triggered factors such as range of motion and effects on proprioceptive input requires greater attention if justice can be done in sport injury research. Nevertheless, the foregoing assertions indicate that shoe type can be a potential predictive risk factor (Marquez et al., 2012) of sports injuries during handball competitions and training which this study sought to establish in Masvingo tertiary handball.
The use of ankle braces to reduce injury incidence have been investigated by a number of authors. In a prospective study by Sitler et al. (1994) on 1601 military recruits playing intramural handball, basketball and volleyball, the unbraced control group sustained more than a threefold incidence of ankle ligamentous injuries compared with braced group. Similarly, Surve et al. (1994) studied the effect of bracing on injury occurrence of ankle sprains in 504 male handball players in which athletes with traceable history of injury, the unbraced control group sustained more ankle injuries (1.16/1000 playing hours) than the group wearing ankle braces (0.46/1000 playing hours). However, the authors reported no differences in the incidence of ankle sprain in un-injured athletes between the unbraced control group and the braced group. An intervention study by Tropp et al. (1985) indicated that ankle braced proprioceptive disk training significantly reduced ankle sprains by 5% while the unbraced control group reported 17% ankle sprains reduction and 3% for the group that wore ankle braces.

Conversely, in the aforementioned study, Mc Mckay et al. (2001) reported the insignificance of ankle tape or braces by elite and recreational handball and basketball players to be unrelated to ankle injury incidences though they, however, pointed out that only a small subgroup wore ankle braces or used tape for support. They suggest this to be attributed to inadequate statistical power to convincingly determine the association between the uses of ankle tape/brace and ankle injury. What is apparent from the above literature is that the use of ankle tape or brace decreases the incidence of ankle injury. An elucidation on injury lessening is that the use of ankle tape/brace as speculated by Engstrom and Renstrom (1998) increases the kinaesthetic awareness of ankle positioning and increases support to the ankle joint by limiting posterior foot inversion. A study by Mckay et al. (2001), however, reported no difference in ankle and injury among handball and basketball players who used ankle tape
or brace and those who did not, which Murphy et al. (2003), contemplates could be linked to little statistical power.

2.5.6 Playing position and injury mechanisms in handball

Playing position has been shown to have a strong association with injury occurrence during training and competition in handball. Several studies have explored risks associated with specific positions, three of which have been summarised by Myklebust, (1997; 1998; 2003). Back players have been seen to experience about 60% injuries, wing players, 28%, line players, 4% and goalkeepers 18%. Research findings by Myklebust have indicated that back players were the most affected group with ACL injuries, followed by wing players, goalkeepers and line players. A recent study by Myklebust (2014) has attributed this trend and tendency for back players to repeated performance of high risk movements of planting, cutting and jumping.

Findings of a similar nature were also announced in parallel studies by Leidinger et al. (2007), Seil et al. (1997), Assembo and Wekesa, (1995) and Oehlert et al. (2004) who all concur that between 52% and 86% of injuries occur in offense. Meeuwisse et al. (2007) revealed lower risk for forwards and highest for central players, though he did not prove a statistically significant difference. Approximately 90% of injuries occur without contact with an opponent (Myklebust et al., 1997; 1998). Of the two main injury mechanisms, it has been found out that approximately 90% of injuries occurred when the player performed a cutting or turning movement or in a one leg landing after a jump. Even if there is no direct player
contact to the knee, some perturbation by opponent interaction can sometimes be observed before the injury (Myklebust, 2014).

Playing position has also been seen to have a strong association with over use injury, thus, can influence injury causation. A reflection from Gundersen and Myklebust ‘s (1998) study demonstrated that 41% of all injuries that needed treatment were overuse in origin and shoulder injury was confirmed as the frequent injury. These high numbers of overuse shoulder injuries have also been established in a Germany study by Gohlke et al. (1993) which reported that 40% of 25 male handball players had been debilitated during handball activity in the previous 6 months due to shoulder pain. Nielsen and Ide (1988) also confirmed that high prevalence of shoulder tendonitis where 8 out of 12 injuries were practice-related. The same study reported a total of 27% overuse injuries. Figure 2.2 below shows the shoulder joint, a commonly injured body limb among handball players.
Similar findings were also reported from the works of Leidinger and colleagues (1990) where “throwing shoulder” and “throwing elbow” accounted for 17.1% and 11.9% of overuse injuries respectively. In accord with the above insertions, Tyrdal and Bahr’s (1996) investigations reported a high vulnerability rate of elbow problems among goalkeepers in the top four divisions. This may be partly due to blocking of hard shots from attackers as well as diving saves to low shots. These numbers are similar to findings by Seil et al. (1998) at a superior non-professional level where one third of goalkeepers suffered from over-use elbow symptoms.

In addition, 17% of the players with overuse symptoms complained about symptoms of the low back possibly related to incorrect posture, bad body mechanics and repetitive moments of force on joints or muscles (Praveen et al., 2012). Research studies on sports injuries in professional and youth handball by European Handball Federation Project (2003-2008),
confirms that the main mechanisms of goalkeeper’s injuries are landing, slipping, and falling (altogether approximately 70% injuries). The attribution to this effect is that goal keepers have too little attention and body tension during the landing phase after the save (EHF project 2003-2008; Luig and Henke, 2010).

In position specific video analysis (EHF safety in sports) wing players were subjected to knee, shoulder and ankle joint injuries. Injury mechanisms were uncontrolled landings and falls as well as collisions. Video analysis showed that even modest contacts can be sufficient to make players lose body-control. With rough tackles and frequent body checking, injury risks in handball are inevitable (Myklebust, 2014). For backcourt players, injury mechanisms occur during interceptions or distortions during landing causing knee and shoulder injuries. Body contact situations result in blunt force causing body twists and distortions which may cause ankle and knee injuries (EHF sports projects 2003-2008; Luig and Henke, 2010).

Similarly, pivot players may sustain knee injuries, shoulder tendonitis, head and hand injuries in body contact and landing situations from distortions, interceptions and blunt force when forcing their way through the defence when performing suicidal jump shots and dive shots in the 6m area. During defensive situations, the body regions injured are hands and lower extremities due to body contacts and landings (mechanisms). The explanations given are (re)acting too late, too slow and poor coordination (lack of block coordination) (EHF sports project, 2003-2008).
In general, players in offensive actions are more at risk than defensive players (Luig and Henke, 2012). It has been confirmed from various researches that attacking back court players have the highest overall incidences of injury, followed by pivot players and central defenders (Luis and Henke, 2012) but pivot players showing the highest rates of head injuries. Female athletes have been reported to incur about 30% injury risk among pivot and backcourt players than any other positions (Frobose et al., 1996) with other studies confirming back court players as experiencing the highest overall incidents with regard to non-contact injuries of the lower appendages (Myklebust et al., 1998; Bradley et al., 2002; Dragoo et al., 2012). The possible reason might be related to adaptation and tactical roles adopted by coaches that players might be involved in during transitional phases of the game as well as their physical capacities.

2.5.7 Training quality, frequency and intensity

The training quality athletes undergo can impact negatively or positively in relation to body conditioning. The most common cause of sports injuries as reported by Shaffer (2006) is improper training whether from a technical or tactical point of view or simply training that is poorly planned and executed. Athletes are exposed to possible sports injuries without adequate preparation for exposure to potential danger to such variables as playing position or type of activity, competition duration or league, competitive and skill level, time dedicated to training and to rest (Watson, 1995). Quantified together, this variable can be turned into a predictive factor (Ferrara, 2007).
As well, performing new or unfamiliar exercises can have detrimental results on athletes as injuries have been seen to frequent at the beginning of seasons, as well as upon introducing changes in the overall training regime (Marquez et al., 2012). High increments of training intensity, training loads and frequencies have been reported as contributory training errors, leading to over-use and overstress in athletes (Watson, 1995; Marquez et al., 2012). These injuries have been seen to manifest themselves in immature locomotion devices caused by unvaried and unbalanced sports practice, especially after training intensification or excessive training (Marquez et al., 2012). Aerobic training increments between 55% and 75% do not transmit negative effects and does not result in injury risk (Tate, 1995) although disproportionate increases in intensity can provoke anxiety and states of distress. Overloading of this nature might also affect tertiary handball players in Masvingo province who are amateurs but mostly involved in academic work with handball being taken as a recreational sport, hence injury sustenance increased significantly as observed in the results of this study.

Higher training volumes have consistently been shown to increase the risk of overuse injury in multiple sports (Valovich et al., 2011; Fleisig et al., 2011). In a study of 2721 high school handball athletes, there was a linear relationship between hours of sport participation and risk of injury (Rose et al., 2011). Specifically, training more than 16 hours was associated with a significantly increased risk of injury requiring medical care.

The volume and intensity of training is correlated with overuse injury risk (Wen, 2007). In youth handball, studies have shown that among throwers, throwing rate has the greatest association with injury rates (Dun et al., 2009). Additionally, form a 10 year prospective analysis of 481 youth handball players aged 9-14 years, Dun et al. (2009) found a 3.5 times
greater likelihood of suffering an injury resulting in time lost from sport participation in those players who executed more than 100 throws per year (Fleisig, et. al., 2011). Among young athletes, shoulder pain was significantly related to training intensity as measured by skill level and number of training hours per week. Similarly, the most dominant body parts that is, throwing arm and landing leg have been seen to be more prone to overuse injury due to overload training loads (Myklebust, 2003). Consequently, the work load varies greatly depending on the sport and characteristics of an individual which makes it a challenge to define sport-specific workload thresholds that are related to increased injury rates (Valovich et al., 2011).

Scheduling issues have recently received more attention as possible factors that increase injury risk in youth athletes. Concern has been raised for year round training in a single sport and simultaneous involvement in multiple teams in the same sport. Tournament scheduling, where several games are often played in a single day, extending over consecutive days, has also been shown a potential factor (DiFlori et al., 2014). In a cohort study on elite handball players below 14 years, Le Gall et al. (2006) reported more acute and overuse injuries in training compared to older players. The frequency was highest early in the season for younger players, compared to older players. The frequency was highest early in the season for younger players, compared to older players who suffered more game related injuries. This suggests that younger players who reach elite levels may not have achieved optimal fitness levels and/ or are experiencing training volumes and intensities that may adversely affect injury risk.
Multi-discipline studies (soccer, handball, cricket, tennis, baseball and athletics) have demonstrated that high workloads between bouts of an activity are consistently associated with increased injury risk (Emery, 2003; Cuff et al., 2010; Fleisig et al., 2011). These relationships between seasonal patterns of participation have been expounded by Cuff et al. (2010) who reported a 42% self-reported overuse injuries in athletes who participated all year versus 3 or fewer seasons.

Tournament scheduling and show cases have also been a concern. Repeated same day exercise has been shown to increase cardiovascular and thermal strain as well as perception of effort in subsequent activity bouts. DiFlori et al. (2014) bemoan the lack of research related to overuse injury issues. They suggest that longer rest periods between matches and games could amplify athletes’ safety and performance, enhance recovery, and minimise the residue effects of previous competitions and environmental exposures (Bergeron, 2009). In terms of overuse injury, scheduling may simply be a marker for a high ratio of workload-to-recovery time. It, therefore, implies that scheduling of matches and training should not be a heavy burden if injuries are to be kept to a minimal.

A good training regime should satisfy the necessary fitness components needed for performance. Watson (1995) attributes over-use injuries to training errors which lead to over-development of one area of the body or one aspect of fitness in relation to others, thereby creating an uneven girth. This creates muscle imbalance on the body limps as the physiological cross sectional area of muscle is proportional to the maximum magnitude of force that it can develop (Murphy et al., 2003). The limb girth has been found to be a
potential risk factor for lower extremity injury with regard to the muscles ability to stabilise and control the joint.

In a study on the relation between limb girth and lower extremity injury, Milgrom et al. (1991) found a significant relation between increased gastrocnemius circumference and incidence of lateral ankle sprain in male military recruits. Similarly, Shambaugh et al.’s (1991) study showed that injured athletes had a greater side to side discrepancy in quadriceps girth (mean (SD) 0.93(0.73 cm) than uninjured athletes (mean (SD) 0.26 (0.57cm).

Poor level of condition in terms of endurance will increase the risk of injury by causing premature fatigue. This condition prevents athletes from extricating themselves from potentially treacherous situations that can be avoided (Watson, 1995). A training regime that does not focus on aerobic fitness is fertile ground for risk factor for injury because, once fatigued; most athletes alter their muscle recruitment patterns which, in turn, may alter the distribution of forces acting on the articular, ligamentous and muscular structures (Murphy et al., 2012).

An attempt to explain factors on severe injury in male handball players by Chomiak et al. (2000) confirmed that poor physical condition was a potential risk factor demonstrating a relation between aerobic fitness and injury. What is intrinsic from the aforementioned studies is that poor planning of training regimes can be a potential predictive risk factor to injuries during training and competition in collegiate handball. What is common is that a number of intrinsic factors (such as poor conditioning), which are health and skill related, are correlated
to multiple injury outcome. As such, training sessions might be sporadic, unorganised uncoordinated and meaningless without taking cognisance of full development on all round fitness components that are related to the physical demands of the game of handball. This research focused on whether any significant association between internal and external risk factors and training quality with injury outcome existed (mechanism, severity, incidence and nature) with the ultimate goal to provide injury preventive measures on potential injury trends.

A number of authors who deal with game performance during a match, claim that one of the important parts of a game performance is also a functional preparation in the meaning of a player’s specific adaptation to load intensity during a match (Moravec, 2004; Votik, 2005; Suss et al., 2009; Psotta et al., 2004). More concretely, load intensity zones for players should be planned and reached during training workouts (in warm ups) so as to adequately prepare them for the demands in match situations (Belka et al., 2010). A study by Belka et al. (2010) on handball players (17-18 years) indicates the suitability of warm up matches to be integrated into the training process because of the similar load intensity with competitive matches. The players spent above the anaerobic level 74% (warm up match) and 66% (competitive match) of the time spend on the court. The study confirmed pivot to be the most loaded player in both types of matches.

In warm up matches, they appeared above the anaerobic level in 82% in comparison with 79% in competitive ones (HR max). For wings it was 67% anaerobic level and 47% from competitive ones load intensity zones. Centre back had load intensity zone pegged at 26% (warm up matches) and 30% (competitive ones). The average time spent by all players above
the aerobic level was 74%, 44 minutes respectively (Belka et al., 2010). In warm up matches, there were 43 goal attacks within a match, with a high amount of errors per match at 15 such as technical errors (attack faults, double dribbling, step etc) appearing during matches. Nevertheless, the physical and technical level of players is a determining factor in terms of injury causation during play in relation to injury outcome. Too high or too little load during warm up can subject the athlete to injury as this can lead to premature fatigue of muscle and stress on the cardio-respiratory and cardio respiratory organs. This can cause strains, ligamental tears and raptures, as a result of poor training quality. This study explored if at all significant association between such internal risk factors with injury outcome existed. It also explored whether playing positions had any significant influence on injury outcome during collegiate handball training and competition. Results showed a strong interlink between athletes and environmentally-triggered variables.

Evidence from literature available indicates that even in developed countries, the injury problem in handball circles still exists. In a study conducted among Turkish handball players by Karanflici and Kabak (2013) during competition, 19.8% of athletes attributed injuries to insufficient warming before competitions, 37.6% of athletes showed illegal behaviour of the opponents and prior to competitions, 12.3% inadequate training in preparation for the competition. Out of 705 players, 505 injuries occurred during competition and 264 during training. A similar 16 year NCAA injury surveillance data, Hootman and Associates (2007) found that injury rates were significantly higher in games than practice for 15 sports studied that included handball. The authors attributed this finding to the fact that the competition allows player to player contact, increased intensity and uncontrolled game situation. Figures are, therefore, indicative of poor training quality prior to competitions which might also be true of Masvingo handball players.
In confirmation with the above research, a similar study by Kamran (2011) on Iranian Professional handball players revealed that the quality of training by coaches (that is, intensity of exercise, rest period between two training sessions and accuracy of training) predisposed players to more injuries. It means that coaches need to make immediate adjustments by addressing the multiple body systems causing negative changes in performance. Although over training syndrome remains a clinical diagnosis, coaches need to be educated on the prevention, warning signs and treatment of overtraining to protecting the safety of the players (Garcia and Bebestos, 2012). Corbin et al. (2013) highly insist that the training load should be altered to include tapering and break for sufficient recovery, which, if not put into consideration, might precipitate a substantial number of game and training injuries.

Handball training sessions should be tailored towards the players’ desire to enhance performance. They should address the known high risk injury situations especially contact situations with opponents and injury situations, especially mechanisms (Luig and Henke, 2010). A training program that is of good quality should have exercises that improve landing, jumping, cutting and planting techniques. Structured warm up programmes, including agility, balance, strength and playing technique exercise designed to improve knee and ankle control during landing and pivoting movements, neuromuscular training for power and strength exercises so as reduce injury risks during competition or sessions, should be formulated (Luig and Henke, 2010). Luig and Henke conclude that a regular structured prevention programme should, thus, satisfy the three criteria namely, basic strengthening; advanced strengthening with integral technical, coordinative and cognitive handball elements; and an individual’s position specific preparation for typical injury mechanisms.
2.5.8 Competition versus practice/training

A number of researchers agree that the injury incidence is greater during competition than training sessions (Dick et al., 2007a; Agel et al., 2007c; McGuine et al., 2006; Olsen et al., 2006; Moller et al., 2012). A prospective study of European handball injuries in 186 men by Seil et al. (1998) revealed that injury incidence during competition was 24 times greater than practice. More than half (54%) of all injuries were located in the lower extremities with the knee being the most common injury.

Messina et al. (1999) reported a greater number of injuries during games than in practice in their prospective study of 1863 male and female high school handball athletes, the ankle and knee being the most vulnerable parts. A similar confirmation was reported by Nielsen and Yde (1989) who recorded 60.5% injuries compared with practice among 123 male Danish soccer players, 84% of all injuries having affected the lower extremity with the ankle being the most commonly injured part. Ekstrand and colleagues (1983) found a significantly greater injury incidence during matches (two thirds of traumatic injuries) than practice (one third of traumatic injuries) in a study of 180 male soccer players. Despite, the differences in terms of sport codes, the nature of handball also share some common ground in that players are exposed to the same type of extrinsic factors such as playing surface, facilities, equipment which may have adverse effects on the players. Players may also sustain injuries during competition and training. Murphy et al. (2003) argue that athletes may be more prone to aggressive, risk taking behaviours during handball competition, which may in turn increase the potential for injury. From this fact, Hatzimanoul et al. (2005) admit that as competition increases, the demands of the game change and the dynamism of the players also increases. With regard to correlation between previous injuries and number of injuries Hatzimanoul et
al. (2005) conclude that the higher the number of previous injuries, the more injuries will occur.

A prospective study conducted during the 2005-2006 school year by Rechel et al. (2010) in handball competition, injury rate stood at 2.73 times higher than practice injury. NATA Injury Surveillance Project showed injury rates to range from 1.5 to 5.0 times greater in competition than in practice for the 10 sports studied (Rechel et al., 2010). In a separate study of North Carolina High School athletes in 12 sports from 1996-1999, injury rates were 4 times greater in competition than practice (Rechel et al., 2010). A number of authors have also confirmed high injury rates in competitive handball (Porat et al. 2004; Hewett et al., 2005; Rechel et al., 2010; Koushki et al., 2011; Hewett et al., 2005). Rechel et al. (2010) have attributed this to amplified playing intensities, aggressive physical contacts and increased exposure to high-risk activities (Marquez et al., 2012).

Compared with practice injuries, Rechel et al. (2010), in an epidemiological study of high school sports injuries sustained, they reported most competition injuries to be season-ending or needed surgical attention. Although authors of few published studies have compared injury severity between competition and practice, one investigator, Porat et al. (2004), found that catastrophic head injuries among handball players occurred most often during competitions. The higher proportion of severe injuries noted by Rechel et al. (2010) were said to be related to increased aggressiveness and physical contact in competition (Lindenfeld et al., 1994; Bere et al., 2014; Koushki et al., 2011). This heightened intensity is believed to precipitate high explosive speeds, high-impact collisions, situations that may call for frequent severe injuries more than the lower impact and controlled contact found more often in practice (Rechel et al.,
2010). In the same study by Rechel et al. (2010), they noted few exceptions of sprains/strains and lower extremity injuries which accounted for the majority of all injuries regardless of the type of sport or whether the injury occurred during practice or competition. These trends were shown to remain consistent with those shown by earlier researchers, who cited high frequencies of sprains/strains (Rechel et al., 2010) and lower extremity injuries (Wedderkopp et al., 2003; Reckling et al., 2003; Moller, 2012) among high school athletes.

Despite the unique characteristics possessed by each sport code and existing differences between practice and competition, all sports involving common activities such as running, jumping, and quick changes of direction, place the lower extremities at risk of injury, particularly sprains/strains (Rechel, et. al. 2010). In this case, handball is no exception since it also combines similar activities during games and training. This research, therefore, intended to interpret risk factors which subjected players to injury. The study has established that significant associations between internal/external risk factors and injury outcome existed.

The type of injury sustained also changes with the level of competition. In handball, the number of over-use injuries significantly rises while the incidence of acute injuries drops as the level of competition increases (Keller et al., 1987; Jorgensen and Winge, 1990). To the contrary, the high incidence of injuries observed in Olympic handball tournaments (2004) and World Championships (2003) reinforces the high incidence of injury risk in matches especially at the highest level (Langevoort et al., 2007).
At the Olympics in London, 75% of the injuries were incurred in match situations and 25% in training (Engebretsen et al., 2013). This picture is approximately the same for other adults and for adolescents and for both genders. In contrast, when looking at ACL injuries, there is an 8 times higher incidence among males compared to a 30 times higher match incidence among females (Myklebust et al., 2008). A trend of this nature might also be true to collegiate handball in Masvingo province since the study focused on both sexes and level of competitions they were exposed to.

Knowledge of match injury allotment for preventive purposes should be undertaken (Myklebust, 2003). In a study conducted by Langevoort et al. (2007) among international handball players, they reported that injury incidences increased towards the middle of each half and decrease towards the end, with 45% recorded in the middle 10 minutes of both halves. A record of 57% injury incidence was noted by Assembo and Wekesa (1995) during the senior International Handball matches in Kenya. In a study among 215 ACL-injured female players, 146 (68%) were reported during match situations with 63% recorded in the first half and 37% in the second half of the match (Myklebust, 2014). Nevertheless, variations of these injuries might be related to game intensity, level of competition and playing status. Similarly, this variable affected collegiate handball in Masvingo Province tertiary institutes, which this study investigated.

Playing at top level increases the risk of ACL injuries. Strand et al. (1990) reported that female players in the top three divisions (Germany) have a higher ACL injury incidence than players playing at lower levels. A similar confirmation was also reported by Myklebust et al. (1997; 2003) in relation to high ACL injury incidences among female players.
Significantly, more injuries can be sustained during games. Meeuwisse et al. (2003) reported more occurrences of ankle sprains to be related to dangers associated with games, but only for ankle sprains resulting in seven (7) or more session losses. Ferretti et al. (1992) believe that the increased frequency of injuries in team handball to be connected with heightened competitive intensities and maximum effort expended during matches. The athletes are at maximum risk, which might make them more vulnerable to injury.

Nielsen et al., (1988) have shown that the rate of incidence of injuries in handball increase during competition than exercise (11.4 and 4.6 damage per 1000 hours play). A similar tendency was also announced by Olsen and associates (2006) and Wedderkopp et al. (1999) who recorded injury incidences of 10.8 and 7.4 respectively, much more than practice sessions. This implies a high incidence of sports injuries in handball during competitions than practice sessions.

Scheduling issues have recently received more attention as possible factors that increase injury risk in youth athletes. Concern has been raised for year round training in a single sport and simultaneous involvement in multiple teams in the same sport (DiFlori et al., 2014). Multi-game scheduling in tournaments extending over consecutive days has been reported to be a potential risk factor (DiFlori et al., 2014). In a cohort study on elite soccer players below 14 years, Le Gall et al. (2006) reported more acute and overuse injuries in training compared to older players with high frequencies being observed early in the season for younger players, compared to older players who suffered more game related injuries. This suggests that younger players who reach elite levels may not have achieved optimal fitness levels and/ or are experiencing training volumes and intensities that may adversely affect injury risk. This
might not spare handball players in Masvingo Province tertiary institutions who are involved in similar tightly scheduled matches in a short space of time.

A number of studies in handball have demonstrated that high workloads between bouts of activity are consistently associated with increased injury risk (Olsen et al., 2006; Flcising et al., 2011; Emery, 2003; Dennis et al., 2005; Cuff et al., 2010). One such study evaluating the relationships between seasonal patterns of athletic participation and overuse injury has been conducted by Cuff et al. (2010). The study demonstrated a 42% increase in self-reported overuse injuries in high school athletes who participated all year versus three or less seasons per year.

Tournament scheduling and showcases have also been a concern. Repeated same day exercises have been shown to increase cardio-vascular and thermal strain as well as perception of effort in subsequent activity bouts. Although DiFlori et al. (2014) show little research linked to issues with overuse injury, they believe that longer rest periods between matches and games have been proposed in an effort to improve athlete safety and performance, enhance recovery, and minimise the “carry-over ” effects of previous competitions and environmental exposures (Bergeron, 2009). In terms of overuse injury, scheduling may simply be a marker for a high ratio of work load- to-recovery time.

2.6 Common anatomical injury locations in handball

It has been generally accepted from available literature that injury in sport is classified into upper and lower extremities of the body which are described below:
2.6.1 Lower extremity

Lower extremity refers to injuries which are located in lower body appendages such as legs, knees, feet, hips and joint structures. Available literature indicates that most acute injuries in handball are believed to occur in the lower body appendages, irrespective of age and gender (Wedderkopp et al., 1997, 1999, 2003; Seil et al., 1998; Petersen et al., 2002; Moller et al., 2012; Reckling et al., 2003; Koren, 2010). With regard to the nature of handball, research indicates that playing the game increases injury risks on lower and upper limp appendages in players (Barami et al., 2010; Luig and Henke, 2010; Clarsen, 2015).

Studies by Bailasha and Gitonga (2007) as well as Bailasha (2013, 2014) have demonstrated the upper and lower body extremities to be the most common sites of sports injuries in handball and volleyball with equipment as the central cause of injury. Shoulder injuries have also been reported to be frequent in handball and volleyball (Myklebust et al., 2013; Bailasha, 2014). The most notable and frequent injury location in handball is the ankle (8% - 45%) while the most severe injuries are knee injuries (7% - 27%), including ACL injuries (Myklebust, 2014).

Integrating the numbers from three international man’s handball championships studied by Langevoort et al. (2007), lower extremity injuries accounted for 43%, 14% of which were knee injuries, while 11% affected the ankle. Papacostas and Malliaropoulos (2011), in their two year study on handball, have reported ankle-foot injuries to be the most commonly affected sites. These were also confirmed by Moller et al. (2012) among Danish youth and senior handball players which had a record of 29%. Mckay et al. (2001) announced an
occurrence rate of 3.85 per participation for foot and ankle injuries with Leidinger et al., (1990) reporting similar figures where 46% of all injuries were seated in the lower extremities, 21% and 12% being located to the knee. In the same study, handball specific injuries, rotator-cuff problems, accounted for 17.1% while “throwing elbow” recorded 11.9% all of them being chronic overuse injuries. A similar record of 22% on knee injuries was also confirmed in studies by Gundersen and Myklebust (2009), with Olsen et al. (2006) reporting lower leg pain (shin splints) to be the most widespread problem among players. These findings were verified by Moller et al. (2012) who also confirmed this as the most common overuse injury type. Moller et al. (2012), in the same study on Danish youth and elite senior handball athletes, has also announced 37% overuse and 63% traumatic incident injuries. Similar results were reported in Masvingo Tertiary institutes since the same sites on players were also vulnerable to handball risk factors.

2.6.2 Upper extremity

The parts referred to as upper extremities commonly include the head, neck, chest, hands, back as well as joint structures. Acute injuries to the upper body appendages are frequent and different studies present numbers ranging from 7% - 50% of total injuries (Langevoort et al., 2007; Wedderkopp et al., 1997; Seil et al., 1998; Olsen et al., 2006). Despite limited literature on overuse injuries in the upper extremities, a study among German male players by Gohlke et al. (1993) showed that 40% of the 25 players examined revealed presence of overuse shoulder tendonitis during training and matches for 6 months. This high prevalence of shoulder problems has later been confirmed in a study by Myklebust et al. (2013) with 57% of 178 tested players reporting presence or having had prior shoulder problems. Further confirmation indicated that 49 (67%) of these players who reported shoulder discomforts had
less training frequencies and 24 (34%) had severe problems which kept them out of matches. The higher injury incidence rate in Masvingo collegiate handball had a similar situation as reported in this study.

It has been found that a high number of head and neck injuries have been reported in top level handball. African study by Assembo and Wekesa (1995) during the East and Central African senior men’s handball championships in Kenya revealed that 43% of injuries among males were located to the head and neck, while the proportion among females was substantially lower with 16%. Similar results were also confirmed in data from Langevoort et al. (2007) from international level players with 29% and 31% being the World Cup 2003 and Olympic Games of 2004 respectively but are higher than those reported by Bailasha et al. (2014) of 13.2%. In a related study by Oehlert and associates (2004), a figure of 34% was confirmed but with few concussions possibly emanating from blows to the face, nose or possible damage to the teeth (Koren, 2010). Assembo and Wekesa (1995) announced only 2 concussions out of 52 injuries while 31 were contusions. Koren (2010) admits that the definition of an injury may have influenced these results where events leading to stoppage of the game (suspensions, breaching rules, etc) were included and where a requirement of time loss did not exist.

Myklebust (2004) has reported that most common types of acute injuries in handball are muscle and ligament strains ranging from 2% - 68% and contusions from 2% - 36%, with less reports on fractures and dislocations except for Fargeli and colleagues (1990) and Assembo and Wekesa (1995) who showed high proportions of fractures, 19% - 22% and 31% respectively. However, Fargeli et al. (1990)’s study was based on patients treated in the
emergency room, which could explain the high proportion of fractures while Assembo and Wekesa (1995)’s study was done among elite male handball players which therefore accounts for these differences. This might explain why their findings have not been replicated in injury surveillance on the elite international level (Langevoort et al., 2007) where fractures represented only 1% - 2% of injuries. Nevertheless, the above authorities have reinforced that various forms of injuries do happen during match situations, though they might vary in number and frequency of occurrence in relation to situational intrinsic and extrinsic risk factors. This might possibly determine the nature, incidence, severity and mechanism of the injury and, as well, the extent to which the sum totals of an array of these risk factors would interact to predispose the players to injury. This study, therefore, investigated the extent to which these factors contributed to injury causation during collegiate handball training and competitions in Masvingo Province with the ultimate goal to recommend solutions to the problems.

The prevalence of jumper’s knee and elbow problems among handball players have also been noted as a problem of concern. A study on jumper’s knee among national elite players has been reported to be 10% among females and 30% among male players (Lian, Engebretsen and Bahr, 2005). Another related study by Tyrdal and Bahr (1996) reported a prevalence rate of 41% of elbow problems out of 729 goalkeepers. The injury mechanism, as speculated by Tyrdal et al. (1996), was related to repeated hyperextension traumas, a relationship that might be possible in Masvingo Province tertiary handball.

In studies conducted by Bailasha (2014) during the Kenyan handball league, significant differences on injuries to the head, shoulder, finger, the knee, hip and ankle for both genders
were frequent. Fisch et al. (2011) commented that the site of a sport injury is specific to the features of a sport and gender which is likely to be the same with case with players in Masvingo tertiary institutions since handball is played under the same specifications of International Handball Federation (IHF).

It has generally been found true that overuse shoulder injury is one of the most prevalent types of injury in handball (Clarsen, 2015). Over arm throwing is one of the key technical skills that provides fast and preciseness as its advantage during training and match situations (Van den Tillaar and Cabri, 2012). Research has indicated that elite players, who perform up to 1200 throws in a normal training week, may be particularly at risk of overuse shoulder injury (Prestkvern, 2013). It implies that the more frequency, intensity and number of throws one partakes; the greater the chances of injury sustenance.

Anecdotal evidence shows that injuries are also located in upper body limbs. A retrospective study on Iranian female handball players (East Azerbaijan Province) by Rasuli and associates (2012) reported a figure of 42.52% upper extremities injuries. In a prospective study of 206 Norwegian male handball athletes (2011-2012 season), Clarsen et al. (2014) reported an average of 28% shoulder injuries (upper extremities). In a parallel study, Bailasha et al. (2014) announced upper limb appendage injuries of 13.82% during an assessment on injury partten among 191 male and 95 female players in the Kenyan Handball League. The differences in figures might indicate unreliable data from retrospective studies due to recall errors than is for prospective studies whose data will be current. Apparent from these assertions is that most upper limb structures predominantly used in handball are susceptible
to injuries and this study reported similar findings among players in Masvingo tertiary institutes.

2.7 Association between intrinsic risk factors and injury outcome

A variety of factors have been proposed to contribute to injuries during training and match situations. Intrinsic factors are defined as individual biological characteristics and psychological traits (DiFlori et al., 2014). Frequently cited athlete-based factors include variations in growth and maturational lines, anatomic alignment, conditioning, biomechanics, history of prior injury, muscle-tendon imbalance, stress, competitive trait anxiety, gender, skill, body weight, self confidence and level of proficiency in sensomotoric development. The contribution of an intrinsic or an extrinsic factor to injury risk is dependent upon individual qualities, current environment of operation and the interaction that occurs during participation (Lysens et al., 2011). Injury sustenance is dependent upon such variables.

2.7.1 Player contact

The aggressive nature of handball indicates that it is a contact sport, hence a certain amount of contact between players is allowed as part of the game. It, therefore, implies that epidemiological studies’ focal reports are mostly based on acute injuries occurring in contact situations, mainly with an opponent (Bere et al., 2014), and 40-60% of handball accidents result from colliding with the competitor (Karanffil and Kabak, 2013).
The game of handball during transitional phases of play involves attacking and defending by the teams involved with application of techniques and tactics. Even if athletes are well trained for the attacking and defending phases of the game, inappropriate contact between players is unavoidable, such as poor timing of contact, accidental contact (collisions) and contact due to foul play, perhaps intentionally (Bere et al., 2014). A study by Ochlert et al. (2004) in handball using video analysis of injuries from the 1992 Barcelona Olympic Games showed that inappropriate player contact was noted at the time of injury in most clips contributing directly or indirectly to the injury. Injury incidences can emanate from direct body contacts between players or by being pushed or held by an opponent, which may put the player off balance and directly cause the injury (Bere et al., 2014).

A typical situation is collision during a forward move by the attacking player towards the defensive line, which represents a basic and necessary move of all back and wing players to develop the attack. When an attacking player receives the ball while moving forward and at the same time has to initiate shooting, he may have minimal time to prepare himself/herself for a subsequent contact with a defending player, who would usually be moving at high speed towards the attacking player in order to stop him (Bere et al., 2014).

Despite numerous repetitions of contact of this nature, mental fatigue and physical unpreparedness for contact by the player might cause injury. Bere et al. (2014) believe that most severe injuries are most likely to occur during fast breaks and the opponent tries to break the counter attack and the subsequent sharp turns and body manoeuvres by both players is likely to result in awkward and unsuspected collisions (Bere et al., 2014).
A contemporary view in handball is that “defence is the best attack”, thus forcing coaches to focus on the defending phase of the game and increasing the extent of game obstruction. This may potentially lead to a higher number of injuries, as inappropriate contact situations also occur during basic manoeuvres performed by the defending player such as obstruction, screening, blocking and stealing the ball (Bere et al., 2014).

Obstruction is a fast tactical move an opponent uses to stop the attacking player, with the intention to stop his action. Inappropriate means such as grabbing the attacking player around the waist while the other hand is blocking the shooting arm near the elbow might be employed, resulting in wrong player contact from bad poor timing of movements or foul play (Bere et al., 2014). During the screening process by the defender who tries to interfere with the attacker’s move by timely positioning his body in an attacker’s line of movement, the defending player often illegally uses his shoulder, elbow or knee. This may result in a collision or falling of one or both parties causing injury (Bere et al., 2014).

Illegal blocking of the ball by a defending player, who uses his leg instead of his arm, can also cause injury to the attacking player. In addition, when the attacking player jumps forward through the defensive line, with the ball held up, the defending player may, by intention or mistake, grab the attacking player, and indirectly contribute to an injury (Bere et al., 2014). In addition, the opponent’s goalkeeper often jumps towards the attacking player (pivots or wings) with the intention of defending the scoring and injuries may occur in contact between the two. To this end, Bere et al. (2014) see the importance of increasing player awareness and responsibility to institute fair play to reduce the risk and prevalence of contact injuries (Bere et al., 2014). As well, contact injuries resulting from poor ball timing
from players with less proficiency: require that they receive proper handling skills to avert this situation (Bere et al., 2014).

Lindenfeld et al. (1994) assessed football injuries among 19-24 years men and women and found 31% of injuries occurred as a result of players’ collision and the highest type of injuries recorded were sprains and muscle soreness. Ankle ligament injuries in men were more than women. Barani et al. (2009) surveyed lower limb injuries in female handball players and reported that the most affected limbs were knee (54.5%) and ankle (20.5%). In addition, the most common injuries were sprains (63.6%) and soreness (11.4%) respectively. Also severe injuries (69.1%) were significantly higher than middle injuries (27.3%) and light injuries (13.6%).

Some researchers have claimed that lower extremities are the most vulnerable areas in contact sports. Rahnema et al. (2009) have stated knee, Ribeiro and Costa (2006), hip, Emery and Meeuwisse (2004), the ankle, is a more commonly exposed limb to injury than other body sites. Different research settings might account for these differences. Murphy et al. (2002) found that most risk factors for lower extremity injuries were due to level of competition which subjected players to immense pressure on the desire to win and avoid losing. This implies that incidence and frequency of injury occurrence significantly rises as competition levels increases and this has direct relationship with the individual’s intrinsic factors and their interaction with extrinsic risk factors.
Koushki et al. (2011) studied the causes and types of sports injuries among male student athletes participating in Olympiad Games in handball. Findings were that injuries incurred were due to contact, inappropriate warm up and non-standard equipment such as type of floor. According to this study, light to moderate injuries were significantly greater than severe injuries. Findings showed that the most frequent type of injuries were muscle-tendinous soreness and bruises in handball. Similarly, this present study also reported injuries from non-standard equipment and contact situations.

A study by Luig and Henke (2010) for European Network for Sports Injury Prevention from 2003-2008 revealed that both men and women (14-45 years) were at higher risk to traumatic and over-use injuries. These mostly affected the head (17.4% men and 13.2% women), the hand wrist accounting for 19, 8% (men) and 19.6 % (women), the knee accounting for 23% (men) and 31% (women) and the ankle accounting for 18, 6% (men) and 22.1% (women) respectively. All these were a result of contact and non-contact with either an opponent or interference with an external factor; hence an inter-link of risk factors is evident in injury causes which similarly affected players in Masvingo tertiary institutes.

In a related study by Kaplan et al. (2008) on rugby players, commonly reported injuries included muscle-tendinous and ligament strains and tears, hematomas and contusions of the lower extremity. To give an indication of the injury sites in the lower limbs, Bathgate et al. (2002), in their prospective study of Australian rugby players, reported lower limb hip injuries of (2%), thigh (19%), knee (20%), lower leg (6%), ankle (11%) and foot (3, 5%). For Kaplan et al., (2008), injuries to lower limb appendages accounted for 13-19% of all injuries that included lacerations, contusions, sprains, dislocations, fractures, rotator cuff tears.
The nature of the game of handball is also similar to rugby. It calls for a lot of contact and evasiveness, requiring physical encounters during jump shots (which can result in over-use of the dominant throwing hand), jumping, landings, sudden turns and cuttings and dive shots in the 6m area. Such manoeuvres can precipitate knee injuries, head injuries, hand and wrist injuries when blocking an attacker. Hard tackling and pushes, as well, can subject the athlete to various forms of injuries. More so, such repetitive stress on biological tissues such as capsules, ligaments or tendons can lead to lower back pain due to muscular imbalances causing periostitis, shoulder pain and elbow pain (Luig and Henke, 2010). Imbalance in the strength of opposing muscle groups pre-disposes the athlete to strain injury of the weaker group as speculated by Watson (1995). For example, the biceps and triceps of the dominant throwing arm during passing and when an all-out effort is needed during the execution of the jump shot and dive shots. In his study, Lysens et al. (2011) found that subjects with high levels of explosive strength were likely to suffer from acute/overuse injuries than individuals with low scores. Watson (1995) concluded that this was attributed to their developing power during sports training, so being at greater risk of violent, acute injuries.

2.7.2 Prior injury

Previous injury has long been seen as the strongest predictor factor of future injuries (Caine et al., 2006; Ramirez et al., 2006; Buist et al., 2010). Underpinned to this assertion, Watson (1995) linked this predisposition to three reasons; chiefly, weaker body after injury experience, premature return to action before full rehabilitation, and re-injury from the same risk factors that precipitated the index injury.
In a review of major studies of handball injuries Keller et al. (1987) found out re-injury to be a common problem that was strongly related to partial rehabilitation. DiFlori et al. (2014) agree that repeated overuse chronic injuries may occur in handball as a result of inadequate rehabilitation of the index injury and/or failure to recognise and correct the factors that contributed to the original injury. A study by Karanflici and Kabak (2013) of 705 Turkish handball players also announced similar results. In a prospective epidemiological study of 164 senior handball players by Cumps et al. (2007), the injury rate of resurginig injury stood at 47.1% and new injuries being 52.9%.

In a comparable study conducted by European Network for Sports Injury Prevention through Luig and Henkel (2010) on Daniel Stephan’s injury career from 1999-2008, indications were that the player sustained an Achilles Tendon recurrence three times, 2002, 2003 (World Cup Championships) and 2006. Besides, the player on average sustained one or two injuries during his career which pre-maturely ended in 2008. McKay et al. (2001a) found out that a history of ankle injuries was the best predictor for the re-occurrence of ankle injuries and resurfacing of other injury types. A similar exploration by Dick et al. (2007a) indicated that the recurrence of ankle injuries ranged from 26%-75%. A similar nature of this kind was also true of the situation among handball players in Masvingo tertiary institutes who incurred different forms of chronic injuries as reported in this study. Intrinsic to the fore going discussion is that a player who participates alongside prior injury has greater chances of suffering new cases that can be more severe than the original ones, let alone if he/she participates in a ‘culture of risk’ related to insufficient injury rehabilitation. It then becomes a challenge if the athlete brings along with him/her technical flaws of this nature to handball which highly involves a lot of player contact and aggressiveness. The diagram below (Figure
2.3) shows the anatomy of an ankle joint and the commonly susceptible ligaments/tissues to injury occurrence among handball players.

![Ankle Anatomy Diagram](http://www.niams.nih.gov)

**Figure 2.3: Lateral View of the Ankle** (http://www.niams.nih.gov Online Nov 2013)

The after-effects of handball injuries, like other sports, are long lasting as this can affect lost time even in school work and further sport participation (Myklebust, 2013). A study by Nielsen and Ide (1989) on re-injury incidences among players confirmed that 41% of injured players still had complaints 6 months after the end of the season. In agreement with these findings was Moller et al. (2012) who discovered that having two or more previous injuries increased the risk of a new injury among the under 16 players.
A study among handball players showed that the risk of a re-injury of a re-constructed ACL was 13%, all of them after returning to match play in handball (Myklebust et al., 2002). With regard to correlation between previous injuries and the number of injuries, Hatzimanoal et al. (2005) conclude that the higher the numbers of previous injuries, the more the injuries are likely to re-surface which Bradford (2000) partly attributes to changes in game demands, intensity and increase in players’ dynamism. The same situation, as discussed above, did not spare collegiate handball players in Masvingo Province and this was a result of interplay of different variables during competition and training which this research determined and explored.

An anterior cruciate ligament (ACL) injury is a serious injury with potential long term health consequences. Osteoarthritis has been established as risk factor that limits the knee’s range of motion with altered function from the swelling (Gillquist and Messner, 1999). A follow-up of handball players with an ACL injury by Myklebust and colleagues (2002) showed those 6-11 years after injury, the prevalence of radiological Osteoarthritis was 42% in surgically treated patients and 46% in those who did not have surgery. The high risk of Osteoarthritis after ACL injury has been shown in a similar study by Porat et al. (2004) of handball and football players. A quick question by Myklebust et al. (2014) is on whether handball play increases the risk of Osteoarthritis even when no injury has been recognised, but from the loading itself.

A study by L’Hermette et al. (2006) found out that the risk of developing premature hip Osteoarthritis mostly affected retired handball players and significantly greater than for the general population. Twenty former male handball players and 39 control subjects indicated
that 60% of the handball players were diagnosed with Osteoarthritis in at least one of the hip joints, compared to only 13% of the control subjects (L’Hermette et al., 2006). This can be true of handball players since the nature of the game calls for sudden changes of direction and stopping, one foot landing during jump shots. This puts a lot of stress on the hip and knee joints. This can provoke over-use and chronic injuries and ligamental raptures on players; hence, there is a strong association between internal and external (surface) factors with injury outcome.

Injury not only compromises important static and dynamic stabilisers of the lower extremity, but may also be associated with differentiation of a joint. Disturbance of the ACL increases anterior knee laxity which may be associated with dislodging that may compromise a portion of nueroceptors that innervate the joint and may lead to worsened proprioception (Beynon et al., 1999).

A number of studies have demonstrated a strong evidence that previous injury, especially when followed by inadequate rehabilitation, subjects an athlete to an increased risk of suffering ankle injuries (Milgrom et al., 1991; McKay et al., 2001; Surve et al., 1994; Bahr et al., 1997; National Collegiate Athletic Association, 2002,), knee, (Messina, Farney and DeLee, 1999) and all injuries as a group (Chomiak et al., 2000). In accordance with the above assertions, Marquez et al. (2012) has noted that previous injuries and incomplete recovery from the same exposure before returning to train or compete at the desired tempo and intensity may provoke previous injury. This has been seen to further provoke the index injury, and the muscle tissues are, therefore, incapacitated; hence delaying the healing process. Walter (1989) demonstrated that previous injuries were one of the most indicative
factors through a multiple regression analysis. To this end, Wedderkopp et al. (1997), in his study of handball injuries, found a much higher relationship between previous injuries and new injuries while a similar trend by Langevoort et al. (2007) showed that the effect of previous injuries stood at 36% in the incident of new ones.

Correlation of an inter-play of two or more variables might demonstrate that the existence of previous injuries greatly enhances the risk of their recurrence. For this reason, Hatzimanoal et al. (2005) warns that a handball player who has had previous injuries must be responsible enough to take shielding measures to avoid a possible recurrence of these injuries in future. Behrman et al. (2000) insist that an injured athlete must undergo complete physiotherapy and avoid a pre-mature return to play, which, according to Lynch and Renstrom (1999), may lead to the development of a chronic problem that might be difficult to cure or treat. More so, Aronen (1991) as well as Ehrich and Gebel (1992), prescribe that it must become part of the consciousness of all players who suffer from an injury to return to their previous sporting activities only after a complete adherence to the rehabilitation programme. This might also apply to handball players in Masvingo tertiary institutes having a similar problem.

In a study comparing ankle sprain incidence among those using sport stirrup (braces) versus an unbraced control group, Serve et al. (1994) noted a significant increase in ankle injury rates among unbraced handball athletes with a previous ankle injury (1R=0, 86/1000 hours) compared to unbraced athletes with no history of injury. (1R=0.46/1000 hours). In a study to investigate the association between injury history and lower extremity muscle strains among Australian football players, Orchard (2001) observed that an injury sustained within the last eight weeks increased the risk of sustaining a muscle strain to the same location for the
hamstrings (RR=6.33) quadriceps (RR=15.61), and calf muscles (RR=8.94). Likewise, injuries sustained outside of an eight week time interval resulted in an increased risk of sustaining muscle strains at the same location for the hamstrings (RR=2.42), quadriceps (RR=3.67), and calf muscles (RR=4.28).

This might similarly affect handball players since the nature of the game shares similar characteristics (running, sudden stops and change of directions, side cuttings and twisting, stepping, jumping) all of which places a lot of stress on the weight bearing structures during different manoeuvres. This study explored and determined the association between external/internal factors and injury outcome, severity, nature, mechanism, circumstance and incidence during collegiate handball training and competition in Masvingo Province. The reason was to recommend injury preventive measures during match and training sessions.

Several reasons have been offered to explain the increased risk of incurring the same type of injury among athletes with an injury risk. These range from proprioceptive defects, muscle strength impairment and imbalance, persistent ligamentous laxity, diminished muscle flexibility and joint movement, and the presence of localised scar tissue, which produces discomfort (Engstrom and Renstrom, 1998). The disparities between studies with regard to the effects of previous ankle injury on future occurrence may be related to the definition of what constitutes an injury, differing assessment techniques, or quality of rehabilitation (Murphy and Associates, 2003). This study, as well, has established and determined similar findings on the interaction of internal and external risk factors among handball players in Masvingo tertiary institutes.
Several studies have reported isolated, inadequate rehabilitation or premature return to play, to be injury risk factors. In a prospective study of overall injury incidence and mechanism among handball players, Ekstrand and Gillquist (1983) noted that athletes who were improperly rehabilitated, or were not ready to return to a pre-injury level of competition are at increased risk of suffering injury. In 32 (25.8%) of the 124 players who suffered a minor injury, a major injury was subsequently sustained within two months, 13 (10.5%) of which were of the same type and location. Injuries were categorised on the basis of duration of absence from practice; a minor injury resulted in absence from practice for less than one week, whereas a major injury resulted in absence from practice for more than one month.

In a similar study of this nature, Chomiak and colleagues (2000) reported that inadequate rehabilitation was a risk factor for severe injury among male handball and soccer players. The research findings indicated that nearly a quarter (n = 23.24%) of the 97 players who reported prior injuries, had re-injuries on the same body limb, 7 of whom had done so within the past three months. In addition, a study of risk factors for ACL injuries among 1643 Australian football players, Orchard et al. (2002) showed an increased risk of ACL injury among those athletes who underwent an ACL re-enactment on the ipsilateral side within the previous 12 months (RR=11.33, 95% CI = 4.02 to 31.91) suggesting that the athletes were not physiologically ready to return to their former level of competition. Those who underwent ACL reconstruction within a period greater than 12 months (RR=4.44, 95%) C1=2.46 to 8.01), were also at risk of sustaining ACL injury. Seven (41%) of these 17 ACL injuries were to the ipsilateral side, and 10 (59%) were to the contra lateral side. Despite rare cases of ACL reconstruction in Zimbabwean sport, chances are that some athletes may sustain such injuries but without them being detected or may receive improper medication and diagnosis unlike in developed countries. The above findings might also have a similar bearing and contributory
effects to high rates of injury occurrence among handball players in Masvingo Province which the study addressed so that safe participatory environments might be created.

Previous injuries should not be ignored as causes of new injuries. To this effect, Langevoort et al. (2007) showed that the effect of previous injuries was 36% in the incident of new ones. But, considering training and competition sessions in the absence of interferences from previous injuries in the incidence of new ones, Rasuli et al. (2012) believe sports injury incidence rate in matches to be significantly higher than practice sessions which they have accredited to players’ use of safety equipment during the match (modifiable factor).

2.7.3 Gender

Morphological differences that exist between gender also imply differences in muscular activation and timing rates relative to Anterior Cruciate ligament injury risk which, put in summary, looks at kinematic issues that include proximal, anterior-posterior, medial-lateral and distal lower extremity. To this effect, injury outcome will be different during play or practice. However, a number of researchers have debated on the relationship between sex and injury occurrence during training and match situation that are related to proximal and distal aspects (Bahr and Holme, 2007; Watson, 1995; Hewett et al., 1996).

2.7.4 Proximal

Irregularity of proximal muscle activation has been recognised to alter the position of the knee in female athletes during landing and cutting. A drop off in activation of the trunk and
hip musculature may cause high risk of lower extremity alignment that may reduce the potential for appropriate muscular response to joint (Lephart et al., 2002). Zazulak et al. (2005) prospectively measured 277 handball players for core stability, subsequently tracking them for three years for knee injury. Their findings on active trunk repositioning and displacements in response to quick force release indicated deficits in trunk proprioception and trunk displacement in females with knee ligament and ACL injuries compared to uninjured females. This suggests that female athletes have decreased core stability and are at risk of knee injury in all sports including handball. A scenario of this nature may not spare women athletes in handball since it is a high intensity sport with frequent physical contact between players, sudden stops and turnings which exposes the knee to a lot of stress.

In relation to body weight, studies by Taimela et al. (1990) and Nicholl (1992) have demonstrated that athletes who are tall or overweight are more likely to suffer from injury. As well, clinical defects can make participation unsafe in contact games especially with old age (Watson, 1995). Both factors of exceptionally being tall and overweight can increase the mechanical stress on the ankle (a weight-bearing structure) causing injury during participation. Watson (1995) admits that a relationship between defects of body mechanics and injury incidence in sports do exist as reported in a study of footballers. The study reported high incidences of strains and over-use injuries in players who had more body contacts and that most injuries sustained were related to poor body mechanics. The report showed that kyphosis, lordosis and scoliosis body types were connected with back injuries, knee injuries and ankle injuries. A scenario of this nature was also true of female and male handball players in tertiary institutions in Masvingo Province and this internal factor subjected players to injuries as some had deformities which they did not want to confide to the coach in fear of losing position in the team.
Females have been reported to have increased hip internal rotation with associated knee valgus (possibly due to wider pelvic girdle and greater adipose tissue) which may stress the ACL (Leiphart et al., 2002; Markolf et al., 1995; Beynon and Fleming, 1998). A comparative study by Zazulak et al. (2005) on a similar issue revealed lower gluteus elecromyographic (EMG) activity in females than males during landing. The proximal stabilising muscles, specifically the gluteus, control lower limb alignment and aid in shock absorbing effects during landing (Deep et al., 1999). During the landing phase after a dive shot jump shot or push by an opponent in handball, players may experience awkward falls which precipitate various forms of injuries. This injury outcome (severity, nature, incidence, mechanism) is directly related to internal and external risk factors of which such interplay is inevitable during play or practice.

In a study by Lindbland et al. (1993), the incidence of sports injuries among women has been reported to double that for men and considered it to be related to different physical structures and anthropometric characteristics. Wedderkopp et al. (1999) accounted lower extremities (with a prevalence of 58.8% of acute injury) the most vulnerable organ to injuries in female European handball players. Wedderkopp et al. (1999) believe the fine structure and low physical power in women are the factors that greatly endanger them. Commenting on this issue, Lindbland et al. (1993) state that female players with the fine structure little muscle mass, less experience and skills than men cannot control the ball correctly. But, injuries were seen to be higher in male players than women in tournaments. The possible explanation for this contradiction is that male players in high competitive levels competed in high speed and have fewer physical contacts with other players (Wedderkopp et al., 1999).
2.7.5 Anatomy

Multiple differences in anatomical risk factors exist between the genders. Biologically, female athletes have increased femoral ante version, an increased Q angle, excessive torsion and subtler pronation compared with her male counterpart Mandelbum, 2007). The size of the intercondylar notch in the femur and diameter of the ACL itself are smaller. Impingement of the ACL against the lateral portion of the medial intercondylar notch has been proposed as a potential anatomical cause of ACL injury (Mandelbum, 2007). Typically, men have a wide U-shaped intercondylar notch whereas women have a narrower cresting wave (A-shape) notch. Owing to the narrower geometry of the female intercondylar notch, the ACL may impinge on the medial boarder of the lateral femoral condyle when combined with a valgus load (Silver and Mandelbum, 2007) which may cause injury during dynamic activities. However, the cross-sectional area of the female ACL is significantly smaller than in men which might, perhaps, provide some protection to the ACL in female athletes. Studies to investigate a direct correlation between ACL size and ACL injury rates are still yet to be conducted (Silver and Mandelbum, 2007).

Research findings by Rauh et al. (2006) have indicated more injury occurrence among male team sports such as handball than those for females, with a significantly higher risk of injury at an incidence rate of 19.6/1000 athletes exposures and boys at 15.0/1000 for high school cross country runners resulting in greater or less than 15 days of disability. In a parallel study by Emery (2005), boys experienced the highest injury rates in handball and basketball whereas participating in gymnastics and hockey caused the highest injury rates for girls. In addition, boys were identified as having greatest risks for injury (OR=1.16-2.4) and re-injury (rates-13.1%-38%) showing that previous injury clearly increases the risk of re-ignition of
prior injuries (Emery, 2005). In a similar exploration, Agel et al. (2005) reported significantly higher injury rates in women than in men in collegiate handball and basketball. Similar patterns might also be true with the case of Masvingo tertiary handball since the sports codes have in common body limps that are exposed during play which this study explored.

2.7.6 Anterior-Posterior

Wojtys et al. (1996) and Malinzak et al. (2001) concede that female athletes demonstrate increased activation of the quadriceps relative to the antagonistic hamstring musculature. This disproportional recruitment (internal factor) of the quadriceps musculature increases anterior shear force at the low knee flexion angles that occur during high risk landing and pivoting movements during handball training and competitions (Myer et al., 2005; Markolf et al., 1995). Renstrom et al. (1994) grant that the quadriceps, through the anterior pull of the patellar tendon on the tibia, contribute to ACL loading when knee flexion is lower than 40 degrees. In this regard, Imran and O’Connor (1997) propose that training interventions that improve muscular contraction during dynamic tasks may facilitate joint compression, which may protect the ACL against anterior drawer.

Quick quadriceps action has been highly associated with females than males (Zazulak et al., 2005) but with an uneven balance in strength and fibre recruitment of the flexor motor activity relative to the extensor musculature. This imbalance has been greatly associated with risk of ACL in female athletes (Hewett et al., 1996). It is, however, believed that improved potency of knee flexors may enhance balance contraction of the quadriceps during landing, providing better control of high knee extension and adduction torques (Hewett et al., 1996). If
fibre recruitment of hamstring is balanced, this may prevent high loads essential to rapture the ACL during dynamic manoeuvres that predispose the athlete to injury. This pattern might also be true of handball players in Masvingo tertiary institutions and might contribute to various injuries during handball activities and require attention. It is worth noting that overloading the body and fatigue may also contribute to injury and load need to be in tandem with the individual’s capabilities.

Available literature indicates that males have greater hamstring quadriceps ratios than females (Urabe et al., 2005). Findings from Urabe et al. (2005) showed that increased quadriceps activity was not balanced by antagonistic hamstring in the female athlete (Zazulak et al., 2005). Padua et al. (2005) found that the quadriceps-dominate muscle activity pattern in female athletes. These authors reported greater quadriceps activity and a decreased hamstrings-to-quadriceps co-activation ratio in females compared to male athletes during hoping (Padua et al., 2005), activities that are seen during jump shots, dive shots and blockings in handball. Reduction of relative hamstrings quadriceps has been seen to assist dynamic lower extremity alignment, related to control of high stress knee loads (Lloyd, 2001). What is intrinsic in this discussion is that fibre recruitment on the hamstrings and quadriceps is dependent upon effort input by the athlete during take-off when making a jump shot or sudden feints and pivoting. An imbalance into force exertion is likely to trigger injury during this phase as well as when landing on hard surface. This same tendency proved to be a high risk factor among handball players in tertiary institutions of Masvingo which this research intended to investigate with the ultimate goal to recommend plausible solutions.
2.7.7 Medial-Lateral

Lloyd (2001) argues that knee ligaments can be protected through contractile activities that come as a result of articular contact forces during motoric activities. A number of authorities agree that decreased medial joint compression is a morphological attribute that impedes passive resistance during dynamic knee valgus, predisposing the female knee to medial femoral condilar lift-off and increasing loads on the ACL (Kim et al., 1995; Lloyd, 2001; Ford et al., 2003). Rozzi et al.’s (1999) study demonstrated unbalanced hamstring during landing in females with Myer et al., (2005) reporting a decreased ratio of medial to lateral quadriceps recruitment in the same sex which increase frontal moment of forces. Together, the neuromuscular imbalances may increase the potential for dynamic valgus when athletes are in high risk positions (Ford et al., 2003, 2005). This might not spare handball pivot and wing players when making suicidal dive shots in the 6-metre zone forcing their way through a pack of defenders in order to score.

Repeated performance of high risk manoeuvres with insufficient neuromuscular control and dynamic valgus may lead to the collapse and damage of ACL rupture (Boden et al., 2000; Teitz, 2001; Hewett et al., 2005). Muscular contraction can decrease both valgus and varus laxity of the knee three fold through interventions designed to improve balance with synergistic and antagonistic recruitment strategies aided with active control of medial-lateral joint loads at the knee (Markolf et al., 2005). Myer et al. (2006 b) demonstrated that exercise-related polymeric and dynamic stabilisation training were effective at improving balance in knee flexor in relation to knee extensor strength. The enhanced balance in lower extremity strength may have been related to the concurrent improvement in medial-lateral ground reaction force control and decreased lower extremity valgus control in the coronal plane.
Improved coronal plane control is believed to significantly reduce injury risk in female athletes (Hewett et al., 1999; 2005 a). The central point of discussion is that injury cause is as a result of moments of forces (intrinsic factors) produced within the elastic components series of muscles during dynamic actions which might not spare players in Masvingo tertiary institutes.

2.7.8 Muscular force output

A report by Zazulak (2005) showed that there was an increase in peak quadriceps activity in females than males during the pre-contact phase of landing with greater femoris activity. This increased activation of the quadriceps musculature combined with decreased hamstrings activity may increase strain on the ACL during landing. This may alter shock absorbing effects during landing and may increase ground reaction forces and torques associated with increased risk of ACL injury (Hewett et al., 2005 c) which subjects the athlete to injury. Besier et al., (2001 a), in a biomechanical analysis of a side step cut at two different angles under both pre-planned and unanticipated conditions, reported an increased varus-valgus and internal-external knee moments during unanticipated movements. They concluded this to be linked to an increased potential for non-contact knee injuries during unanticipated sport movements.

Unanticipated movements of this nature can affect athletes from any sport code that might lead to injury precipitation. Similar findings were also announced by Mclean et al. (1999) who noted that females had significantly larger valgus angles. According to their findings, most ACL injuries were reported to have occurred in the deceleration phase during landing.
from a jump, a stop or a change of direction—which is always true, in the case of handball activities that might call for sudden and sharp changes of direction.

Similar demands are also placed upon a handball player who should execute sudden stops and changes in direction, sudden outbursts of speed when defending and attacking, quick reactions during non-contact situations. All these cases can situate undue stress on the weight bearing structures (knee and ankle) which can make the player more vulnerable to knee ligamental tears (knee tendonitis) and foot injuries.

In a prospective study, Hewett et al. (2005) evaluated athletes playing high risk sports of handball and basketball. Nine out of twenty five (9/25) females had ACL injuries and were noted to have a different knee posture with knee abduction angle increased by 8°; 2.5 times greater knee abduction moment, and higher ground reaction forces with stance times 16% shorter. The overall result was an increase in motion force and more quickly acquired moments. This increase in valgus and hip abduction loads increases risk of ACL injuries. Hewett et al. (2005), therefore, proposed the need for developing and implementing neuromuscular control programmes to reduce injury occurrence. Considerations of this advice might assist in injury reduction among handball players in Masvingo tertiary institutes.

An amalgamation of an athlete’s recollection of injury situations involving interviews, trigger events and description of body and joint alignment, can be helpful for a meaningful application of the multi-factorial approach to injury cause (Bahr, 2003). Seil et al.’s (2006)
study of 35 healthy high school handball players (18 Male 17 female) examined of knee during planned and reactive start tasks revealed that lateral jumps to be more dangerous than stop jumps. Results showed that female subjects had less knee flexion, greater maximum knee valgus and greater shear forces and knee moments in reactive jumps than their male counterparts (Seil et al., 2006). Reactive jumps were different from planned jumps suggesting problems in comparison of basic gait laboratory situations to playing scenarios. Seil et al. (2006) proposed on the need for the inclusion of appropriate sport-related tasks that take into cognisance directional reactive versus planned tasks (reaction time component).

Athletes interviews should be detailed and use appropriate standard assessment of sports injury vocabulary, including external and internal factors, history of specific conditions experienced by the player at the time of injury occurrence (Seil et al., 2006). According to Olsen et al. (2004), the athlete will specifically be able to describe the playing situation, field position, player and opponent behaviour, whole body joint kinematics and kinetics of the injury. In sports demanding rapid direction changes, such as handball, the mechanism of injury by athlete description or observation is predictable.

### 2.7.9 Anterior Cruciate Ligament (ACL) functions

It has been established that knee injuries, especially those involving ACL, are a significant concern for adolescent athletes. Its chief role is to provide knee stability ensuring the tibia does no slide forward in relation to the femur restricting extreme knee extension, varus and valgus knee dislodgment, and tibial rotation (Dawkins, 1991). This provides protection to the cartilaginous shock absorbers of the knee (the menisci) from possible damages that could
emanate from cuttings, rapid accelerations and decelerations associated with quick directional changes and pivoting in sports as handball (Dawkins, 1991). As such, the after-effects and frequency of ACL injury have been reported by many researchers and clinicians to inflict notable limitations in future participation of physical activities (Kohrt et al., 2004; Dahman et al., 2006) the case of which might be related to prevailing circumstances in Masvingo tertiary handball.

Anecdotal evidence indicates that, regardless of ACL re-construction, those athletes who sustain an ACL injury are at 10-fold higher risk of developing early-onset degenerative knee osteoarthritis than the non-injured population (Lohmander et al., 2007; Hewett et al., 2009). Lohmander and Associates reviewed 127 individual studies of follow-up after ACL rapture/or surgery, including subjects who sustained their ACLs during their teenage years. Results indicated that an average of 50% reported knee osteoarthritis with related pain and functional disfigurement at 10 to 20 years after injury (Lohmander et al., 2007). This means that adolescents with ACL injuries have a high risk of suffering from chronic pain and functional limitations from knee osteoarthritis by their twenties or thirties, which also includes the age range included in this study. A similar nature of this kind might also not spare female and male handball players in Masvingo tertiary institutes during competitions and training, hence might increase rate of injury recurrences.

2.8.0 Mechanisms of Anterior Cruciate Ligament Injuries

The diagram below (Figure 2.4) shows the position of Anterior Cruciate Ligament in a knee joint and the commonly affected knee tissues:
It has been established from various studies that approximately 80% of ACL tears occur from non-contact situations while the athlete is landing from a jump, decelerating suddenly, or quickly changing direction. Biomechanical video analysis by researchers has indicated injury onset to occur when the centre of gravity is usually behind and away from the base of support, commonly during full knee extension; while the lower extremity is in ‘dynamic knee valgus’, a position characterised by hip internal rotation and adduction, tibial external rotation and foot evasion (Myer et al., 2013; Hewett et al., 2009). These findings corroborate those from biomechanical cadavers and vivo studies, thereby signifying that the highest strain on the ACL occurs during isolated cases with the knee at an unmitigated position (Dharamsi and...
LaBella, 2013). Hence injury grounds seem to be much entangled in biomechanical aspects of sport.

2.8.1 Susceptibility of girls to ACL injury risks

A number of factors have been raised in epidemiological research to explain the interaction between external and athlete related factors linked with ACL injuries in female athletes that include hormonal and neuromuscular factors. For example, much as it is like any other ligaments, the ACL is thought to have oestrogen, testosterone and relaxin receptors suggesting that sex hormones may affect the mechanical properties of the ACL and thus influence the risk of ACL injury despite heterogeneous data from studies investigating their effects (Dharamsi and LaBella, 2013). The female ACL tends to have half a millimetre more laxity during the midpoint of the menstrual cycle (Dharamsi and LaBella, 2013). Shear and colleagues (2003), however, have indicated that ACL injuries have been shown to cluster near the start of menses, at the polar opposite time in the cycle.

Dharamsi and LaBella (2013) assert that the primary mechanism by which sex hormones influence ACL injury is likely to be through indirect effects on neuromuscular growth and maturation during puberty, rather than through direct effects on the ligament. Research indicates that increased developmental of new body dimensions of height and weight during pubertal growth spurts, affects the body’s centre of gravity which presents difficulties in balancing during body manoeuvres of landing, cutting and pivoting (Dharamsi and LaBella, 2013). The explanation to this point relates to accumulation of adipose tissue on girls’ hips putting a lot of stress on knee ligaments and tissues, eventually leading to injury. During
puberty, boys undergo a large testosterone surge, which mediates significant increases in hypertrophied muscular strength levels and allows them to better manage their new body dimensions and shifting of centre of gravity during athletics manoeuvres (Dharamsi and LaBella, 2013). Girls, however, experience only a small increase in testosterone levels at this stage, resulting in a much smaller increase in muscle mass and strength but greater adipose tissue levels, which may be insufficient to control their new body dimensions during athletic manoeuvres (Dharamsi and LaBella, 2013). A fusion of these intrinsic factors and extrinsic causes are sufficient enough to ignite injury in Masvingo collegiate handball among females.

2.8.2 Motoric oriented risk factors

Current evidence suggests girls to be more vulnerable to non-contact ACL injuries than boys due to less neuromuscular control of knee motion during athletic manoeuvres (Dharamsi and LaBella, 2013). It is suggested that motoric actions are different from those of boys during landings or quick and swift directional changes (Dharamsi and LaBella, 2013). To this end biomechanical studies have acknowledged 4 common neuromuscular strategies in girls related to dynamic knee valgus, a position that subjects the ACL to high risk of tearing.

In girls, the dominant use of quadriceps muscles more than hamstrings, reduced knee flexion with increased quadriceps action and decreased hamstring action in girls than boys in relation to kinematic and kinetic analysis, have been reported (Dharamsi and LaBella, 2013). This “quadriceps dominant” strategy has been shown to increase both anterior tibial translation and strain on the ACL (Chappell et al., 2007). Renstrom et al. (2008) believe ACL strain can significantly be reduced through synchronisation of the hamstrings, that is, balanced fibre
recruitment during dynamic activities as when performing an all-out take off effort during a defensive block from a jump shot.

Research indicates unbalanced leg strengths in girls while for boys this tends to be equal. This uneven gait in leg strength promotes asymmetric weight distribution between the feet upon landing, causing a shift of the body’s centre of mass away from its base of support, a position associated with increased risk of ACL injury (Myer et al., 2013). This implies unequal moments of force on tendons and ligaments as greater viral loads placed upon the weight-bearing structures, eventually leading to knee tendonitis or knee avulsions from lack of shock absorbing effects. The tendency for girls to have less core strength and stability, additionally, makes it more complex for them to control their ever-changing centre of mass and avoid its drifting away from the base of support (Myer et al., 2013).

Available literature indicates girls’ joint motion tendency to be associated with bones and ligaments as opposed to muscular contraction to achieve joint position and absorb the landing forces (Myer et al., 2013). Myer et al. (2013) suggest that neuromuscular risk factors could be remedied through training unlike anatomic risk factors which are largely non-modifiable. If a situation of this nature exists among Masvingo handball players, possible remedies to it could be provided to ward off the problem.

2.8.3 Competitive trait anxiety

With regard to psychological factors, research studies by Junge (2000) have shown that events can influence the risk of athletics injuries. The author hypothesised competitive
anxiety to be associated with injury occurrence besides other psychological factors such as personality traits. In a prospective cohort study to measure the influence of psychological factors on injuries, Steffen et al. (2009) life stress events proved to be a significant predictor for new injuries among female handball players. In a related study on high school handball players by McGuine (2006), they were shown to exhibit higher levels of life stress events, and high fatigue during pre-season leading to increased risk of injury (McGuine, 2006). Poor conditioning and high levels of stress may contribute to injury cause and this might relate to prevailing situations in Masvingo collegiate handball which require attention.

According to Jones and Cale (2009), cognitive anxiety was seen to increase in players prior to competition, with decreased self-confidence due to inexperience. Their study indicated high progressive increase in cognitive anxiety than in men as competition drew closer but little differences of state anxiety being reported by Sanderson (1989) despite earlier signs of somatic anxiety women earlier exhibited. This has been found to affect the athlete’s locus of control and neuromuscular activity which might pre-dispose the athlete to injury during training or match situations due to lack of concentration (Jones and Cale, 2009). To some extent, there is an association between competitive anxiety and stress with injury outcome and this is also dependent upon competition level or training intensity and how this is perceived by the athletes and might also influence the severity of the injury. Handball players in Masvingo tertiary institutions seem to be experiencing similar problems during competitions predisposing them to injury risk hence preventive ways needs to be drawn so that participating environment might be acceptable.
Anxiety is an internal risk factor that plays a pivotal role in sport. According to Singh and Rathore (2012), it can greatly affect sports participation which precipitates high levels of anxiety and is determined by how an athlete handles it. Its degree also varies in a number of different conditions and Rathore (2012), believes it to increase as competition level rises and low in non-competitive sports, because at high competitive situations, participants are expected to win and great demands are placed upon them to succeed. The degree of perceived anxiety is a significant variable to be considered in the performance of an individual (Agiyajit and Singh (1992). Its presence precipitates low concentration levels during sporting pursuits and amplifies injury likelihood.

Amu (2005), in a study of university players, found no gender difference in pre-competitive somatic anxiety but observed gender disparity with male players exhibiting higher levels than their female counter-parts in pre-competitive cognitive anxiety. In a related study, Bridges and Knight (2005) also noted a significant positive linear relationship between cognitive anxiety and performance for basketball players with Kuis and Roudsepp (2005) also confirming a moderate level of state anxiety and very high self-confidence of players prior to matches. Humara (1999), however, bemoans that although anxiety has a considerable impact on performance, it should not be viewed in isolation but be amalgamated with other components of an athlete’s functioning as well. Bekiari et al. (2006) described that male volleyball and handball players rated higher somatic levels and were more affected by the verbal aggressiveness of their coaches than female volleyball players. This brings stressful situations due to destructive feedback, less focus and high injury chances from internal and external risk factors. Wilson and Raglin (2007) discovered that predicted and actual pre-competition anxiety values did not differ for either age or gender for the more important meets. The correlation between predicted and actual pre-competition anxiety occurred in
groups for both the less important and more important meets (Wilson and Raglin, 2007). What is intrinsic in the above claims is that competitive trait anxiety varies from individual to individual and is dependent upon the tendency and purpose of competition situations that might have different threatening effects. The same effect might also be true of handball players on various levels of competitions. Such state provoking situations (psychological factors) might incite and pre-dispose athletes to injury during competition and training (Bah and Holme, 2003, 2005, Watson, 1986; van Vulpes, 1989). Taken together, the psychological and physical demands experienced by athletes makes the occurrence of injury almost inevitable (Watson, 1995) which Frey (1991) terms “culture of risk” in sport where athletes are socialised into accepting the physical risks of participation as “part of the game”. This acceptance comes in the form of playing with pain and injuries and linking pain tolerance (psychological and physical) with desirable characteristics (Watson, 1995). This means players can willingly or unwillingly participate in sports (handball) being driven by the desire to accomplish good results but with greater injury risks.

According to Carron (1984:134), “the degree to which an athlete finds the whole competition experience enjoyable is strongly related to his/her trait anxiety level”. From his review, Carron concluded that trait anxiety pause a major impact on how competition is perceived and the athlete’s previous experience of success or failure can trigger anxiety (Morris and Summers, 1995). The social pressure from a “win at all costs” philosophy, combined with fear of injury and fear of not meeting the expectations of significant others (coaches, parents, fans) are common sources of anxiety (Cratty, 1989) and this can be attached to a person’s strong affiliation between sport success and self-esteem (Chu, 1982). Tied to this, Young and Cohen (1981) discovered that a relationship between self concept and the incidence of sports injuries existed in which injured high school female basketball players had stronger self-
concepts than non-injured players. The researchers speculated that self-confident players were more inclined to take risks than their peers with lower self-concept scores. An increase in risk taking would imply increase in incidence rates of injuries.

On the contrary, Lamb (1986) discovered an opposite relationship in which he concluded that players with lower self-concepts were more prone to injury than those with strong concepts. Nevertheless, these disparities might be relative to the situational factors on the ground and how the individual might perceive as threatening to the competitive situation (internal and external). Such factors are likely to disengage normal motor-performance and psychological processing on the task at hand, thereby pre-disposing the athlete to injury (Eysenck, 1992; Morris and Summers, 1995). The same factors might also apply even to handball players in tertiary institutes of Masvingo Province which might be contributory to a rise in injury incidences during training and competitions they are exposed to.

2.8.4 Self-Confidence

Self-confidence, mood disturbances and somatic anxiety have all been linked to athletic performance (Usher and Hardy, 1996). Incentives, previous performance (Woodman and Hardy, 2001) and self-confidence (Carver and Scheir, 1988) are considered as factors that relate to athletes’ practice efficiency as they can either play a facilitative or debilitative role to the players. Research findings by Usher and Hardy (1996) demonstrate that successful athletes have lower anxiety than less successful athletes prior to matches. Self-confidence is one of the most important psychological components that relate to sport performance (Feltz, 1988). Successful performance enhances perceived self-efficacy while repeated failures
harms self-confidence (Bandura, 1997). As a moderating variable, it can either increase or decrease the impacts of anxiety levels (Hanton and Mellalieu, 2002).

Findings by Jung Lin et al. (2011) on tennis players showed that an increase in self-confidence can lead to a high increase in anxiety levels associated with injury risks during performance. It means high self confidence levels can cause injury risks in even in handball players.

Composure, timing, space and effortless rhythm are the performance hallmarks of confident athletes. They thrive on pressure and look for challenges that extend their limits and display and look for challenges that extend their limits and display their skills (Morris and Summers, 1995). They think and act differently from athletes who lack confidence. Doubt, anxiety and uncertainty plague the thinking of athletes who lack confidence. Compared to highly confident athletes, the less confident are likely to be less persistent, and more hesitant, make more unforced errors that can pre-dispose them to injury during training and competition (Morris and Summers, 1995). Athletes, who exhibit high levels of self-confidence and self-esteem set relatively higher performance goals, persist longer at tasks and react more adversely to continued failure than athletes with a high external locus of control. McAuley and Gross (1983) found out that habitually successful athletes focus on internal causes (ability and effort) to explain their performance.

With regards to self-confidence, Dosil (2004) advises on the necessity to deal with any situation guarantees and sporting-sports. Realistic assessment of the situation athletes’ face
and anticipation of the most likely problems and what to do are the bases on which to lay a solid self-confidence (Gonzalez and Coronado, 2011). Similarly, setting goals, challenging but reliable plans by coaches through attractive targets, realistic and focused on performance and not the result of competitions, for athletes to step up or gradually regain credibility in their abilities, helps in building self-concept. This instils the aspect of self-confidence in athletes during practice and competitions (Buceta, 2004; Lock and Latham, 1991; Smith, Smoll and Curtis, 1991). Planning that is unfocused and lacks direction is most likely to precipitate stressful situations which increase injury risk by attentional and somatic changes in athletes such as peripheral narrowing and distraction (attentional) muscle tension, fatigue and reduced coordination during competition and training (Andersen and Williams, 1988). Stressful situations can, thus, result in several biological alterations that can impact the likelihood of an athlete being injured when placed in stressful competitive situations (McDermott, 2013) because self-confidence would have been mislaid. Attached to these assertions is the relationship that exists between loss of self-confidence in the player, stress, loss of focus by the athlete in training and competition situations whose interplay may precipitate unsafe environments that pre-disposes the athlete to injury. The summation of these (variables) predictors might, therefore, determine the nature, severity, and mechanism of injury sustained which also related to collegiate handball in Masvingo province which this research investigated.

2.8.5 Body weight

Individual characteristics such as body weight, Body Mass Index and height as internal factors and the environment, can lead to injury incidence (Barani et al., 2009). The handball sport is also no exception from this issue and the players’ accident and crashing to each other
through direct contact or frequent falling can result in lesions. Mohammed Abdul Salam (2011) studied the relationship between BMI body fat percent, height and weight with sports injuries among 12-15 year students and found a positive relationship between height and weight with bone and muscle injuries. Engerbretsen et al. (2008) surveyed 31 teams with 508 players of football that had history of knee injury. Furthermore, Arnason et al. (2004) and Steffen et al. (2008) also confirmed the positive impact of these factors in sport injuries. The intrinsic fact from the aforesaid research studies is that the inter-play of height, weight and body mass index have a direct bearing as the stress placed upon the knee during jumping (when blocking or making jump shots), running, sharp turns and cuttings during play. This increases the vulnerability of knee ligaments resulting in injury sustenance. Similar movement qualities in soccer are also seen during the game of handball. This will be no exception to collegiate handball players in Masvingo province as strong relationships between these internal factors also exposed players to unsafe practice environments.

The association between morphology and performance has been considered in many contexts, commonly in youth participation. According to Matkovic et al. (2003), the morphologic characteristics of athletes can determine the success that athletes will achieve in a few particular sports. Anthropometric profile of elite handball players is first based in height and weight (Blanco, 2004). It seems height determines the scope of use of vertical space (Aila, 1996) and weight is correlated with athletes’ speed, endurance and power (Aila, 1996; Cavas, et. al., 2004). As a result of equal opportunities for participation, handball players are grouped by chronological age (age groups e.g. U20, U23, U30). However, differences between the youngest and the oldest ones (in the same group) may result due to significant differences in body size (Sharp, 1995). Literature also reports that significant developmental advantages in terms of height, weight and strength have relevant impact on perceived
potential performance (Barnsley et al., 1992; Riemmenich and Rogol, 1995) and predicted success in sports (Helsen et al., 2005).

Studies by Williams and Starkes, (2004) Ward and Williams (2003) and Helsen et al., (2000) on athletic success has shown that weight and height differ with experience as a function of age and body size. These variables are very important to achieve a high level of performance in handball (Massuca, 2011). Vand den Tillar and Ettema (2012) showed that body size had a strong positive effect on the throwing performance and isometric strength. Weight appears to be essential, especially in 1 versus 1 situation (Moreno, 1997) and for this reason, elite handball players are very heavy (Bayer, 1987) though it can be influenced by regular training (Massuca, 2011).

However, studies by Tyler et al. (2006) indicate that handball and football players who are overweight have an increased risk of sustaining ankle injuries. Injuries of the same type have also been shown to be prevalent among soccer players from a report by Hagglund and Associates (2013). Faude and colleagues (2013) believe overuse and groin injuries in sport emanate from being overweight. Despite the advantages brought forth by these variables, a mis-match of players in terms of height and weight might cause injuries during contact situations, especially in handball. The effect of collision forces might, therefore, precipitate various forms of injuries on the upper and lower appendages of the body (Koren, 2010, Leidinger, 1990; Langevoort et al., 2007; Seil, 1998; Oehlert et al., 2004).
2.8.6 Proficiency level of players

The relationship between skill level and injury has been analysed by a number of studies in spite of their contradictory findings. In a study of the association between age, skill level and injury occurrence among 264 male handball and soccer players, Petersen et al. (2000) reported that young players with less skill proficiency level had a twofold increased incidence of all injuries as a group compared with more skilled athletes. More than 79% of all injuries were sustained in the knee, ankle and lumbar spine. Similarly, in a study of factors related to severe injury in 398 male handball and soccer players, Chomiak et al. (2000) confirmed that less proficient athletes reported a two fold increase in incidence of all severe injuries as a group compared with the more proficient ones. A severe injury was defined as one resulting in complaints lasting more than four weeks, absence from sport for four or more weeks or an association with serious damage to the musculoskeletal system (fracture, dislocation or damage to the visceral system). The knee and ankle were the most commonly injured body parts and 74% of all injuries were located in the lower appendages.

In a study of risk factors for lower extremity and back injury among 712 handball athletes, Hopper et al. (1995) reported highly skilled to be more likely to incur injury (54%) than less skilled athletes (19% of all other levels). The most common injury site was the ankle.

Hosea et al. (2000) found a more than two fold increased incidence of ankle injury at collegiate level compared with high school in 11780 male and female handball and basketball athletes. With regard to skill level, studies by Peterson (2000) and Chomiak et al. (2000) have shown that athletes with lower level of skill proficiency are at increased risk of suffering
injury. However, Murphy et al. (2003) bemoans the difficulties on comparing results of these studies as they investigated different sport codes which might have diverse criteria for grouping skill levels. They further argue that less skilled athletes may not compete for as long as those in higher skill level groups are still fit to compete. This implies that, depending on the methodology used, low level skill groups may not have the same number of injuries as high skill level groups, but show a higher incidence rate based on less exposure (Murphy et al., 2003). Instead, highly skilled players may play at a more aggressive intensity than lower skill levels thereby increasing the risk of injury. The same cause might also prevail in Masvingo collegiate handball as temptation might be to overstrain and overload skilled players than the less skilled leading to injury cause.

2.8.7 Age factor

Age has been seen to be a causative risk factor associated with injury prevalence and exposure time. Together with experience both factors have been reported to increase injury risk (Dirx et al., 1992). Research findings by Murphy et al. (2003) and Verhagen et al. (2004) indicate a degree of relationship between old age and injury occurrence for lower body appendages as old players have more exposure hours than young players. To this end, however, risk factor studies have shown the multiplicity of incongruous results on the effect that age has on injury.

A study on the aetiology of handball injuries among players of 12 years and above, Dirx et al. (1992) reported that players above 20 years had a great risk of injury than younger players and their results indicated that age and growing experience precipitated more injuries. The
same study revealed that about two thirds of all injuries occur in competition and one third during training exercises. Luis and Henke (2010) believe injury outcome become more pronounced as competition gain more significance with advanced age and performance level, despite there being more time spend in training than in competition. Injury risk, thus, increases proportionally with increase in age, experience and as competition level increase, so does the risk of injury (Inkar, 1996; Karanflici and Kabak, 2013). The explanation for this is that physical fitness (strength, speed, endurance etc) increases with age and thus the game is played with more speed and power and a significant relationship between age and injury is inevitable. In concurrence with Dirx et al. (1992) and Murphy et al. (2003), Luig and Henke (2010) reported that younger athletes were more prone to injuries of the upper appendages, especially finger injuries; whereas with advancing age, there is an increase in injuries in view of the lower extremities, in particular, knee injuries. In regard to the aforementioned research findings, this study sought to explore and examine whether there are any correlations and associations between injury occurrence and age during collegiate handball training and competitions.

Increased injury incidence has been announced with increased age among handball players (Chomiak, et. al., 2000; Lindenfeld, et. al., 1994). Ostenberg and Roos’ (2000) study of 123 female handball and soccer players (14-39 years) showed a significantly increased risk for athletes over 25 years (odd ratio (OR) = 3.7, 95% confidence interval (C1) = 1.4 to 10.0) in comparison with younger athletes. Most injuries reported (80%) were located in the lower extremity with knee, foot, ankle, thigh and back being the most common injury sites. In a parallel study of Australian handball and football players, Orchard (2001) observed that athletes over 23 years were more prone to hamstring and calf strains though no association with quadriceps strains was observed. This was partly due to injury definition which was
defined as an event that occurred during a game and caused a player to miss the following competition. A different finding may have resulted had injuries occurring in training sessions been considered in addition to games in this investigation (Murphy et al., 2003). This study, however, looked at both injuries incurred during training and competitions in order to provide plausible solutions, recommendations and prescriptions should injury occur. This might assist stakeholders already inclined into the sport in assessing risk factor situations in handball and provide meaningful training sessions. This might, as well, motivate players and attract new ones into the sport.

A study of recreational sports injuries including, handball, among subjects aged 9-56 years by Stevenson and colleagues (2000) revealed that athletes aged 26-30 years were at 55% increased risk of injury compared with those below 26 and over 30 years. Similarly, Knapik et al. (2001) reported that men in the age range 25-35 were at significantly increased risk of sustaining an injury of any type from a study of 1230 military recruits aged 25-35 years, though age was not a risk factor for woman. An injury was defined as an accident that resulted in damage to the body and necessitated a visit to a medical care provider. Results showed an 83% for lower appendage and back injuries for men with 87% being reported in women. Differences in results suggest high susceptibility to emanate from morphological differences in sex which might also relate to high injury rates in Masvingo tertiary handball for athletes in the age range of 18-30 years that this study investigated.

Research among indoor handball players by Lindenfeld et al. (1994) indicated men over 25 years to incur high injury rates (7.9) than males between 19-24 years (3.8), 16-18 years (4.9) 12-15 years (4.4) and those below 12 years (2.8). Females reported a highest 6.3 for the 12-15
age range compared with those below 12 years (5.6) and those in the age range 16-18 years (4.6), 19-24 years (4.9) and those above 25 years (5.1). Injury was defined as any incident that caused a player to leave a game, required a stoppage in play by a referee or player, or resulted in the player requesting medical attention. The body parts most often injured were the ankle and knee. The definition could have influenced these study results which might also relate to results of this study.

An increased injury incidence at a younger age was confirmed in studies by Mckay et al. (2001) and Peterson et al. (2000). In the aforementioned risk factor study of all injuries as a group among male players, for Peterson et al. (2000), handball and soccer players between 14 and 16 years had an increased risk of injury than those in the age range 16-18 years. Similarly, Mckay et al. (2001) confirmed high ankle injury rates among elite and recreational basketball and handball players, below 6 years than those above 7 years. Despite the variations in nature and sport codes demands as asserted above, all authorities share a common ground that the interaction of age and players’ level of experience be it during practice or competition; can be determined by internal factors in injury mechanism and severity. A combination of two or more risk factors (external and internal) can significantly contribute to various injury forms of varying degrees for any age group. Taken together, then, injury incidence, mechanism, severity and nature are dependent upon external (such as opponent, playing position etc.) and internal (such as prior injury, age, gender etc.) predictor variables. The purpose of the study was to explore whether there are any significant associations between such factors and injury outcome during-collegiate handball training and competition so as to provide suitable recommendations for safe participation in the sport.
2.8.8 Stress and injury relationship in sport

Stress is believed to be a potential predictor risk factor in sporting circles as it has been found to manifest itself negatively in different ways. It is based on an individual’s reaction to internal and external stimuli, which poses a real or perceived threat to the maintenance of the individual’s homeostasis that, in turn, affects the individual’s performance (Lenz, 1991). It can be internal or external, expected or unexpected (Lenz, 1991) as can be the case of anxiety that brews moments prior to the game. It is a reaction of the organism to situations that are threatening (Buceta, 2004). Stress can be precipitated from an imbalance between imposed demands placed upon the player and skill proficiency (Baumann, 1993; Bump, 1989; Martens, 1987). This imbalance can be from a positive to a negative direction, and the performance will be affected.

Meyers (2001) believes that stress brings about physical effects within the body that are detrimental to sport performance. This stress can come via pressures from parents and coaches to perform at a certain level, attempting to balance a large number of activities, or the increased level of competition in amateur sports (Spano, 2008). A review of experimental studies by William and Anderson (2007) revealed that 85% of the studies showed a positive relationship between life-event stress and the increased risk of injury for athletes. Several studies have shown links between an athlete’s history of life stressors and the likelihood of injury occurrence (Nigorikawa et al., 2003; Rodgers and Landers, 2005; Steffen et al., 2009). This relationship is dependent on whether the appraised stress is positive or negative to the individual, as research has shown that only life events thought of as negative increase the likelihood of injury (Sarason et al., 2008).
Contemporary research has shown a number of researchers in the field of sport psychology to uphold Williams and Anderson’s (1988) stress model (Maddison and Prapavessis, 2005; Terry et al., 2005; Rogers and Landers, 2007; Iverson and Johnson, 2010; Iverson et al., 2013). According to this model, any potentially stressful situation will draw out a stress response, whose strength varies along a continuum (Anderson and Williams, 1988). Influence of the severity is dependent upon how threatening the athlete perceives the situation to be and through variables.

Three moderating variables have been linked with injury incidence, that is, an athlete’s personality, history stressors and coping resources. To verify this, Williams et al. (1991) established that subjects with relatively more life stress displayed a high state of anxiety during stressful situations and had greater narrowing of peripheral vision as measured by accuracy of subjects observational of stimuli. In concurrence with the above studies were Cryan and Alles (1983) who also recorded a high rate of injury occurrence among high-stress football players with a similar relationship being confirmed by May et al. (1985) and Petrie (1992) in contact sports. Apparent from these assertions is that stress, as an internal factor, can contribute immensely to pre-disposition of a player to multiple injuries for as long as they are to participate in any discipline. Similar occurrence might also happen to collegiate handball players in Masvingo province which was the main thrust of this research study to find out whether there might be any associations between external/internal risk factors, injury prevalence and injury outcome during handball training and match situations.

According to Abernethy (1987) stress may cause the athlete to attend to stimuli not relevant to the task, consequently inhibiting the direction of important information. This implies loss
of concentration on the task at hand. On the other hand, over-attending to internal rather than external factors has been shown to increase the likelihood of injury in sport and inhibit the athletes’ psychological rehabilitation (Williams and Roepke, 1993). For instance, injury may occur due to the athletes’ attentional narrowing, in which the athlete focuses exclusively on a particular stimulus or on relatively few, readily apparent stimuli, instead of certain stimuli (Morris and Summers, 1995). This may be true and dangerous especially in contact sports like handball in which the player might fail to anticipate body contact with oncoming opponent and react according to the situational demands thereby predisposing the athlete to severe injury.

In their model of stress and athletic injury, Andersen and William (1988 : 299) assert that “during stress, narrowing of visual field may occur, leading to a failure to pick up vital cues in the periphery and thus increasing the likelihood of injury”. In a similar research, Williams and Roepke, (1993:820) established that “with increased stress, the attentional field involuntarily narrows and becomes more internally focussed”. Apparent from these authorities is that there is a strong relationship between stress, (internal factor), injury incidence and injury mechanism during play or training.

As well, the nature and severity of an injury are dependent upon the individual’s internal make-up factors (such as stress, competitive trait anxiety self-confidence and so on) and how they interrelate with the external environment in which he/she will be currently operating (such as opponents, equipment facility and many more). An inter-play of these factors can, therefore, subject the player to multiple injuries. This is in line with findings by Krohne and Hindel (1988:88) who note that ... “high anxious players should not be able any longer to use
all their technical and tactical skills... since a great deal of their attention is distracted from the actual contest”.

A study by Bramwell et al. (1975) on 57 events of collegiate sports (handball included) based on coach and game-related stressful events revealed that players with the lowest life-events scores had an injury rate of 35% whereas those with medium and high scores recorded figures of 44% and 72% respectively. Similarly, Cryan and Alles (1983) announced high injury rates among high-stress football and handball players than was reported for low-stress players while Coddington and Troxel (1980) reported a five-fold risk for 748 high school football, volleyball and handball players who also had lost parents than those reporting no such loss (10.9%). A study by Hardy et al. (1991) has also demonstrated that social support can have a pivotal role in the relationship between life stress and injury incidence in team and individual sports. Results portrayed that increase in injury rate correspondingly rose in relation to an increase in life-events but with a decrease in social support revealing that the higher the life stress scores, the greater the chances are for a person to become ill or injured during the season (May et al., 1985). Common to the foregoing studies is the impact and likelihood that various stressors have upon athletes during competition and training. The result is the athletes' pre-disposition to multiple injuries that are multi-factorial in their nature, mechanism and severity. A scenario of this nature did not in any way spare collegiate handball players in Masvingo Province which was the main focus of this study.

A two year study by Kerr and Minden (1988) of 41 elite female athletes showed that there was a significant relationship between life stress and occurrence and severity of injury. Related causes for injuries were lack of concentration, physical fatigue, defective equipment
and re-injury. According to study findings by Potgieter (2003), injury rise was related to approaching competition as 15% of injuries occurred a month prior to competition and considerably rose to 27% a week before while 21% was recorded on competition day. The possible explanation for such a significant increase in injury rate as explained by Potgieter (2003) could be due to increased training frequency and intensity. For Kerr and Minden (1988) this is unlikely because elite athletes usually taper as competition draws near. For them, the injury pattern could be attributed to heightened stress associated with the looming competition. At the same time negative life stress has been associated with the incidence of injury (Crane and Green leaf, 1999) and this correlation has been found to occur even in athletics, (Hanson et al., 1990), volleyball (Hardy and Rechel, 1988) and handball (Dirx et al., 2001). Common in the above assertions are negative effects brought forth by stress and its associated characteristics prior to, during and after competitions. This variable, therefore, psychologically affects the athlete and makes injury occurrence inevitable during training and competition situations.

Life events and daily hassles have been reported to impede physiological concentration and may lead to injury cause depending upon factors such as task complexity, sport type, age, gender and the amount of social support and structure in the situation (Nideffer, 1989). For instance, injuries in sports like swimming and running may be incorrectly attributed to factors such as overtraining when poor concentration is a causative factor (Nideffer, 1989). However, the nature of handball injuries can be a result of both factors (poor concentration and overtraining) as it requires a combination of reaction speed and time, sudden turnings and stopping, correct timing and concentration which should all be realised in a fit body.
Intrinsic factors such as muscle tension, fatigue, reduced coordination and distraction increases injury risk (Anderson and William, 1988). Spano (2008) speculated that stressful events emanate from numerous biological changes that can impact the likelihood of an athlete being injured. Spano (2008), however, warns coaches to guard against such symptoms as upset stomach, headache, sweaty palms, and nervous habits, lack of energy, insomnia, anxiety, impatience, anger and irritability which could give rise to injury occurrence. While these serve as symptoms and markers for coaches, parents and trainers should monitor their athletes as these stress results can have effects on sports performance eventually leading to deleterious results on the particular athlete (Spano, 2008). This implies that when placed in a stressful competitive situation, their stress response will be exaggerated and could make the athlete prone to injury (McDermott, 2013). Other effects of stress that can lead to an increase in injuries include attention span and an increase in muscle tension which decreases muscular coordination (Spano, 2008).

Research has shown stress to cause the release of the hormone cortisol, resulting in a state of hypercortisolaemia or high-blood-cortisol levels (Gocentas and Lander, 2012). Cortisol is an immune suppressive hormone in the body that works as a muscle catabolist (Perna and McDowell, 1995). This steroid hormone is believed to inhibit protein synthesis and is released in higher levels following exhaustive exercise (Hayes et al., 2010). Upon release of cortisol, the body’s metabolic rate increases, magnifying cortisol’s other effects on body composition and reduced immune system function (Lowery and Forsythe, 2006). Long term hypercortisolaemia can result in bone demineralization, muscle catabolism, impaired antimicrobial defence and emotional disturbances which all can contribute to injury in athletes (Flynn et al., 1994). It implies that handball players might also fall prey to these effects resulting in injury cause.
Perna and McDowell’s (1995) research further concedes evidence to previous notions that psychological stress may play a role in increasing the effects of cortisol on the body. Their study on elite athletes established that athletes with high life event stress experienced more skeletal muscle symptoms and had a significant increase in cortisol levels post-exercise. Despite higher cortisol levels shown in the low-stress group, Perna and McDowell (1995) believe this to have been a preparatory effect, as the levels of post-exercise decreased significantly. Therefore, athletes with high life event stress are more susceptible to injury and illness following high action-loaded maximal exercises due to cortisol effects (Perna and McDowell, 1995).

Hagglund et al. (2013) argued that stress is an important factor in causing injuries to players who have had previous injuries and have returned to participation. Their pre-mature return to participation while under stress and fear of re-injury may lead to reduced concentration while playing, delaying the recovery process and is, therefore, regarded as a major contributor of handball re-injuries (Hagglund et al., 2013). In addition, stress from other sources of distraction, can precipitate reduced attentiveness, causing poor coordination which may lead to injury sustenance (Hagglund et al., 2013). Their findings suggest that it is necessary for players to be properly managed following an injury for them to return to participation when they are both physical and psychologically fit, in order to avoid stress which may lead to re-injury. To reduce the incidence of the injuries, preventive measures have to be followed, some of which will be discussed later in the chapter.

Peripheral decrease in vision can be a stressful effect. A study by Rogers and Landers (2005) on 171 high school soccer players (98 male, 73 female) showed that an increase in state
anxiety was relative to decrease in peripheral vision and that these results were greater before the game than before practice. The results uphold previous works of Williams and Anderson (1988) stress-injury model as correlations between both life event stress (LES) and negative life event stress (NLES) and injury were noted. In relation to other studies, Rogers and Landers (2005) concluded that those individuals with decreased coping skills had a decreased chance of sustaining injuries. Based on peripheral vision alone, researchers were able to correctly classify almost 70% of the athletes as injured or healthy. What is intrinsic in the aforesaid discussion is how “stress” as a variable relates to “injury” sustenance prior to and during competition and practice on the athlete. Common is the fact that there are a number of variables (such as personality history of stressors and coping resources) that can contribute significantly to stressful situations on the athlete in sport, termed, “factors of distraction” which prohibits concentration eventually leading to players’ susceptibility to injury. A similar incident of this nature would not spare collegiate handball players in Masvingo province which the researcher intended to determine and explore in order to find if there are any significant associations of internal and external factors and collegiate handball outcomes during competition and training.

Moderator variables also play a role in determining whether or not stress leads to any injury. It is an intermediary that alters the character, course or potency of an association that links a self-determining and reliant variable (Smith et al., 1990). Put in another way, it has a regulatory effect on a certain variable. In sport psychology circles, normally moderator variables appear in the forms of social support, sensation-seeking motivation, and internal locus of control or other coping skills (Smith et al., 1990). A conjunctive pattern means that in the case of multiple variables, they must occur in a specific sequence or combination. The implication is that players who lack social support, psychological counselling exhibit high
stress levels that reduce players’ concentration during play resulting in injury occurrence. This might also lack among handball players in Masvingo tertiary institutes making them possible risk factors contributing to high injury rates which this study investigated.

In sport psychology research, coping and effectiveness are key variables that can be studied. In this regard, Lazarus (2000) insists on the need for effective implementation of performance enhancing stressors for athletes to manage stressful and endangering situations during training and match situations (Nicholls et al., 2009). A study by Smith et al. (1990) on the effects of social support and coping skill as possible moderator variables indicated low amounts of effects on negative life events relationship with athletic injuries in adolescents. In a parallel study by Hazzard (2004) to assess the moderation effect using competitive trait anxiety and mood as the association, results showed that high coping skills moderated the depressing effects of the trait nervousness and frame of mind. This points to the fact that application of moderator variables play a critical role in creating safe playing environments in handball which this research study investigated.

2.9 Association between extrinsic risk factors and injury outcome

Extrinsic factors refer to the external forces related to the sport type, the biomechanics of the activity and the sporting environment and include sport technique, training quality, match officiating quality, training environment, equipment, training intensity, weather conditions, playing position, and match schedules (Lysens et al., 2010). A combination of these variables may trigger injury occurrence, though some of them are adjustable factors (Luig and Henke, 2013). Bailasha et al. (2014), Barami et al. (2010), Bailasha and Gitonga (2007) and Akpata
(1997) in their research studies found that most injuries sustained in handball which affected the upper body extremity, were a result of sub-standard equipment. This was similar to handball equipment in most of Masvingo tertiary institutes which had hazardous effects to players during match and training.

2.9.1 Officiating quality

The quality of officiating and upholding of rules has an important influence on the incidence of sports injuries and should be formulated with safety considerations uppermost (Watson, 1995). Koren (2010) and Langevoort et al. (2007) concur that most injuries in team handball occur in contact situations with another player. High competitive levels from major tournaments on studies conducted by Langevoort et al. (2007); Assembo and Wekesa, (1995) have shown that contact injuries ranged from 80% to 92%. Of the total, 50% of these injuries recorded during these major tournaments, were a result of breech of rules that warranted sanctioning. A similar figure of 45% (167 out of 310) was noted by Langevoort et al. (2007) although 60% of these (98 out of 167) were followed by a sanction of the referee. These figures are indicative of poor quality officiating and lack of fair play implementation during match situations resulting in players sustaining a substantial number of injuries.

Failure to adhere to fair play has been linked to a third of injuries that occur in team handball (Ekstrand and Gillquist 1983 a; Keller et al.,1987) and has been identified as the most central cause of school sport injuries (Watson, 1996). Attributed to such causes might be miss-match of age, size, physical maturity and experience between opponents (Watson 1995). Compounded with poor officiating quality, these variables fuelled up injury sustenance
among athletes during training and competition in collegiate handball in Masvingo province. This research, therefore, intended to find out if any significant associations between injury outcome and officiating quality (external factor) existed and whether the injuries were related to any seditious events and a host of other factors.

Results of a study by Kamran (2011) in Iranian professional handball players showed no significant differences between men’s and women’s handball referees in sanctions against foul actions that lead to injuries exist. Serious injuries have been strongly linked to lack of knowledge of handball rules, decision making skills, and judgement skills affecting referees’ performances. Junge et al.’s (2006) study revealed high injury prevalence rates from fouls in women handball players than was reported for men. A different trend, however, from Assembo and Wekesa (1998) revealed more contact injuries for men in match situations (66.67%) than was reported for women (19.37%). Responding to this issue, Kamran (2011) feels loss of fair play spirit and high degrees of psychological pressures and aggressive contacts on players to be fertile ground for injury cause on opponents. This issue related well to the situation players in Masvingo tertiary institutes were exposed to, which reported a high prevalence rate of 65% contact injuries among handball players.

The influence of coaches, the media and spectators has been reported to affect the outcome of matches and competitions. Verifications by Estriga et al. (2010) in 15 matches of Portuguese male elite handball championships (2009-2010), have revealed that a quarter of all decisions made by referees were errors with half of them being severe ones. Most of them were difficulties noted when ruling the 7-meter throws, 2 minutes and suspensions with a strong bias towards the most important teams (Estriga, et. al. 2010). As a result, the study recorded a
total of 2570 incidents with 160 interventions being considered incorrect while 252 were considered as an oversight of intervention. The rate of increase in mistakes progressively rose with increase in playing time around the first 10 minutes and last 5 minutes of the match (Estriga et al., 2010).

The explanation to this might be related to high explosive rates of speed and aggressive rates from high energy outputs by both teams as well as fatigued muscles as the game reaches regulated time. Other studies conducted in linked sport codes (Trudel, et. al. 2000) document the beginning and the end of the game as the moment when transgressive contacts occur. According to Estriga et al. (2010), the number of errors rose significantly when the score was unbalanced by 5 goals of difference or more which was attributed to referees’ low concentration levels in situations with outsized score differences.

Globally, it has been observed that 77% of the decisions made by referees are considered inaccurate. In this regard, such poor officiating has been strongly linked with injury cause during matches. Estriga et al.’s (2010) findings, therefore, reinforces that referees must pay particular attention to the disciplinary faults in order to control the aggressiveness and to protect the physical integrity of players.

Analysis distribution of incidents by Estriga et al. (2010) was done relative to the circumstances of the game and roles of players. Seventy eight percent (78%) are said to have occurred during organised defence, 9% in the defensive transitions with only 11% in the organised defensive phase and offensive transition (2%). Most incidences were reported
among pivots, centre backs, and wing players with 59% occurring between the 6, 9, and 12 metre zones. Comparatively, 66% errors were committed between 6 meter to 9 meter line and the wings 16% errors and 8% faults. It, therefore, implies that injury sustenance and frequency during match situations can be related to quality officiating and playing positions. Hence similar happenings and implications were reported in this study where 16% of circumstantial injuries recorded, were sanctioned fouls from umpires.

2.9.2 Weather and season of the month

Injury occurrence has been linked to multi-factorial effects of environmental and atmospheric conditions during match and training situations (Van Mechelen, 1996). A number of studies have confirmed the effects environmental risk factors impose on the prevalence of ACL injuries in sport. An investigation of 22 National Football League teams during 5 seasons by Scranton et al. (1997) showed an increased incidence of non-conduct ACL injuries in dry compared to wet conditions. Similarly, Bradley et al. (2002), in a descriptive epidemiological study for the same league (1986-1995 seasons), showed that practice-related ACL injuries were more common during the pre-season months of July and August with constant numbers for the remaining season. The same study reported that game-related ACL injuries were highest in August and December as well as in hot compared to cold conditions.

In contrast, Orchard and Powel’s (2000) evaluation of 5918 league games, (handball included) (1989-1998) indicated that weather conditions had no influence on the risk of ACL sprains in natural grass. Low risks were, however, reported in artificial turf of open stadiums during cold weather (with no effect of whether the playing surface was wet or dry) compared
to hot weather conditions. The incidence of ACL sprains was lower during the cooler months of the season in open stadiums (both Astro Turf and natural grass) but not in domes. Silver and Mandelbaum (2007) believe this reduction is directly related to lower shoe-surface friction coefficient. It implies that injury incidence is relative to existing atmospheric and prevailing weather conditions and this also might determine their prevalence and frequency. Differences in research findings might also point to differences in environments in which studies were conducted and exposure to extrinsic risk factors such as type of grass and quality of artificial turf in relation to coefficient and shoe type. This study, however, reported a significant number of contact injuries (65%) and non-contact (19%) caused by natural surfaces, wet slippery surfaces and cold weather conditions since competition seasons fall within rainy and wet seasons, between January and July. No artificial turf surfaces exist in Masvingo tertiary institutes, but natural, hard and bumpy surfaces.

Numerous publications have been made to demonstrate the influence of weather conditions on the prevalence of injuries among male Australian footballers (Orchard, 2001; Orchard et al., 1999, 2001; Orchard et al., 2005). An evaluation of 2280 matches (1992-1998) by Orchard et al. (1999) revealed high precipitation prior to matches and low rainfall increased risk of non-conduct ACL injuries in male players with similar results established by the same group two years later (Orchard et al., 2001). The study also showed ground hardness to amplify risk of ACL injury early in the season among Australian footballers (Orchard et al., 2001) but four years later, a prospective cohort study revealed more non-contact ACL injury risks to be caused by grass more than hard surface and weather conditions (Orchard et al., 2005).
In a parallel study on the influence of different climatic conditions in Europe on ACL injuries among professional handball players (humid subtropical weather-hot humid summer and cool winter marine west coast-warm summer but wet winter dry-hot/cool humid summer, Walden et al. (2013) announced low incidence rates of ACL injuries in northern countries than was reported in southern countries. What is apparent is that injury incidences are, therefore, associated with warm/hot, dry and wet weather conditions compared to warm/hot summer and winter seasons. Incidences might also vary because the risk factors are temporary and, as well, might be dependent upon individual internal risk factors such as fitness condition, protective equipment and level of exposure to field/weather conditions, match schedules, skill level and officiating quality (Henke and Luig, 2012) and also precipitated similar threats to handball players in Masvingo tertiary handball.

2.10 Injury prevention sequence: Epidemiological viewpoint

Injury prevention research, as described by Van Mechelen (1992), is a four step sequence that folds into each other systematically and was developed from the work of Finch (1996) and recently supported by Henke and Luig (2013) and Clarsen (2015). According to these authorities, the magnitude of the problem must be first identified and described in terms of the incidence and severity of sports injuries. Secondly, the risk factors and mechanisms that are attributed to injury occurrence in sport must be identified (See Figure 2.1 above). Measures that are likely to reduce the future risk and or severity of sports injuries should be introduced as the third step with such measures directly rooted from information on the aetiological factors and injury mechanisms as identified in the second step (Luig and Henke, 2013). Finally, the outcome of the measures are evaluated by revisiting the first step through time trend analysis of injury patterns or by means of randomised clinical trial (Bahr et al.,
This implies that this can be carried out in retrospective or prospectively over a period of intent as was the case in this study which was (prospectively) carried over a period of two years to explore injury sustenance during training and competition Masvingo collegiate handball.

Injury prevention sequence requires that injury causes are well-known and be based on information related to risk factors and injury mechanisms that an athlete is exposed to (Bahr and Holme, 2003; 2005). As a basis for epidemiological studies, Meeuwisse (1994), therefore, developed a model to account for all the risk factors involved with the view that an array of external and internal risk factors is responsible for injury causes. Regardless of the type of injury, Meeuwisse et al. (2007) believe a chain of shifting circumstances combine and result in injury sustenance. To attain a better understanding of injury aetiology and appropriate prevention strategies, a re-look is needed beyond the initial set of risk factors. The influence of those risk factors on change through earlier cycles of participation, whether associated with prior injury or not, is also critical. Internal factors such as age, sex, previous injury and trait anxiety may influence the risk of sustaining injuries, predisposing the athlete to injury, and, therefore, by definition, risk factors (Meeuwisse et al., 2007).

In addition, external factors such as shoe traction and floor friction, as a result of their cleats, may modify injury risk, making the athlete even more susceptible to injury. It is the inter-link of athlete-related and environmentally-related peril factors that render the athlete susceptible to injury, but cannot stand alone as much as necessary to cause injury (Bahr and Krosshaug, 2005). As speculated by Meeuwisse (1994), Finch (1996), Van Mechelen (1992), Gissane (2001), Meeuwisse et al. (2007), Luig and Henke (2013), the summation and complex
interlink of these risk factors sets the platform for the athlete to incur an injury in a certain situation. The inciting event which Luig and Henke, (2013) has described as the “trigger event”, sums up the final link in the series of events that necessitates injury cause (Meeuwisse, 1994; 2007). According to Luig and Henke, (2013), this seditious event has strong links with the inception of injury, human and environmentally-triggered events such as human error, breach of rules, muscle rupture, slippery surface, and defective equipment.

The nature of injury in sport is different. According to Meeuwisse et al. (2007), exposure is a permutation of two aspects, a risk factor and participating embedded within that risk factor. Meeuwisse et al. (2007) believe that an individual may be exposed to the same or different risk factors repeatedly through multiple participations. Since injury occurrence does not lastingly remove an individual from partaking sport, it implies that it may not have a predetermined closing stage (Meeuwisse et al., 2007). This being the case, Meeuwisse et al. (2007) is of the view that a linear approach that contains a start point and end point does not mirror the correct nature of injury in sport. The same fact has been previously recognised by Gissane et al. (2001) who noted that a linear model does not fully relate the after-effects of injury.

To address this issue and uphold the works of Van Mechelen (1992), Meeuwisse (1994) and Finch (1996) developed a cyclic model for the investigation of contact sports to report the return of fit players to sport. The recognition noted was that athletes could return to the lower level of sport, but their approach did not permit them to return to the cycle of exposure (Gissane et al., 2001). The missing link not emphasised from the previous models is that there may also be recurrent changes in susceptibility to injury in the course of sports participation.
without injury and that these exposures can produce adaptation and continually change risk (Meeuwisse et al., 2007).

In view of this, Meeuwisse et al. (2007) developed a new model representing a dynamic approach that incorporates the consequences of repeated participation in sport, both with and without injury. Despite variations in schools of thought as discussed above, the authorities tend to agree that a dynamic and multi-factorial approach in sport injury research is very instrumental if injury preventive and management measures are to be fully realised. Bahr and Holme (2005) justify the need to use a model that takes into consideration all of these factors at the same time, and not only examine the biomechanics associated with injury or the individual or external risk factors in isolation.

2.11 Preventive intervention measures for sports injuries

The essence of injury prevention in handball is to minimise absenteeism from participation in matches due to risk factors and maximise player’s internal drive. It is generally accepted that basic physical preparation during training is essential to meet the increased demands and dynamics of the current game. Precedence should be set on preventing injuries caused by premature fatigue, insufficient regeneration or athletic mismatching for players with regard to endurance, strength, flexibility and speed, (Luig and Henke, 2010). In response to the same issue, Luig and Henke (2010) strongly feel that formulation of structured and supervised athletic conditioning programmes that address individually adapted endurance training, functional weight training, dynamic mobilisation and agility drills, should form the basis of handball training programmes.
To achieve basic strength and power training, Marquez (2010) recommends the use of bench press and squats and specific power training with heavier and lighter balls (Van den Tillar and Marques, 2013), as well as with a pulley system (Ettema et al., 2008), jumps in different directions and change in direction (Marques, 2013). Training programmes should include fast accelerations with stops and short sprints with directional change (Buchheit, 2013). Movement specific to handball (Wagner and Muller, 2008), including game based training focusing on specific movements instead of shuttle runs and high intensity running, should constitute a training programme. Key period for basic physical preparation during the pre-season is highly recommended. Athletes in bad athletic condition are significantly more vulnerable to acute and overuse injuries (Luig and Henke, 2010). The aforesaid elements need regularity to have a preventive effect. In addition, a warm up for 15 minutes three times a week halves risk for injury (Barksjoberg, 2012).

Basic and advanced technique training need to constitute training programmes to prevent injuries since handball crucial movement patterns are of highest importance for the athletes’ game performance to improve typical handball elements (Luig and Henke, 2010). Good jumping for shooting and blocking, quick feet movements are needed for feints, direction changes, turns, starts and stops in defence and offense being augmented with good ball handling, passing, dribbling, catching and stealing. In this regard, Luig and Henke (2010), however, believe technique training is required to perform these tasks safer as they also bear an increased injury risk. They advocate for proper training in jumping and landing techniques in terms of knee and ankle control for athletes to sustain crucial situations like single leg landings such as when performing jump shots.
Correct ball handling is an important factor to prevent numerous finger and sprain injuries and quick controlled feet assist in coping with pivoting movements (Luig and Henke, 2010). Technique training, if already applied from tender ages, combines performance enhancement and aspects of injury prevention (Luig and Henke, 2010). Technique training should be adapted to advanced demands of athletes progressively adding controlled perturbations (contact) during execution of movement patterns since intense physical contact is an inherent element of handball, and players should get used to it and cope with it during competition (Luig and Henke, 2010). High injury rates in Masvingo collegiate handball might suggest improper training methods and programmes they are subjected to.

Neuromuscular training has also been seen to yield positive results in preventing lower limb injuries, using proprioceptive balance training. For this reason, Luig and Henke (2010) advocate that exercise on unstable devices such as wobble boards, slings or mats and combinations which are stabilisation and plyometrics are helpful when conducted regularly during in-season and off-season. These should be incorporated and perfectly integrated into warm up routines.

In response to the same issue, Dharamsi and LaBella (2013) strongly feel that various neuromuscular training (NMT) programs should be designed to strengthen hamstring and core muscles to improve balance as well as teaching athletes how to recognise and avoid dynamic knee valgus, a similar contentment which has also been shared by Hewett et al. (1999); Mandelbum et al. (2005); Soligard et al. (2008); Kiani et al. (2010) and LaBella et al. (2012). Most of these programmes have been shown to reduce ACL and other lower-extremity injuries. Pooled results from prospective cohort studies and randomised, controlled
trials have demonstrated a 72% reduction in ACL injury rates among adolescent female athletes (Myer et al., 2013). According to Dharamsi and LaBella (2013), this body of scientific research provides significant evidence to advocate that NMT be routine in girl high school sports. This was even applicable in older female ages in tertiary institutions and clubs in Masvingo Province.

2.12 Essential basics of NMT training programs

Research has shown that neuromuscular training programs are somewhat variable with respect to the number and types of exercises included and the frequency of training. Some studies have specified one or two types of exercises such as plyometrics exercises (repetitive jumping to build muscle strength and power) and/or balance exercises, whereas others applied a more comprehensive approach, incorporating plyometrics, strengthening, stretching and balance training (Myer et al., 2013; Renstrom et al., 2008). Studies by Hewett et al. (2006) and Yoo et al. (2010) have indicated three key components that should constitute a good NMT training program: firstly, progressive strengthening for the core and lower extremities; secondly, plyometrics and thirdly, feed-back driven technique modification.

In compliance with this issue, Hewett et al. (2006) believes NMT programs that are restricted only to balance training cannot effectively reduce ACL injury risk. According to research findings by Dharamsi and LaBella (2013), progressive strengthening exercises such as squats and lunges target the hamstrings, gluteal muscles and external rotators, muscle groups that work to counteract the hip adduction, hip internal rotation, and external tibial rotation
associated with dynamic knee valgus. This has also been seen to improve trunk strength and stability.

Plyometrics exercises target muscle groups from a stretching position and then rapidly contracts with maximum force. This pairing of eccentric and concentric muscle contractions increases muscle power. These exercises are applicable and relevant when designing conditioning programs for handball players so as to minimise injury occurrence during training and competitions. Warm up exercises should, therefore, bear exercises of a similar nature that are handball-oriented (Dharamsi and LaBella, 2013).

With regards to feedback, Dharamsi and LaBella (2013) reiterate that NMT programs should be supervised by qualified coaches or instructors who have been specifically trained in recognising dynamic knee valgus. They insist that athletes should be taught how to recognise and avoid unsafe knee position correcting athletes’ improper form and not allowing them to progress to more challenging exercises until they have demonstrated consistently proper form with less difficulty exercises (Dharamsi and LaBella, 2013). If programs of this nature could be followed as prescribed, this might also effectively reduce injury prevalent rates and related medical costs in tertiary handball of Masvingo Province.

2.12.1 Scientific and opinionated approaches

Injuries require systematic recording at all levels of competition in order to identify individual and situational risk factors as this would greatly assist in monitoring injury trends and evaluating effects of applied prevention measures. In addition, stakeholders and
federations inclined into the sport need to understand injury trends, mechanisms, risk factors and prevention perceptions brought to light as well as solid knowledge of effective applicable and acceptable counter-measures. Tied to this, adaptations of the educational framework in handball injury prevention should form the integral part of preventive measures to effectively reduce injury through conducted seminars and workshops (Luig and Henke, 2010).

Reduction of competitive match schedules could also help reduce the number of injuries during and immediately after competitions. This would allow for sufficient regeneration and reduction of overuse symptoms and acute injuries due to fatigue or inadequate cured disorders (Luig and Henke, 2010).

2.12.2 Therapeutic and non-therapeutic services

It has been widely accepted in sporting and health circles that pre-season screenings help prevent and reduce injuries in athletes during competition and training. In response to this concern, Wilmore and Costill (1994) believe the athlete’s background of injuries should be given the confidentiality it deserves and any disclosure of the medical information should be done with the prior consent of the athlete. In relation to prevention measures and negative impacts precipitated by injuries, McAuley, cited in Kanhukamwe (2004) and Luig and Henke (2010), strongly recommends that a pre-participation physical examination be carried out for every athlete prior to participation in sporting activities. Similar sentiments have also been echoed by Rogalski et al. (2013) who maintain that a player returning from out-of-season or injury has to be fully assessed before returning to participation. Consequently, McAuley (1994) has identified three reasons for carrying out exercises of this nature, that is:
• To detect if any defects or conditions exist which might place the athlete at risk or increase injury chances in that particular sport.

• To bring to the athlete’s attention any weaknesses or imbalance so that corrections, if any, may be undertaken before beginning of a particular activity.

• To determine whether the athlete may participate safely in spite of having a recognizable problem.

Central to this discussion is the need for attainment of a medical clearance certificate from recognised medical practitioners for every athlete as a preventive measure to injuries during training and competition. Also implicit to this discussion is that such regular pre-season screenings would detect potential risk factors for injuries or damages such as cardio-vascular diseases, muscular imbalances; athletic and neuromuscular deficits which might have negative impacts on individual performance. As well, this assists in performance diagnostics that identify the athlete’s individual needs for improvement; hence increasing physical condition and general performance, resulting in the reduction of acute and chronic injuries. A supervision of the athlete by coaches and physiotherapists is seen as beneficial (Luig and Henke, 2010). Therefore, the decision about the health of the athlete must be determined on the basis of a sound therapeutic understanding devoid of manipulation and other persuasive sources. As the primary goal of sportsmen and women is to maximise their performance, preventive measures can best be integrated as core components in sport performance enhancement programmes (Luig and Henke, 2010). This will increase chances of successful and sustainable injury prevention in training and coaching (Taphin, 2005).
2.13 Chapter Summary

With the tremendous increase in the number of people participating in sport in different countries, it is worth noting that sport has become a significant part of developed and developing countries, communities, tertiary institutions, clubs and schools, Zimbabwe being no exception to this. Available literature demonstrates that this increased trend in sport participation, however, increases the exposure to risk factors such as the occurrence of injuries (Van Mechelen, 1992; Murphy et al., 2003; Bahr and Holme, 2007) as well as a rise in medical costs (Conroy, 1984; Egger, 1990). Junge et al. (2013) and Kirisci (2010) have demonstrated that there is increased prevalence of injuries in general, and in handball specifically, during games more than during training sessions.

In relation to anatomical sites, more injuries have been seen to occur in lower body appendages (Wedderkopp et al., 2003; Reckling et al., 2003; Moller, 2012) than upper body appendages (Olsen et al., 2006; Lagerholm, 2007) and these have been seen to have devastating effects in player performance during training and matches. It has been noted that injury mechanisms, severity and prevalence during matches and training vary in their occurrence in relation to gender (Watson, 1995; Hewett et al., 1996; Bahr and Holme, 1997) because of anatomical differences. Figures also differ respectively as females tend to be more prone than their male counterparts (Myklebust et al., 1998; Meyer et al., 2004; Zazulak et al., 2005).

Empirical findings from various researches conducted on injury risk factors indicate that the interaction and computation of intrinsic factors (athlete related factors) and extrinsic factors
(environmentally related factors) can substantially influence injury sustenance in players during matches and training sessions, including handball, (Koren, 2010; Koushki et al., 2011; Myklebust, 2013; Karanflici and Kabak, 2013). Only two studies in handball, however, have been conducted in Kenya, an African state, by Assembo and Wekesa (1998) during the International Senior Men’s Championships. The other study was conducted by Bailasha et al. (2014) to assess injury patterns in the Kenyan handball league but no study, as of now, has been conducted in Zimbabwe.

The chapter has ended by highlighting major findings on possible preventive measures (pre-habilitation rather than rehabilitation) that could be instituted to reduce injury occurrence during match and training situations (Luig and Henke, 2010; Marquez, 2013; Buchheit, 2013). Despite the fact that injury occurrence is rampant among some African states, even in developed nations the same catastrophe still exists. This international problem has, therefore, drawn the attention of the International Olympic Committee to launch international symposiums and conferences on epidemiological injury research for all sport codes to tackle this issue.
CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

This study conducted an epidemiological research on how external and internal risk factors contribute to injury during training and competition in Masvingo tertiary institutes. This Chapter explains the methods utilized in the study. It discusses the overall research design, research settings and the study’s multiple data collection activities used to collect sufficient data to answer the research questions. Included in this Chapter as well, are descriptions of the study sample and sampling procedures, sampling techniques and ethical issues, measurement tools and procedures as well as piloting of the research instrument that was used. The questions of reliability and validity were addressed; together with the data analysis and presentation methods that were used in Chapter Four. Finally, it ends with the chapter summary.

3.2 Research philosophy

Any research endeavour one partakes in is guided by a research philosophy and theory. Creswell (2006) asserts that a research philosophy is a belief about the way in which data about a phenomenon was gathered, analysed and used. This research was confined within the constructs of positivism which belongs to epistemology (http://researchmethodology.net/epistemology). It can be specified as a philosophy of knowing which adheres to the view that only “factual” knowledge is gained through scrutiny, measurement and trustworthiness.
In positivist studies, the researchers’ role is only limited to data collection and interpretation through objective approach. The research findings are thus quantifiable, leading to data collection methods and analysis. The Positivist philosophy is in accordance with empiricists’ view that observation and measurement is the core of the scientific undertaking (Collins, 2010; Nyaruwata, 2013). This philosophy “has an atomistic, ontological view of the world as comprising discrete, observable elements and events that interact in an observable, determined and regular manner” (Collins, 2010:27). Underpinned to this philosophy is its strong alignment to science as the principal ground that takes a deterministic-scientific approach based on the assumption that a certain variable causes a certain outcome and the researchers’ role is to discover specific nature of cause and effect relationship. It is mechanistic in its acceptance to the use of mechanical nature of scientific approach to explain how researchers develop hypotheses to prove/disapprove through application of specific study paradigms. Chosen methods are mechanically applied so as to operationalise theory and hypotheses. Application of methodology involves selection of sample, measurements, analysis and reaching conclusions about hypotheses (Collins, 2010).

It is, therefore, within the context of this research philosophy (positivism) that this study was conducted since it is scientific in its approach. The study sought to determine the interaction between internal and external risk factors in producing injury mechanisms in tertiary handball during training and competition. High cumulative injury rates prompted the researcher to carry out a research of this nature, mechanisms of which have a biomechanical and kinematic orientation (deterministic scientific approach).
Data collection was done using a standardised injury report schedule to record injuries from tertiary handball players in Masvingo Province through appointed team designates (chosen sample). It was hypothesised that players in tertiary institutes were susceptible to a host of risk factors during training and competition and that no significant differences in injury pattern existed between genders. In order to test this hypothesis, descriptive statistics was employed to analyse quantified data. This suited the research in the quantitative paradigm and cohort study design, an observational study with a practicable method of studying injury prevalence, severity, mechanisms and incidence rate and in order to measure the cause and impact of athlete and environmentally-triggered risk factors on player performance. The cohort approach was adopted in order to operationalise the hypothesis which is aligned to the basic precepts of positivism (deterministic, mechanistic and empirical). This assisted the researcher in measuring the severity of the problem (injury occurrence) from statistical presentations (inferential analysis) so that the necessary conclusions and recommendations on the problem under study could be arrived at. This research philosophy necessitated the adoption of a practically based conceptual framework with a scientific sport orientation by Meeuwisse (1994) on contemporary epidemiological injury research methods which influenced the choice of research design, paradigm, sample, instrument, and methodology used in this study. This framework takes cognisance of the aspect of STEM, a current blue print Zim-Asset policy adopted by the Ministry of Higher and Tertiary Education, Science and Technology through which research in sport should be scientifically driven (Doctor Godfrey Gandawa, The Sunday Mail, 17 April, 2016).
3.3 The study paradigm

This study belongs to the quantitative research paradigm. According to Sousa et al. (2007), quantitative research plays an important role in developing evidence-based knowledge as well as quantifying relationships between and among variables. For quantitative research, the focus is to quantify collected data to make an inference to it in order to answer the research questions. Questions in the questionnaire (injury report schedule) consisted of quantitative variables as the normal situations in the quantitative design. This design was chosen because it was suitable and efficient in gathering as much data from a number of variables and exposures. This quantitative approach suited the nature of the research design adopted (cohort prospective) as it was instrumental in gathering data from multiple determinants and variables with the view that injury outcome can be multi-factorial in origin or nature. The choice of this quantitative design was for its suitability in describing the associations and relationships between the categorical outcomes (dependant variables) and predictor variables (independent variables) in complex epidemiological studies of this nature as well as ability to measure associations or relationships between exposures and occurrence of injury (risks). Its ability to handle such large amounts of data greatly assisted in data analysis and comparisons to make valid conclusions and recommendations at the end of the study. In alignment with this quantitative study, a prospective cohort research design was adopted which is explained below:

3.4 The research design

Three main study designs are available to study risk factors for sports injuries, namely case control studies, cohort studies and intervention studies (preferably done as a randomised controlled trial). For case control study designs, information on risk factors is done for
injured and non-injured players in retrospective since the approach is to identify persons with the injury of interest and then look backward in time to identify factors that may have triggered the injury. However, its inability to record real time information and “recall errors” makes it unreliable. Intervention study approach involves determining if a particular intervention designed to eliminate or at least reduce a risk factor, also results in a reduced injury. Interventional studies are designed for randomised large scale clinical trials to find the casual nature of a modifiable risk factor as well as the effectiveness of modifying that factor on preventing injury outcomes (Bar and Holme, 2003).

For the purpose of this study, a cohort prospective design was used. It was chosen for its current recognition as it helps generate legitimate period knowledge (Bailasha, 2014) about aspects of development at different stages of life compared with retrospective designs which are affected by recall errors. Its choice offered a reasonable alternative of identifying real time information on the current state of factors that contributed to injury occurrence in tertiary handball without unearthically interfering with the privacy of participants unlike other designs like randomised experimental research designs (Bailasha, 2014; NATA, 1990). This design was applicable because real time information of sports injuries was observed and recorded from an identified cohort of handball players during training and match situations through appointed team designates. In a cohort study design, all data are collected in a standardized manner prospectively in time.

Linked to this line of exploration, Bahr and Krosshaug (2005) indicate that data collection is systematic and involves one or more groups of subjects (cohort) defined by their exposure status, being followed through time to identify an outcome of interest with the ultimate goal
to determine whether initial exposure status influences risk of any subsequent injury onset. The approach involves measuring potential risk factors before injuries occur, after which new cases and exposure are reported during a period of follow-up (Silman and MacFarlane, 2004; Bahr and Holme, 2003). In this case, potential risk factors of intent were identified (athlete and environmentally-triggered variables) and became the basis through which follow-ups were made over a period of two seasons to measure potential risk factors in relation to exposure hours of match and training sessions.

Cohort studies often involve monitoring subjects over an extended period of time, and consequently they are useful for investigating multiple determinants and outcomes (McNeil, 2000). In this case, a group of players (cohort) exposed to identified risk factors was chosen. This research design enabled the researcher to track and determine the influence of external factors (facility, equipment, opponents, playing position, match schedules) and internal factors (prior injury, age, gender, stress) from time to time. Collection and quantification of data from these variables was made possible. The design was chosen for its suitability to handle large amounts of data from a large sample size with regards to contemporary epidemiological injury researches in sporting circles. Quality control is simplified and completeness can be secured to a high degree (Bahr and Holme, 2003). Prospective cohort studies can provide direct and accurate estimates of incidence and relative risk. Monitoring of participant players was done prospectively through team designates using an injury report system to ensure full collection of accurate data was recorded as events unfolded over the prescribed two seasons of study.
In a cohort study, a group of injury free subjects exposed to the determinant of interest is first selected, together with a comparable group of subjects exposed to the determinant, and the subsequent outcome status of the two groups is then compared (Silman and MacFarlane, 2004). The identified cohort comprised uninjured players at the beginning of the season that was monitored over the period of study. Analysis examined if persons exposed to a possible casual factor are injured more frequently than those who are not exposed (McNeil, 2000).

Silman and MacFarlane (2004) have identified four major advantages associated with prospective cohort studies; Firstly, it can be determined which exposure is measured, how and if and when change in exposure is measured. Secondly, procedures to allow future identification and tracking can be implemented. Thirdly, the nature of outcome measures can be determined. For reasons alluded to by the foregoing assertions (Silman and MacFarlane, 2004; Bahr and Holme, 2003; Bahr and Krosshaug 2005; McNeil, 2000), the researcher used the cohort approach to collect baseline data on potential risk factors identified for two consecutive seasons from handball players (2014-2015). The effects of selected variables were measured alongside the large sample chosen. The cohort approach is suitable when the injuries outcome is common and is particularly suited to determine the effects of exposure on a variety of risk factors and outcomes as was the case in this study. For this reason, prospective cohort studies are considered the most powerful methodology in epidemiologists’ armoury (Silman and MacFarlane, 2002).

The choice of this cohort approach also assisted in the identification of multiple injury outcomes from a single exposure. At the same time, this approach, in theory, also permitted setting up systems to notify change in exposure status during the follow-up period, an option
that may be lacking in a retrospectively derived cohort with only “point” data on exposure (Silman and MacFarlane, 2002:35). This cohort approach assisted in understanding how a host of factors and circumstances might have negatively impacted on player performance in handball training and competition. Hence this would militate against their safe participation (Bahr and Holme, 2003; Bahr et al., 2009; Cumps et al., 2007; Langevoort et al., 2007; Koren, 2010). The researcher, therefore, felt the cohort approach had a strong bearing towards understanding the problem under study.

### 3.5 Research population

Handball has gained much popularity in tertiary institutions of Masvingo over the last few years since its inception in 1995 when the country hosted the All Africa games. However, despite a high influx of players into the sport, lack of published statistical information on the pandemic of injury occurrence in Masvingo tertiary handball exists, which this study focused on. The population for this study was drawn from ten teams registered for 2014-2015 Zimbabwe Teachers’ Colleges Sports Association (ZITCOSA) Zone A handball games. According to gender, five were male teams, the other five being female teams whose league has become so competitive that injury sustenance has been seen to be an occupational hazard.

There are six training institutions in Masvingo involved in tertiary league games, including handball, except for one university which recently became operational in 2014, hence was not included in this study. The five were, therefore, considered for choosing a representative sample that was selected for use in the present study, excluding eight teams from the other two remaining zones, B and C.
### 3.6 Sample

Selection of a sample in quantitative research should be done in such a manner that it is unbiased and represents the population from where it is selected. The purpose is to draw inferences about the group from which the researcher has selected the sample and this is guided by a pre-determined sample size based upon other considerations, in addition to other resources (Kumar, 2010). Since the research study was based on the quantitative paradigm, the researcher chose to work with a larger sample of five teachers’ colleges in Masvingo Province. Two handball teams from each college, male and female, comprising a total of 160 players, 20 coaches, 5 team rehabilitation technicians and 5 team medics, were chosen, giving a total of 190 participated in the study. This number was based on the principle that a larger sample size will ensure inclusion of people with diverse sports backgrounds, thus making the sample representative enough to make inferences and draw conclusions at the end of the study. Subjects chosen played for college teams and were players of the original teams in the age range 18-30 years. A total of 15 were picked for the pilot study, while 160 were administered with questionnaires. In this study, considerable importance was put on a larger sample size in order to test the associations and interaction of a host of athlete and environmentally-triggered variables in injury causes, mechanisms and outcomes. The intention was to assess the variables and their impact.

The sample chosen for this study comprised diverse groups; players, team coaches, rehabilitation technicians and team medics. Coaches are custodians in the technical and organisational issues whose roles are crucial in the development of emotional, psychological and physiological functioning of players. Rehabilitation technicians and team medics would be more on the curative and injury management side should injury occur. All stakeholders
would work in loco-parentis roles during training, competition and psychological orientation of injured/non-injured players. Players are the key stakeholders whose future in handball technical and physical upkeep is largely dependent upon cohesiveness of medics, coaches and rehabilitation technicians, in spite of the possibilities of ruinous effects that injury might bring. The chosen sample was, therefore, the basis that was used in this study for predicting the prevalence and outcome of handball injuries in tertiary institutions of Masvingo Province.

3.7 Sampling, sampling technique and procedures

Data gathering is crucial in research, as the data is meant to contribute to a better understanding of a theoretical framework (Bernard 2002). It then becomes imperative that selecting the manner of obtaining data and from whom the data is acquired be done with sound judgment, especially since no amount of analysis can make up for improperly collected data (Korb, 2012). According to Korb (2012), the sampling technique should be clearly spelt out in theoretical (a general description of the sampling technique) and practical (its application to the study) terms as is also the case with research design. For this study, random sampling was employed with specific focus on stratified random sampling. In this case, respondents who took part in this study provided a sample closely related to this study, carrying out specific roles within handball training, coaching and administration and how these stakeholders were affected by various factors which subjected players to injuries and unsafe practices.

A number of sampling procedures have been developed in research with the view to ensure that a chosen sample adequately represents the target population. All research endeavours are
guided by the theory of sampling which requires the researcher to gather information from a population of intent from which a sample to be observed is determined, whose findings can be generalised or extended back to the population (Korb, 2013). Therefore, the representativeness of the sample of the target group in sampling is the key foundation of population validity in any research. This means procedures that yield the sample to be used in the study should be clearly outlined.

In compliance with this theory, the population was divided into two groups based on their relevant characteristics (males and females) and selection of the participants was done within these groups. This ensured that specific sub-groups of people were adequately represented within the sample for male and female players. Players were drawn from original College teams that participated during 2014-2015 handball tertiary games. To achieve the sample, the strata were determined by dividing the population according to gender and the number of participants for each stratum was also determined. The units of analysis were split into respective strata using the hat-and-draw method for both sexes to come up with the requisite number that constituted the sample used in this study.

To ensure this, stratified random sampling was used. Korb (2012) asserts that groups from which participants are selected should be based on relevant characteristics. In using stratified random sampling, the population was divided into two strata or layers and a simple random sample or a systematic sample from each stratum was taken (Korb, 2012; Tichapondwa, 2013). This sampling method was adopted for its cost minimization, the method is less cumbersome since the use of a sample reduces time involved and the latest or current data can be captured or collected from the sample (Ahmed, 2009). In this case, appointed team
designates prospectively recorded all injuries as they occurred during handball training and competition days. This lessened the burden on the researcher who only had to collect the data from research sites fortnightly, having made some pre-arrangements with team officials.

For reasons alluded to by the above assertions, this method was adopted in the study since players, coaches, team medics and rehabilitation technicians were primarily and directly involved in the problem under study. Their encounters, feelings and experiences in injury incidences in relation to exposure in games and practice in collegiate handball represented fertile ground for information to make generalizations on the problem under study. As well, this technique fitted well into the nature of the study design since measurement of potential risk factors was done prospectively to give statistically meaningful outcomes from multiple determinants that were being explored. Hence the likelihood of intended results on the phenomenon under study was unearthed.

Subjects were randomly selected. To ensure equal chances of selection, all the 190 entries were numbered and corresponding numbers of slips of paper for male and female players put in a hat and thoroughly mixed. When a slip was drawn, its number was recorded and the slip put back in the hat. When a previously drawn number was drawn again, it was ignored and put back into the hat. The process was repeated until the desired sample size of 80 male and 80 female players was achieved.
3.8 The research instrument

For the purpose of this study, a self-administered questionnaire with formal methodological considerations (a standardised injury report schedule) was used. It was based on the questionnaire previously used by Langevoort et al. during the 2007-2008 London Olympic Games, F-MARC during FIFA World Soccer Games currently adopted by International Olympic Committee (2009) for injury research for all sport codes. It contained two sections (A and B, Appendix A), with information regarding demographic data of players (gender, age, height, playing experience in handball, injury history-Section A).

The second section contained an injury profile, anatomical sites vulnerable to injuries (head/neck; upper and lower body appendages; the trunk), types of injuries, injured body limps, nature of injury (contact/non-contact, fracture, foul), circumstances regarding injury causes, and injury classifications. It further indicated injury mechanisms, playing positions, injury severity (days in absence of play or training) and whether the injury occurred during training or competition. Detailed injury reports describing all the aforementioned aspects were completed by players with the assistance of team medics, rehabilitation technicians and coaches who were also the assessors of incurred injuries.

3.9 Data collection method

Pre-season meetings (face-to-face) with one team designate, a trainer/coach and team therapist or sports director from each college were carried out in order to explain the study purpose and proceedings. Guide notes on the proper completion of the questionnaire were made available to all medical and technical staff of each team. Research assistants were
initially guided by the researcher on the process of observation and recording on the report schedule based on the characteristics of the injuries. Personal commitment was asked of coaches and team medics/rehabilitation technicians to prospectively document injuries incurred during the two seasons. Appointed designates, in turn, organized meetings with all players during the season preparation period to inform them about the practical issues.

All baseline data were collected through an injury report form by the appointed designates and a standardized questionnaire to collect bio-data information (such as playing position, years of experience, nature of injury, severity, incidence, mechanism) with close-ended questions. It was based on the conceptual model for the causation and management of sports injuries (McIntosh, 2005; Meeuwisse et al., 2007). Its design allowed recording of multiple injuries during training and competition in real time (Bailasha et al., 2014). Recorded information included injury incidences, mechanisms, types and severity of injury. It was used to explore the association of external and internal risk factors with injury incidences during collegiate handball training and competition, as well as determining the prevalence of injuries and associations between these variables and injury outcomes (dependent and independent). The questionnaire was related to injuries players incurred in handball within the period from 2014-2015. Each player filled in the form. Follow-ups were done monthly through constant visits to motivate them. Injury forms were filled in accordance with the injury definitions and diagnosis made by the team medic or rehabilitation technician every time a handball player sustained an injury in relation to exposure to risk factors. In the case of a lighter or minor injury, sometimes the player was examined just by the coach or no examination was done at all. This included time loss injuries, injury mechanisms, incidence and injury severity.
The proceedings adopted for returning the questionnaires were established considering the structure and organisation of each team. All team designates/collaborators proposed to deliver the questionnaires at the end of each season (2014 and 2015). Check lists were handed out to check whether all injury forms had been accounted for and to determine whether a follow-up was necessary when the players would have not gained full recovery at the end of the season. Regular contacts by the researcher were made by telephone and email to ensure that a proper report of injuries was made as intended. An injured athlete was re-introduced into the study after recovery from an injury. A player could, therefore, sustain one or more injuries. The total number of games and sessions conducted by every team were collected.

The instrument has proven validity and reliability as it has been widely used in epidemiological research in sporting and health circles. The injury report system applied in this study was developed for the documentation of injuries during team sports in the Kenyan Handball league during 2013-2014 season (Bailasha et al., 2014), eight different team sports during Athens’ 2004 Olympic games (Junge et al., 2006), several international football tournaments (Yoon et al., 2008; Junge et al., 2006 a, b) and World Handball Championships for 2001 and 2003 (Langevoort, et. al. 2007). For the reasons cited above, this instrument has proved to have the capacity to elucidate players’ current situation, and reveal the true state of prevailing circumstances as well as gathering as much quantitative data sufficient enough to make analysis on the problem under study.
3.10 Data analysis procedure

All data analysis was conducted according to a pre-specified analysis plan. Descriptive statistics were employed to summarise all demographic data and categorical variables using percentages, means and frequencies presented in tables in the next Chapter. Inferential statistics (cross tabulation) were used to determine if there was any association and influence between risk factors, exposure time and injury outcomes, as well as the prevalence of injuries during training and competitions. Details of key variables pertaining to injury mechanism, nature of injury, injury incidence and injury severity in relation to internal and external factors, were tabulated and statistically represented using the chi square statistic test of independence. All baseline data information collected prospectively, was summarized statistically to show whether or not there were any significant results as well as correlations of injury and risk factors. Data was monitored for quality and completeness by the researcher and appointed designates at research sites using established verifications, validation and checking process through registers and injury report forms.

With regard to this, Junge et al. (2006) believe that such kind of standardised assessment of sports injuries provides not only important epidemiological information but also creates the opportunity for monitoring long term changes in the frequency and circumstances of injury and for comparison with other types of sports. Missing data collected via baseline was tracked monthly until received or confirmed not available. Analysis and discussion were done inferentially to establish the degree of deviation from sub-problems and pre-conceived assumptions.
3.11 Statistical analysis and presentation

The National Athletics Injury Report System, (NAIRS) (Van Mechelen et. al., 1992) was used to delineate four provisional codes as slight, mild, moderate and severe injuries. Relative risks of 95% confidence interval were calculated to show the relationships between the independent and dependant variables. A multivariate approach was used with the view that injuries may be generated by the interplay of several confounding risk factors (Bahr and Holme, 2003). To achieve this, a Chi-Square statistic test of independence was adopted and considered suitable to describe the associations and relationships between the categorical outcome and predictor variables (independent) (Scott et al., 2013) in epidemiological studies of this nature.

The Chi-square strength lies in its ability to provide information not only on the significance of any observed differences, but also on exactly which categories accounted for any differences found (McHugh, 2013). This richness of detail allows the researcher to understand the results and derive more detailed information from this statistic than from many others (McHugh, 2013).

Completed data was presented using prevalence tables and bar graphs to describe categorical data, while means, prevalence and percentages were used to describe continuous data. Calculated injury incidences for males and females were presented separately and then compared.
The set of covariates in this case included age, gender, body weight, prior injury, stress, self-confidence, trait anxiety, facility, equipment and opponent, playing position, weather and month of the season, training quality, coaching style, officiating quality and match schedule. The dependent variables were injury incidence, injury mechanism, nature of injury and injury severity. Injury incidence rates were calculated taking exposure into account and expressed as the number of injury occurrence per 1000 hours of match (injury incidence = n/1000h, Phillips et al., 2001). The total exposure hours were calculated by multiplying the maximum number of players allowed on the field of play and duration of the match in hours with the number of matches (Junge et al., 2004). Incidence and severity were graded and grouped into four categories of severity including: 1- slight (meaning that the player can participate in the next match or training session), 2- mild (unable to participate in the training sessions or competitions for 1 to 7 days, 3- moderate (absence from competitions or training sessions for 8 to 21 days), and 4- severe (being away from the competitions and training sessions for more than 21 days (Olsen et al., 2005; Seil et al., 1998). Injured anatomic areas were categorised as follows: head, neck and trunk (chest, abdomen and waist), upper extremity (shoulder, elbow, forearm/upper arm, elbow, wrist and fingers) and lower extremity (hip joint, thigh and pelvis, groin, knee, lower leg, ankle and foot/toes) (Olsen et al., 2006; Langevoort et al., 2007; Rasuli et al., 2012). Injury types were classified as strains, sprains, dislocations, contusion, concussion, and ligamentous tears (Langevoort et al., 2007).

For clarity in terms of injury incidences in different playing positions, five classes based on players specific roles on the field of play, were created: pivot players, goalkeepers, left and right wings(wings), backcourt players (left, centre and right backs) and line players (Moller et al., 2012; Piry et al., 2011). With regard to the kind of collisions resulting in injuries, an injury sustained by a player perpetuated from a direct shot of an opponent, or being pushed,
stopped or blow at the part of the body other than the injured part, were classified as “contact” and if injury was a resultant of running, turning, jumping or falling, then the injury was classified as “non-contact” (Cumps et al., 2007; Piry et al., 2011; Olsen et al., 2005). The mechanism leading to injuries included foot plant and cutting (including sideways, forward and backward manoeuvres), shooting (jump/diving/snap shots), landing, dribbling, turning and blocking. Descriptive information on the injuries was based on the information gathered from the injury report system instrument during training and matches. Data collected were statistically presented in tabular form and bar graphs for analysis to determine the prevalence and associations between internal and external risk factors and collegiate handball outcomes during training and competition in order to come up with valid recommendations at the end of the study.

3.12 Validity, reliability and piloting of the instrument

Validity and reliability are two of the most important criteria by which a quantitative instrument’s adequacy is evaluated (Polit et al., 2000). Validity refers to the extent to which an instrument measures what it is invented to be measuring (Mokkink et al., 2010). It is an overall evaluative judgement of the sufficiency and aptness of inferences drawn from test scores (Mesick, 1980). It is not determined by any single finding but is established progressively through the accumulation of different types of evidence such as face validity, content validity, criterion validity and construct validity (Davidson and Keating, 2014; Mokkink et al., 2010). Other dimension properties such as reliability and responsiveness, also affect an instrument’s overall validity (Mokkink et al., 2010).
Face validity refers to whether when merely looking at it, an instrument appear to be assessing the considered necessary qualities (Streiner and Norman, 2008; Mokkink et al., 2010). Content validity refers to the degree to which the content of an instrument adequately reflects the construct of interest (Davidson and Keating, 2014) and is a subjective judgement obtainable from users and experts in the field (Terwee et al., 2007). Reliability is the ability of the instrument to yield a similar result when repeated under the same conditions (Bless and Higson-Smith, 2000).

Before administering this instrument to the respondents, it was pre-tried using a smaller related sample in order to fine tune it during data collection for the main inquiry. Piloting research instruments helps to check the clarity of the wording of the questionnaire, instruments layout, eliminate ambiguity or difficulties in the instructions, reveal omissions or previously unanticipated answers and identify redundant questions and those that are commonly misunderstood (Anderson, 1993). With regards to this, a pilot study was conducted using one team of 16 players from ZITCOSA Zone A during pre-season games to assess face validity of the items and checking its applicability and clarity of wording.

To determine its content validity, a copy of the instrument was sent to a panel of experts comprising five coaches, five rehabilitation technicians and one team medic from each institute in Masvingo Province who dealt with sports injuries. They all commented that it was of good clarity on contents; hence it showed its explicable, validity and reliability under similar conditions as attested by the foregoing research studies. It was also to determine the average time taken to complete the injury report form (Baker and Risley, 1994). To determine this, a pre-test was implemented to evaluate the understanding of questions and to confirm its
accuracy for capturing the intended information. For this purpose, a team of tertiary handball players completed the preliminary version of the questionnaire. The pilot study was done after ethical clearance from Zimbabwe Open University (ZOU) and responsible authorities of the five research sites in Masvingo Province where the study was conducted. Data were collected at the grounds where coaches, team medics and rehabilitation technicians gathered for training. Respondents were issued with injury report forms followed by oral explanations of the nature and objectives of the study and the purpose of the pilot study. An individual oral reflection was done considering their impressions about the questionnaire presentation, issues and question types, including the requested information about injuries. After reading and understanding the purpose of the study, they signed a consent form. In the event that the participant needed clarification, the researcher was present to give assistance. Completed forms were immediately collected by the researcher. Two weeks later, an identical questionnaire was again re-administered to the same respondents (Singh et al., 2011) for its re-assessment to determine the repeatability of answers in each section of the questionnaire since the research settings under which the study was conducted were different. It took, at most, 15 minutes to complete it which again yielded positive results, thereby demonstrating its validity and reliability in data gathering prior to its administration to the intended population during the course of the study.

The injury report system has shown to be valid and reliable as it has been developed for the documentation of injuries by Assembo and Wekesa (1995) during the East and Central African Men’s Senior Handball Championships in Kenya, Bailasha (2014) during the Kenyan handball league. The same instrument has also been used in eight different team sports during Athens’ 2004 Olympic Games (Junge et al., 2006), 2008 Olympic Multi-Sport games, World Handball Championships for 2001 and 2003 (Langevoort et al., 2007) and several
international football tournaments (Yoon et al., 2007; Junge et al., 2006 a, b). Currently, it has been accepted and adopted by International Olympic Committee (IOC) in injury research for all sport codes world-wide including international research institutes such as Oslo Sports Research Centre (Norway), Sports Injury Research Centre (Canada) and Clinical Sports and Exercise Medicine Centre (South Africa) (F-MARC 2009). Owing to its wider use and acceptance at a wider spectrum and for reasons alluded to by the aforementioned authorities, the researcher saw it appropriate to adopt this instrument as it had the capacity to gather as much quantitative data as possible on the problem under study for analysis. Hence it showed its explicability, validity and reliability under similar conditions during the course of this study.

3.13 Ethical and legal considerations

Ethical issues form an “integral” part of the research planning and implementation (Mertens, 1998: 23). One of the purposes of research especially in the theoretical perspective is to build up understandings that are trustworthy and which are arrived at in an ethical way (Merrian 1998). In this regard, the major issues considered in this study were the seclusion and well being of participants, and the necessity to give a clear outline of the study to participants so that their involvement were undertaken on a voluntary basis (Mertens, 1998; Schumcher and McMillan, 1993). Associated considerations will be the necessity to obtain the required clearances from the appropriate authorities to undertake the study, including gaining authority of the participants’ employer.
To comply with these ethical considerations, application was done on appropriate forms and with the necessary accompanying documentation to tertiary institutions in Masvingo Province where the study was conducted. These requests for approval set out the details of the study and included the title of the study, the researcher’s name and contact details, supervisor of the research and contact, background to the study, aim of research, purpose of the research and information regarding the confidentiality of the research. These were explained to relevant administrative bodies and players. In relation to the latter, and to safeguard the privacy of the participants, each questionnaire distributed was given a reference number known to the researcher alone (anonymity). The number was allocated so that follow-up contacts could be done with participants who had indicated their willingness to participate in the study. Also, in relation to the privacy issues, details of the storage and disposal of materials gathered during the study were outlined.

3.14 Chapter Summary

This chapter outlined the research design of the study. It aimed at gaining an insight into the sporting environment of the participants in handball within the framework of the research related to the purpose of the study and centred on the research questions. The research design was a cohort prospective study that set out to gather real time information relating to injuries handball players sustained during training and matches in Masvingo tertiary institutes. Coaches and rehabilitation technicians collected data from injured players at research sites. A total of 190 participants from the five institutions consented to participate in the study. Out of 190 participants, 160 were handball players, 10 were team medics/rehabilitation technicians and 20 were coaches. A standardised injury report instrument was adopted in this study which was prepared along the lines of Langevoort et al. (2007) Junge et al. (2004; 2006),
Yoon et al. (2007) and Assembo and Wekesa (1995) who conducted similar studies in how external and internal factors contributed to injury during different international tournaments in World Handball Championships. Quantitative analysis was applied to the data to provide insights into the demographic features of players. Quantitative analysis was also used to examine and explore the influence and interplay of particular variables (internal and external) on injury cause among handball players in relation to issues raised in research questions.

The study was designed cognisant of the validity and reliability issues associated with conducting a study from an epidemiological approach and conceptual perspective of epidemiology injury research. The research design set out to address the ethical considerations raised by the study from the conceptual and theoretical frameworks raised earlier in Chapter Two. Associated with this aspect of the study, approval was sought from the appropriate authorities to carry out the research; procedures were put in place to obtain voluntary participation in the study and to safeguard the privacy and well-being of the participants, and to address the ethical considerations associated with the researcher’s interaction with the participants (Mertens, 1998). The data gathered was analysed and results presented in the next chapter.
CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This Chapter presents the results of the study in the form of tables, graphs, percentages and frequencies. It begins with the presentation of bio-data on baseline characteristics of handball players by age group, gender, height, weight, experience and previous handball injuries. Data about injury incidences, prevalence, mechanism, nature, anatomical location, severity and circumstances surrounding injury occurrence are also presented. A Chi-Square set at a value of 5.991(5% level of significance) was used to analyse data. Injury mechanisms along with incidence in relation to different playing positions are also alluded to. The Chapter shows how objectives of the study have been achieved and discussed on aspects related to the prevalence of handball injuries. The Chapter also determines the significant relationships and associations between internal and external risk factors with injury outcomes and their impact on player performance (nature, mechanisms, incidence and prevalence). The Chapter ends with discussions and comparisons based on findings reported by some authorities in similar epidemiological injury research studies that have a bearing towards results made in this study.
### 4.2 Demographic characteristics of handball players

Table 4.1 below presents baseline characteristics of handball players in the study.

#### TABLE 4.1: BASELINE CHARACTERISTICS OF 153 HANDBALL PLAYERS BY AGE GROUP AND GENDER

<table>
<thead>
<tr>
<th></th>
<th>FEMALES</th>
<th></th>
<th></th>
<th>FEMALES</th>
<th></th>
<th></th>
<th>FEMALES</th>
<th></th>
<th></th>
<th>FEMALES</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AGE (Y)</td>
<td>18-21 (12)</td>
<td>22-25 (40)</td>
<td>26-30 (10)</td>
<td>18-21 (10)</td>
<td>22-25 (45)</td>
<td>26-30 (25)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEIGHT (M)</td>
<td>1.5-1.6 (31)</td>
<td>1.61-1.69 (39)</td>
<td>1.7+ (10)</td>
<td>1.5 - 1.6 (4)</td>
<td>1.61-1.9 (66)</td>
<td>1.7+ (10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEIGHT (KG)</td>
<td>55-70 (37)</td>
<td>71 – 86 (32)</td>
<td>87+ (11)</td>
<td>55 – 70 (57)</td>
<td>71 – 86 (13)</td>
<td>87+ (10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXPERIENCE (YEARS)</td>
<td>Less than 1 (6)</td>
<td>1 – 3 (34)</td>
<td>4+ (40)</td>
<td>Less than 1 (18)</td>
<td>1 – 3 (40)</td>
<td>4+ (22)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRIOR INJURY</td>
<td>0</td>
<td>26</td>
<td>17</td>
<td>16</td>
<td>19</td>
<td>14</td>
<td>18</td>
<td>21</td>
<td>28</td>
<td>20</td>
<td>25</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 4.1 above presents the demographic characteristics of a cohort of 160 handball players, male and female, with an age range of between 18 and 30 years, who agreed to participate during the study. Out of 160 players, 153 of them participated during the study. The number represented players from the ten tertiary teams in Masvingo Province. The questionnaire on baseline characteristics was completed by 153 players showing a response rate of 96%.

The average age was 24, with most players in the age range of 22 to 25 (40 female, with 45 male in the same range), followed by age range 26-30, female (28), male (25) and the 18-21 age range having 12 and 10 for female and male age groups respectively. The highest weight was 55 – 70 kg range, male (57) and female (37), followed by 71-86 kg range, female (32) and male (13) and 87kg upwards, female (11) and male (10). Generally, a greater number of
players have had previous injuries with 59.3% average for females and 63% for males contributing to an average of 61.2% for both sexes. 37% did not indicate previous injuries.

4.3 Association between intrinsic risk factors and injury occurrence: Categorical variables

In order to determine if there was any association between categorical variables in relation to injury occurrence, a Chi-Square test of independence at a value of 5.991, 5% level of significance, was used to test hypotheses of the study and analysis of data since it is the appropriate non-parametric statistical tool for the analysis of nominal data (Hinton, 1995). It was hypothesised that handball players in tertiary institutions of Masvingo Province were exposed to a host of internal and external risk factors which predisposed them to injuries during training and matches. It was also assumed that the pattern of injuries between and within genders would not be significantly different. The Chi-Square was adopted for its robustness in data distribution and its ability to provide succinct detailed information on the significance of any observed differences and categories accounting for noted differences. This richness of detail allows the researcher to understand the results deriving more detailed information from this statistic than from any others (McHugh, 2013). The variables that were calculated using a Chi-Square were age, height, weight, experience, prior injury, circumstances (contact/non-contact), injury severity, anatomical sites and playing positions. For all tabulations and analysis made in this study, the total response rate was 96%. Tables 4.2-4.9; 4.12-4.15 and 4.18-4.25 below present the results of Chi-Square calculations and analysis for categorical variables:
4.3.1 Association of injuries by age

Table 4.2 below presents results on the association of injuries by age using Chi-Square calculation.

**TABLE 4.2: ASSOCIATION OF INJURY OCCURRENCE BY AGE OF PLAYERS (N=153)**

<table>
<thead>
<tr>
<th>AGE (yrs)</th>
<th>18-21</th>
<th>22-25</th>
<th>26-30</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>22 (15)</td>
<td>40 (41)</td>
<td>11 (17)</td>
<td>73</td>
</tr>
<tr>
<td>MALES</td>
<td>10 (17)</td>
<td>45 (44)</td>
<td>25 (19)</td>
<td>80</td>
</tr>
<tr>
<td>TOTAL</td>
<td>32</td>
<td>85</td>
<td>36</td>
<td>153</td>
</tr>
</tbody>
</table>

Table 4.2 above shows a wide distribution of injuries with the greater number of cases being observed in the 22-25 age range (85/153, 56%), followed by the 26-30 category (36/153, 24%) and 18-21 age range (32/153, 21%). More injuries were reported in males (80/153, 52%) than females (73/153, 48%).

Since Chi-Square calculation ($x^2 = 10.2$) exceeds the critical value of 5.991, results (table 4.3) indicate there was a significant difference, at 5% level of significance, in injuries between males and females with respect to age. A significant difference was also noted in the 26-30 age range in injury occurrence in both genders (11 and 25) as well as the 18-21 age range (22 and 10) respectively. Not much of a difference in injury occurrence was noted in the 22-25 age groups (40 and 45). Overall, results of the study indicated that males (80) incurred more injuries than their female counterparts (73), showing a significant relationship between injury sustenance and gender. This might be attributed to morphological structures and biological make up that exists between the two genders which might be contributory factors to differences in injury rates. This means that a relationship exists between age of player and injury occurrence in relation to gender.
4.3.2 Association of injuries by height

Table 4.3 below presents players’ heights and association of injuries by Chi-Square calculation.

TABLE 4.3: ASSOCIATION OF INJURY OCCURRENCE BY HEIGHT (N=153)

<table>
<thead>
<tr>
<th>HEIGHT (m)</th>
<th>(1.5-1.6)</th>
<th>(1.61-1.69)</th>
<th>(1.7+)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>31 (17)</td>
<td>36 (49)</td>
<td>6 (8)</td>
<td>73</td>
</tr>
<tr>
<td>MALES</td>
<td>4 (18.3)</td>
<td>66 (53)</td>
<td>10 (8)</td>
<td>80</td>
</tr>
<tr>
<td>TOTAL</td>
<td>35</td>
<td>102</td>
<td>16</td>
<td>153</td>
</tr>
</tbody>
</table>

Results in Table 4.3 above indicate that more injuries were incurred in males (80/153, 52%) than females (73/153, 48%). Results also show that those within the 1.61-1.69 height had the highest record of injuries (102/153, 67%), followed by those in the 1.5-1.6 category (35/153, 23%) with the least number being reported in the 1.7+ category (16/153, 11%). Results in Table 4.3 above show that the Chi-Square of 30.053 exceeded the critical value of 5.991 at 5% level of significance, indicating a significant difference in injuries between males and females with respect to height. Injury sustenance was greater for males (80) than females (73). A significant difference was also observed for the 18-21 age range (31 females, 4 males) as well as the 22-25 categories (1.61-1.69 m-66 males and 36 females).

Results are indicative of significant associations that exist between injury occurrence, height and age factors with respect to gender. Results also show that injuries incurred for both genders (1.61-1.69 m), were three fold (102/153) that for the 1.5-1.6 range (35/153) and seven times to that for 1.7+ (16/153). This implied that there is a significant relationship between injury occurrence height, age and gender. Injury variations could be related to physical and morphological differences as well as being novice to the game demands.
4.3.3 Association by previous injuries

Table 4.4 below depicts results of no previous injury report and association with new cases using Chi-Square calculation.

**TABLE 4.4: ASSOCIATION BY PREVIOUS INJURIES (N=153)**

<table>
<thead>
<tr>
<th>AGE (yrs)</th>
<th>18-21</th>
<th>22-25</th>
<th>26-30</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO INJURY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FEMALES</td>
<td>3 (3)</td>
<td>8 (8)</td>
<td>4 (4)</td>
<td>15</td>
</tr>
<tr>
<td>MALES</td>
<td>2 (2)</td>
<td>5 (5)</td>
<td>3 (3)</td>
<td>10</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5</td>
<td>13</td>
<td>7</td>
<td>25</td>
</tr>
</tbody>
</table>

Results in Table 4.4 above indicate that more female athletes (15/25, 9.8%) were injury free than their male counterparts (10/25, 6.5%) before the commencement of the study with the greatest number reported for the 22-25 age range (13/25, 8%). The 26-30 age group was second (7/25, 5%) with the least record being observed in the 18-21 age range (5/25, 3.3%) in both genders. This implies safety precautionary measures players observed in sport. As shown in Table 4.4 above, results indicate no association between injury occurrences with no previously reported cases, an indication of adherence to sports safety by players as depicted by Chi-Square calculation of 0. This means that injury cannot be associated with no previous reports.

4.3.4 Association with one previous injury

Table 4.5 below presents results on the association between new injury occurrences for players who reported one case of previous injury.
TABLE 4.5: ASSOCIATION WITH ONE PREVIOUS INJURY (N=153)

<table>
<thead>
<tr>
<th>ONE INJURY</th>
<th>18-21</th>
<th>22-25</th>
<th>26-30</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>15 (13)</td>
<td>10 (11)</td>
<td>5 (6)</td>
<td>30</td>
</tr>
<tr>
<td>MALES</td>
<td>13 (15)</td>
<td>13 (12)</td>
<td>7 (6)</td>
<td>33</td>
</tr>
<tr>
<td>TOTAL</td>
<td>28</td>
<td>23</td>
<td>12</td>
<td>63</td>
</tr>
</tbody>
</table>

Results shown in Table 4.5 above shows a slight difference in injury occurrence between genders with new cases for one previously reported injury (30/63, 19.6% and 33/63, 2.5%). A decline in injury occurrence is seen with increase in age level across all categories (28, 18.3%; 23 15%; 12, 7.8%). Total number of injuries for players who reported one injury was 63. Results show little significant differences in injury occurrence in both genders (30/63 females and 33/63 males). However, significant differences were noted among age ranges (18-21, 28/63); 22-25, 23/63 and 26-30, 12/63). Females appear to be more vulnerable to the effects of previous injuries for ages 18-21(15) than males (13) and 22-25 age range in males (13) than their female counterparts respectively, but with little effects for the 26-30 age range for both genders (5 and 7) respectively. This implies that a previously reported injury triggers surfacing of new chronic injuries in relation to age and gender.

4.3.5 Association with two previous injuries

Table 4.6 below shows the outcome from two previously reported injuries by players with new injury cases using Chi-Square calculations.

TABLE 4.6: ASSOCIATION WITH TWO PREVIOUS INJURIES (N=153)

<table>
<thead>
<tr>
<th>TWO INJURIES</th>
<th>18-21</th>
<th>22-25</th>
<th>26-30</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>3 (4)</td>
<td>5 (6)</td>
<td>10 (9)</td>
<td>18</td>
</tr>
<tr>
<td>MALES</td>
<td>6 (5)</td>
<td>10 (4)</td>
<td>12 (13)</td>
<td>28</td>
</tr>
<tr>
<td>TOTAL</td>
<td>9</td>
<td>15</td>
<td>22</td>
<td>46</td>
</tr>
</tbody>
</table>
Table 4.6 above shows that injury rates increased with age for players who reported two previous injuries for both genders (9/46, 6%; 15/46, 10%; 22/46, 14%). Generally, male players (28/46, 18%) sustained more injuries than female players (18/46, 12%). The total number of injuries was 46. Results indicate significant differences and association in injury occurrences across all ages and genders for players who reported two previous injuries (18-21, 9/46); (22-25, 15/46) and (26-30, 22/46). A significant difference is also noticeable between genders with more injury cases being reported in males (28/46) than females (18/46).

Results portray a significant rise in injury occurrence in relation to increase in age for all ages with the greatest effects observed in the 26-30 range (22/46). Cumulatively, results depict a strong association between two previously reported injuries and surfacing of new cases for both genders which may be attributed to re-injury and insufficient rehabilitation and physical integrities of players. Males were more susceptible to injury than females across all age ranges, suggesting more physical contacts during training and matches and less of protective measures through sanctioned fouls by match officials. This means injury occurrence declines with increase in age for both genders due to adherence to rules, regulations and precautionary measures.

4.3.6 Association with more than three injuries

Table 4.7 below shows results on the effects of more than three prior injuries in association with newly reported cases by Chi-Square calculation.
TABLE 4.7: ASSOCIATION WITH MORE THAN THREE PREVIOUS INJURIES * (N = 153)

<table>
<thead>
<tr>
<th>THREE INJURIES *</th>
<th>18-21</th>
<th>22-25</th>
<th>26-30</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>4 (4)</td>
<td>3 (3)</td>
<td>1 (1)</td>
<td>8</td>
</tr>
<tr>
<td>MALES</td>
<td>5 (5)</td>
<td>4 (4)</td>
<td>2 (2)</td>
<td>11</td>
</tr>
<tr>
<td>TOTAL</td>
<td>9</td>
<td>7</td>
<td>3</td>
<td>19</td>
</tr>
</tbody>
</table>

Not much of significant differences in injury occurrence were observed for players who reported more than three previous injuries for both genders (8/19, 5% and 11/19, 7%), though male players reported more injuries (11/19) than their female counterparts (8/11). The total number of injuries incurred was 19. A decline in injury sustenance was observed and is age related 18-21 (9/19), 22-25 (7/19) and 26-30 (3/19), possibly as a result of adherence to safety precautions in addition to maturational experience and improved level of proficiency in the game.

4.3.7 Effects of prior injuries on player participation

No significant differences were noted for players who reported no previous injury and over three injury cases as well as those who reported one previous injury or less ($x^2 = 1.078$). The reason was adherence to safety precautionary measures that players undertook and level of understanding in terms of game demands and approaches during play. The Chi-Square value was far below the critical value of 5.991 at 5% level of significance hence; there was no relationship with occurrence of new injury cases across all age ranges for this section. A significant difference, however, could be noted for players who reported two previous injuries (46) of age range 22-25 with more cases (twofold) being reported in males (10) than females (5). A similar trend could also be seen in both genders for the 18-21 category (6 and 3 correspondingly) though there were no significant differences observed from the 26-30
category in both genders (10 and 12). Results thus reinforce a strong correlation of injury occurrence with respect to age, injury provocation and surfacing of new cases. This was due to unconditioned bodies, lack of safety approaches to the game, frequency and heightened intensities of exposure rates/levels these novice players were subjected to in training and competition situations.

4.3.8 Association of injury occurrence with sport experience

Table 4.8 below illustrates results on the association between injury occurrence and sport experience between genders by Chi-Square calculation.

<table>
<thead>
<tr>
<th>EXPERIENCE (YRS.)</th>
<th>LESS THAN 1</th>
<th>1-3 YEARS</th>
<th>4 YEARS +</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>6 (18)</td>
<td>31 (34)</td>
<td>36 (28)</td>
<td>73</td>
</tr>
<tr>
<td>MALES</td>
<td>18 (13)</td>
<td>40 (37)</td>
<td>22 (30)</td>
<td>80</td>
</tr>
<tr>
<td>TOTAL</td>
<td>24</td>
<td>71</td>
<td>58</td>
<td>153</td>
</tr>
</tbody>
</table>

Results in Table 4.8 above shows that experienced male players incurred a greater number of injuries (80/153, 52.2%) than female players (73/153, 47.7%). Results reflect a significant difference in injury occurrence at 5% level of significance as indicated by the Chi-Square of 9.12 which was far above the critical value of 5.991 with respect to game experience for both genders. A significant difference was seen in the 26-30 age range (males and females) who reported an experience of 4 years and above females, (36, females, 22 males). This was followed by the 18-21 category with less than 1 year experience (males, 18 and females, 6) male results being three times those for women. For those who had 1-3 years experience (22-25 years), the difference in injury occurrence was not great (males, 40; females, 31) but a significant difference is visible from the other two categories 18 and 6 for less than one year.
and 36 and 22 for four years and above. The general trend of high injury rates indicates a strong relationship between years of experience and injury occurrence for both genders. This was due to the provocation of prior injuries from physical and aggressive contacts. This resulted in the re-ignition of index injuries and surfacing of new cases and from unfavourable conditions under which players were subjected to during training and match situations. More so, tight match schedules and insufficient regeneration could have ignited some nabbing effects pre-disposing players to high levels of psychological traumas, stress and anxiety, leading to high injury rates. In addition, more experience could mean attainment of high level of proficiency in skill development, greater exposure time eventually leading to greater injury risks. Generally, results show that injury sustenance was greater among males than females across all age ranges.

4.3.9 Association of injury occurrence in relation to weight

Table 4.9 below presents results on the association of injury occurrences based on players’ weights.

<p>| TABLE 4.9: WEIGHT BY GENDER (N=153) |</p>
<table>
<thead>
<tr>
<th>WEIGHT (kg)</th>
<th>55-59</th>
<th>60-69</th>
<th>70+</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>35 (44)</td>
<td>29 (20)</td>
<td>9 (9)</td>
<td>73</td>
</tr>
<tr>
<td>MALES</td>
<td>57 (48)</td>
<td>13 (22)</td>
<td>10 (10)</td>
<td>80</td>
</tr>
<tr>
<td>TOTAL</td>
<td>92</td>
<td>42</td>
<td>19</td>
<td>153</td>
</tr>
</tbody>
</table>

Results in Table 4.9 above indicate that weight contributes to injury occurrence. The trend is that those with less weight (55-59 kg) suffered more injuries (92/153, 60%) followed by those in the category of 60-69 kg (42/153, 27.4%) and those above 70kg recording the least number of cases (19/153, 12.4%). Not much of a difference in terms of injury occurrence was
seen between males (52.3%) and females (47.7%), although both genders reflect the greatest injury percentage for the 22-25 kg category (60%) than others with respect to weight. The Chi-Square calculation of 11.258 (5% level of significance) exceeding the critical value of 5.991 indicates a strong relationship between injury occurrence and weight of players and gender. No significant difference was reported for those who were 70 kg and above but those in the 60-69 kg category, 22-25 years, (42) and 55-59 kg category (92) and those having 70 kg and over (19). These differences could be attributed to more contact situations of players, variations in experiences and mismatch of players with age and weight variations as well as lack of specific competition formats. This, tied together with different levels of fitness condition, culminating from high competitive environments and the aggressive nature of the game, is fertile ground for injury sustenance in players. This indicates a strong association between injury occurrences and weight of players. This means that there is an association between intrinsic risk factors and injury occurrence in handball from mis-match of players. Players with less weight incur more injuries in contact situations while those with greater weights may suffer from knee tendonitis and ankle problems since they are key weight bearing structures.

4.4 Impact of risk factors on player performance

4.4.1 Prevalence and injury incidences during match and training

Table 4.10 below shows results on the prevalence and incidence of match and training injuries players incurred during the study.
A total of 242 injuries (96% response rate) were recorded during the two seasons, with female players recording the highest of (130, 54%) injuries than males (46%, 112). Of these, 73 occurred during match situations and 57 during training. For men, 68 occurred during matches and 44 during training sessions. Considering exposure hours of 1904 (training) and 560 (match hours), the result was 130 injuries for female and 112 injuries reported for males. Results of the study indicate no significant differences in injury occurrence between the two genders with respect to match and training schedules ($x^2 = 0.613$). Both genders reported more injuries during competitions (141, 58%) than in training (101, 42%). Females reported more injuries in training (57) than males (44). A similar trend was also noted for matches (73 females, 68, males) though the difference was slight.

### 4.4.2 Anatomical sites and injury types

Table 4.11 below presents results of the study by anatomical location and injury types that players incurred in handball for the duration of two seasons.

<table>
<thead>
<tr>
<th>GENDER</th>
<th>MATCH INJURIES</th>
<th>TRAINING INJURIES</th>
<th>TOTAL INJURIES</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>73 (76)</td>
<td>57 (54)</td>
<td>130</td>
<td>54%</td>
</tr>
<tr>
<td>MALES</td>
<td>68 (65)</td>
<td>44 (47)</td>
<td>112</td>
<td>46%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>141</td>
<td>101</td>
<td>242</td>
<td>100%</td>
</tr>
</tbody>
</table>
### TABLE 4.11: ANATOMICAL LOCATIONS AND INJURY TYPES IN 153 PLAYERS: SUMMARY

**EXPOSURE HOURS: 1344 TOTAL INJURIES = 242.**

<table>
<thead>
<tr>
<th>LOCATION &amp; TYPE</th>
<th>TOTAL NO: OF INJURIES</th>
<th>OVERUSE INJURIES</th>
<th>traumatic Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HEAD / NECK</strong></td>
<td>38 (16%)</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>Sprain</td>
<td>10</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Strain</td>
<td>20</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Contusion</td>
<td>8</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td><strong>UPPER EXTREMITY</strong></td>
<td>54 (22%)</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Shoulder/Upper arm</td>
<td>21</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Elbow/Upper arm</td>
<td>13</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Hand/Wrist</td>
<td>10</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Fingers</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dislocation</td>
<td>2</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><strong>LOWER EXTREMITY</strong></td>
<td>120 (50%)</td>
<td>68</td>
<td>52</td>
</tr>
<tr>
<td>Hip/Groin</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Thigh</td>
<td>11</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Knee</td>
<td>47</td>
<td>25</td>
<td>22</td>
</tr>
<tr>
<td>Lower Leg</td>
<td>24</td>
<td>14</td>
<td>10</td>
</tr>
<tr>
<td>Ankle/Foot</td>
<td>32</td>
<td>18</td>
<td>14</td>
</tr>
<tr>
<td><strong>TRUNK</strong></td>
<td>30 (12%)</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>Strain</td>
<td>14</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Contusion</td>
<td>13</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>2 (52%)</td>
<td>1 (48%)</td>
</tr>
</tbody>
</table>

Based on the results of this study shown in Table 4.11 above (96% response rate), most injuries were located in the lower extremities with 120, 50%, followed by upper extremities which accounted for (54%, head and neck (38%) and the trunk, accounting for the least (30, 12%). The results also show that the majority of injuries were of overuse type, with a total of (68) cases being reported for lower extremities, traumatic injuries reporting (52) for lower extremities as well. For upper extremities, (30) overuse and (24) traumatic injuries were reported, head and neck reported (18) overuse and (24) traumatic injuries while for the trunk (11) were overuse and (19) being of traumatic type. Results also indicated a significant
difference as more injuries were located on the lower extremities (120) than the upper extremities (54), head and neck (38) and trunk (30). The general indication was that 62% of injuries were seated in the lower body extremities than upper body extremities (38%). This means that injury occurrence is associated with an interface between athlete and environmentally-triggered risk factors. Hence a strong association between these variables exist.

### 4.4.3 Injuries for upper limb, lower limb and trunk appendages

Tables 4.12-4.15 below show the common types of injuries players sustained on upper limb, lower limb and trunk appendages during training and competition using Chi-Square.

**TABLE 4.12: ANATOMICAL INJURY LOCATIONS FOR HEAD AND NECK APPENDAGES.**

<table>
<thead>
<tr>
<th>HEAD AND NECK</th>
<th>OVERUSE</th>
<th>TRAUMATIC</th>
<th>TOTAL</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPRAIN</td>
<td>4 (5)</td>
<td>6 (5)</td>
<td>10</td>
<td>4%</td>
</tr>
<tr>
<td>STRAIN</td>
<td>8 (9)</td>
<td>12 (11)</td>
<td>20</td>
<td>8%</td>
</tr>
<tr>
<td>CONTUSION</td>
<td>6 (4)</td>
<td>2 (4)</td>
<td>8</td>
<td>3%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>18</td>
<td>20</td>
<td>38</td>
<td>16%</td>
</tr>
</tbody>
</table>

Results in Table 4.12 above confirm that players incurred more traumatic injury types (20/38) than those that were of overuse type (18/38) for the head and neck category, with an overall percentage of 16%. The greatest casualties were seen in players who sustained strains (20) followed by sprains (10) and contusions with the least figure of (8). Total injuries were 38.
Results in Table 4.13 above signify that the number of injuries players sustained was greater for overuse injury type (30/54) than traumatic incident type (24/30) with respect to upper limb appendage. Total injuries incurred were (54) for upper limb appendage. Most injuries were located on the shoulders (24), followed by hand/wrist (15), fingers (8), elbow/upper arm (6) and dislocation (1). These were a result of contact with players and equipment as well as players’ physical integrities that were related to individual players. This implies that injury sustenance is strongly influenced by the interplay of external and internal risk factors such as surface type, equipment, weather conditions and player’s state of fitness. Hence a relationship between these risk factors exist which also impacts negatively on player performance.

<table>
<thead>
<tr>
<th>OUTER EXTREMETY</th>
<th>OVERUSE</th>
<th>TRAUMATIC</th>
<th>TOTAL</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHOULDER/UPPER ARM</td>
<td>14 (13)</td>
<td>10 (11)</td>
<td>24</td>
<td>10%</td>
</tr>
<tr>
<td>ELBOW/UPPER ARM</td>
<td>2 (3)</td>
<td>4 (3)</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>HAND/WRIST</td>
<td>9 (8)</td>
<td>6 (7)</td>
<td>15</td>
<td>6%</td>
</tr>
<tr>
<td>FINGERS</td>
<td>4 (4)</td>
<td>4 (4)</td>
<td>8</td>
<td>3%</td>
</tr>
<tr>
<td>DISLOCATION</td>
<td>1 (1)</td>
<td>0 (0)</td>
<td>1</td>
<td>0%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>30</td>
<td>24</td>
<td>54</td>
<td>22%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOWER EXTREMETY</th>
<th>OVERUSE</th>
<th>TRAUMATIC</th>
<th>TOTAL</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIP/GROIN</td>
<td>4 (3)</td>
<td>2 (3)</td>
<td>6</td>
<td>2%</td>
</tr>
<tr>
<td>THIGH</td>
<td>7 (6)</td>
<td>4 (5)</td>
<td>11</td>
<td>5%</td>
</tr>
<tr>
<td>KNEE</td>
<td>25 (27)</td>
<td>22 (20)</td>
<td>47</td>
<td>19%</td>
</tr>
<tr>
<td>LOWER LEG</td>
<td>14 (14)</td>
<td>10 (10)</td>
<td>24</td>
<td>10%</td>
</tr>
<tr>
<td>ANKLE/FOOT</td>
<td>18 (18)</td>
<td>14 (14)</td>
<td>32</td>
<td>13%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>68</td>
<td>52</td>
<td>120</td>
<td>50%</td>
</tr>
</tbody>
</table>
More overuse injuries (68/120) were reported in players than those that were of traumatic nature (52/120) with respect to lower limb appendage as shown in Table 4.14 above. Results indicate variations in injury sites, with the knee being the most vulnerable site (47), followed by the ankle/foot (32), lower leg (24) and thigh (11). The least record was reported for the groin/hip (6). The cumulative figure was 120 injuries for lower limb appendages. Results, therefore, show the impact of risk factors on player performances as indicated by high prevalence rate of injury occurrence. This is indicative of the relationship that exists between internal and external risk factors in precipitating injuries among players.

### TABLE 4.15: ANATOMICAL INJURY LOCATIONS FOR THE TRUNK APPENDAGE (N = 153)

<table>
<thead>
<tr>
<th>TRUNK</th>
<th>OVERUSE</th>
<th>TRAUMATIC</th>
<th>TOTAL</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRAIN</td>
<td>5 (5)</td>
<td>9 (9)</td>
<td>14</td>
<td>6%</td>
</tr>
<tr>
<td>CONTUSION</td>
<td>4 (5)</td>
<td>9 (8)</td>
<td>13</td>
<td>5%</td>
</tr>
<tr>
<td>OTHERS</td>
<td>2 (1)</td>
<td>1 (2)</td>
<td>3</td>
<td>1%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>11</td>
<td>19</td>
<td>30</td>
<td>12%</td>
</tr>
</tbody>
</table>

Results in Table 4.15 above reveal that players suffered more traumatic incident injuries (19/30) than those reported for overuse type (11/30) with respect to the trunk appendage. Cumulatively, 30 injuries were reported. No significant differences were noted between contusions (13) and strains (14).

Generally, results on the anatomical location of injuries (Tables 4.12 - 4.15) above indicate that the commonly injured sites were the shoulder/upper arm, elbow/upper arm, hand/wrist, fingers, hip/groin, thigh, knee, lower leg, ankle/foot, and a few unclassified cases. Common injuries included sprains, strains, contusions and dislocations. Injuries were of overuse and
traumatic types. The highest number of injury cases were reported for the knee 47(19%), followed by ankle/foot 32(13%), lower leg 24(10%), shoulder 24(10%), hand/wrist 15(6%), thigh 11(5%), fingers 8(3%), hip/groin (2%), and elbow/upper arm 6(2%).

Results also confirm that strains were the most dominant type of injury which reported a high of 34(14%), followed by contusions with a record of 21(9%), sprains 10(4%) and others 3(3%), with only one case of a dislocation 1(0%). The knee, ankle/foot, lower leg and shoulder were the most vulnerable anatomical sites which accounted for the highest number of injuries. A similar trend was also observed on injury types incurred. More injury cases were located in the lower limb appendage (lower body extremity) 120/242, (50%), followed by upper limb appendage (upper body extremity) 54/242, (22%), head and neck 38/242, (16%) with the least record of injury cases being reported for the trunk appendage 30/242, (12%). In consequence, results generally confirm that players suffered more overuse injuries (127/242, 52%) than those that were of traumatic type 115/242, (48%) with respect to the aforementioned appendages. This, therefore, indicates that injury incidences are associated with the interaction that is produced between internal and external risk factors.

It has generally been found true that overuse shoulder injury is one of the prevalent types of injury in handball (Clarsen, 2015). Over arm throwing is one of the key technical skills that provides fast and preciseness as its advantage in training and match activities (Van den Tillaar and Cabri, 2012). It is believed that elite players, who perform up to 1200 throws in a normal training week, may be particularly at risk of overuse shoulder injury (Prestkvern, 2013). This finding shares a similar trend with the results of this study as a substantial number of players suffered shoulder pain problems (10%), even though the figure was below
those of Myklebust et al. (2013) among Norwegian female handball players. This could also be linked to provocation of prior shoulder injuries from insufficient body conditioning and inadequate injury rehabilitation.

4.4.4 Association of injury occurrence with head/neck, upper/lower limb and trunk appendages

In general, a significant difference was observed in injury occurrence among players (5% level of significance) as shown by the chi square calculation ($\chi^2 = 6.861$). This was above the critical value of 5.991 with respect to different anatomical regions that were affected. Some significant differences were also observed among categories of the lower limb appendage (120; head and neck (38); upper limb appendage (54) and trunk (30). A significant difference was also noted with the overuse injury type for lower limb appendage injuries (68, 57%) and trunk related injuries (11, 37%); the upper limb appendage (30, 56%) and head/neck injuries (18, 47%).

A similar tendency was also noted within the traumatic injury type between the trunk (19, 63%) and lower limb appendage (14, 43%). However, traumatic injuries for lower limb appendages were two times (52) those for the upper limb appendage (24), with a similar pattern being noted for overuse (68) injuries and (30) in both appendages respectively. Lower limb injuries were two and half times (120) greater than upper limb injuries (54). The explanation to these variations in injury sustenance was the vulnerability and exposure rates and incidences in contact situations of body limbs than others with respect to the nature of the game such as hands and legs. The general trend of the injury pattern was that most injuries
that players sustained were seated in the lower limb appendage (127/242, 52%) and they were overuse in origin than upper limb appendage 115/242, 48%). These were of traumatic type (see summary table below). Overuse injuries were a result of repetitive and wearisome use of principal body limbs such as hands during throwing, passing and shooting phases (causing shoulder tendonitis, strains, and sprains) as well as single-legged landing after a jump shot. This might lead to failure of the landing leg to produce shock absorbing effects during contact with the ground which when transmitted through the tendons and bones, might result in the damage of musculotendinous units, leading to chronic overuse injuries such as ACL injury. Traumatic injuries were a result of equipment (finger injuries caused by poor timing during receiving, hard shots during blocking contacts) and the poor state of facilities players were exposed to during training and competition. The results reinforce the notion that injury occurrence is attributed to different inciting events with respect to internal and external risk factors; hence significant relationships can be drawn from these results. Table 4.16 below makes a summary of anatomical injury locations.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>OVERUSE</th>
<th>TRAUMATIC</th>
<th>TOTAL</th>
<th>% TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head and Neck</td>
<td>18</td>
<td>20</td>
<td>38</td>
<td>16%</td>
</tr>
<tr>
<td>Upper Extremity</td>
<td>30</td>
<td>24</td>
<td>54</td>
<td>22%</td>
</tr>
<tr>
<td>Lower Extremity</td>
<td>68</td>
<td>52</td>
<td>120</td>
<td>50%</td>
</tr>
<tr>
<td>Trunk</td>
<td>11</td>
<td>19</td>
<td>30</td>
<td>12%</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>127</td>
<td>115</td>
<td>242</td>
<td>100%</td>
</tr>
</tbody>
</table>

4.4.5 Severity of match and training injuries

Table 4.17 below presents results on the severity and classification of 242 injuries that players sustained over the two seasons of study in training and competitions.
TABLE 4.17: SEVERITIES OF 242 INJURIES (N = 153)

<table>
<thead>
<tr>
<th>TIME LOSS</th>
<th>PARTLY INJURED</th>
<th>FULL ABSENCE INJURY</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLIGHT (0 DAYS)</td>
<td>22 (20)</td>
<td>8 (10)</td>
<td>30</td>
</tr>
<tr>
<td>MILD (1-7 DAYS)</td>
<td>41 (34)</td>
<td>11 (18)</td>
<td>52</td>
</tr>
<tr>
<td>MODERATE (8 – 21 DAYS)</td>
<td>96 (91)</td>
<td>43 (48)</td>
<td>139</td>
</tr>
<tr>
<td>SEVERE (21 DAYS+)</td>
<td>0 (14)</td>
<td>21 (7)</td>
<td>21</td>
</tr>
<tr>
<td>TOTAL</td>
<td>159</td>
<td>83</td>
<td>242</td>
</tr>
</tbody>
</table>

Results of the study indicate a significant relationship between external risk factors, athlete-related risk factors and the resultant severity of injury outcomes ($\chi^2 = 47.5$). Concerning the severity of injuries, results of this study (Table 4.17 above) indicated that most injuries sustained during training and competitions were moderate (139; 8-21 days). This was followed by the mild category (52; 1-7 days), while the least record was reported from the severe category (21; more than 21 days). Only (30) reported no injury during the study-slight (0 days). The study showed that time loss injuries for partly injured players were greater (159) than those who were in full absence (83), showing a significant difference in injury severity between the two categories. Results indicated a trend that a greater number of players sustained more than one injury for both genders as shown by the figure of (159) and (83) above. Results of the study also indicated that the greater majority of players sustained moderate injuries (96, partly injured) and (43) did not attend match or training sessions as they underwent full rehabilitation. A number of (21) experienced severe injuries which required more than 21 days to fully recovery. This is suggestive of the interaction between internal and external risk factors on injury outcomes, severity and mechanisms. This means that internal and external risk factors significantly contribute to injury sustenance which negatively impacts on player performance.
4.4.6 Mechanisms of injuries in handball

The major injury mechanisms in handball that precipitated an array of type of injuries for the duration of the study are presented in Graph 4.1 below.

GRAPH 4.1: MECHANISMS OF INJURY IN HANDBALL (N=153)

Results shown on the bar graph above indicate that the main mechanism that accounted for the greatest percentage of injuries was plant and cutting manoeuvres (31%). This was followed by shooting (22%), blocking (21%), turning (19%), landing (7%), and dribbling having a lowest of (1%). The general tendency, according to the results of the study, was that 56% of the injuries were located in the lower limb appendages. This was a result of different body manoeuvres during plant and cutting actions with similar results of 44% being reported in the upper limb appendages of the body due to shooting, blocking and crushing into opponents. A further analysis of the results indicates that 80% of the injuries were associated with wing players, while 70% were sustained by pivot/central players, central backcourt players (60%), goalkeepers (55%) and back court players (53%), showing relatedness
between playing positions, injury mechanisms and injury outcomes (See Tables 4.18 - 4.22 below):

**4.4.7 Position-related injury patterns in players**

Tables 4.18 - 4.22 below shows patterns of injuries sustained by players in different playing positions.

**TABLE 4.18: INJURY INCIDENCES IN DIFFERENT PLAYING POSITIONS, (N = 153)**

<table>
<thead>
<tr>
<th>GOALKEEPERS</th>
<th>18-24 YEARS</th>
<th>25-30 YEARS</th>
<th>TOTAL INJURED</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>2 (2)</td>
<td>3 (3)</td>
<td>5 OUT OF 20</td>
<td>25%</td>
</tr>
<tr>
<td>MALES</td>
<td>3 (3)</td>
<td>3 (3)</td>
<td>6 OUT OF 20</td>
<td>30%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5 (5)</td>
<td>6 (6)</td>
<td>11 OUT OF 20</td>
<td>55%</td>
</tr>
</tbody>
</table>

Results in Table 4.18 indicate that male goalkeepers sustained more injuries than female goalkeepers (6/20, 30% and 5/20, 25%). This was during training and competition, possibly from slipping, falling and landing after saves. Total number of injuries for goalkeepers was 11. The number was lower than Praveen et al. (2012) of 70%. The explanation was lack of shock absorbing effects of the body during contact with ground reaction forces, as well as contact with equipment during defensive manoeuvres such as blocking. This subjected the players to ankle injuries (47), knee injuries (32), shoulder tendonitis (24) and lower leg injuries (24). These were also found to be common and contributed high numbers of injuries during this study. Figures, however, show no significant differences in injury occurrence between the genders across all age ranges.
Results on table 4.19 above indicate a significant difference in injury occurrence for wing players between the genders. More injuries were reported among male players (20) than females (12). There was a significant difference in injury occurrence between the genders for the 25-30 age range as the male figure was two and half times (12/17) greater than the figure reported in females (5/17). No significant differences were noted in the 18-24 age range for both genders (7/15 and 8/15 respectively). The total number of injuries sustained by wing players was 32. They were caused by the nature of position in relation to more physical contacts with opponents during feinting, faking, budging, twisting and turning movements which are position-specific skills characteristic of wing players. The end results would be uncontrolled landings and falls leading to multiple ankle, knee and hand injuries as reflected in the results of this study.

As shown in Table 4.20 above, male central back court players had a twofold injury occurrence rate than their female counterparts (8/12, 67 %; 4/12, 33%) during the two
seasons. A similar pattern was also observed between the genders for the 25-30 age category (6/8 and 3/8). Cumulatively, 12 injuries were incurred in backcourt players. Results show a significant difference in injury occurrence between the genders. The explanation to these differences was attributed to great speed, divergence of players’ physical integrities, and the hard-line nature of male players than their female counterparts. Physical contacts and uncontrolled landings during interceptions led to distortions, direct forces and twisting movements that extremely contributed to hand, shoulder, ankle and knee injuries of the lower (120) and upper limb (54) appendages.

TABLE 4.21: BACKCOURT PLAYERS (N = 153)

<table>
<thead>
<tr>
<th>BACKCOURT PLAYERS</th>
<th>18-24 YEARS</th>
<th>25-30 YEARS</th>
<th>TOTAL INJURED</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALES</td>
<td>3 (3)</td>
<td>4 (4)</td>
<td>7 OUT OF 30</td>
<td>23%</td>
</tr>
<tr>
<td>MALES</td>
<td>4 (4)</td>
<td>5 (5)</td>
<td>9 OUT OF 30</td>
<td>30%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>7</td>
<td>9</td>
<td>16 OUT OF 30</td>
<td>53%</td>
</tr>
</tbody>
</table>

Results presented in Table 4.21 above reflect that male backcourt players sustained more injuries (9/30) than female players (7/30), though no significant differences were noted in all genders and age categories. The rate of susceptibility was equally the same. Total injuries reported were 16. The causes of injuries were a result of contact with opponents and equipment as well as athlete-related factors. Part of the explanation was lack of simultaneous block coordination from jump shots, poor reaction and speed timing to hard and fast shots and unanticipated shots due to lack of concentration during play. This resulted in head, neck, hand/wrist, ankle, knee and finger injuries as well as precipitation of strains and sprains.
From the results shown in Table 4.22 above, a greater number of injury occurrence was noted among male pivot players (8/20, 40%) than female players (6/20, 30%), though the difference is not very significant except for the 25-30 category where injury report for male players was 3 times (6) that for females (2). The reverse is, however, true for the 18-24 age range, with female players reporting a twofold rate (4 females) than their male counterparts (2). The explanation was that there were more novice female players in the 18-24 age range than males. Stiff competitions, tight match schedules and exposures also immensely contributed to high numbers in males in the 25-30 age range than females. In addition, awkward landings from dive shots, jump shots, illegal pulling and aggressive forces (during individual and tactical group defence), also led to shoulder, hand, knee, head, strains and sprains. These were seen to be a common feature among players during this study.

Generally, results in the above tables (4.19 - 4.22) indicate variations in position specific injuries that the players sustained during the study. The highest number of injury cases was reported among wing players 32(80%). This was followed by pivot/central players 14(70%), central back court players 12(60%), goalkeepers 11(55%) and backcourt players backcourt players 16(53%). A slight margin in injury occurrence was seen among goalkeepers for both genders (5, 30% and 6, 25%) but with more cases being reported for males than females for
wing players (20, 50% and 12, 30%) and pivot players (8, 45% and 6, 25%) respectively. Injuries in males for central back court players significantly doubled that for females (8, 40% and 4, 20%). The general indication was that more injuries were reported for males (44/85) than their female counterparts (41/85) across all playing positions despite this small difference of figures. These injury variations were attributed to position-specific situational and circumstantial playing contacts which precipitated different mechanisms of injury. In addition, kinematic and biomechanical errors in relation to players’ individual physical capacities significantly contributed to injury cause among players in both genders.

4.4.8 Association of injury occurrence with playing positions

According to results in Tables 4.19 - 4.22 above, no significant differences in injuries (5% level of significance) were reported between males and females with respect to playing positions as the Chi-Square calculations of 3.831, is far below the critical value of 9.488. However, some significant differences in injury occurrence were observed among playing positions, notably, goalkeepers (11, 55%) and pivot players (14, 70%); wing players (32, 80%), centre back players (12, 60%) and pivot players (14, 70%). Results also indicated significant relationships between playing positions and injury occurrences as depicted by variations in position-specific injuries that the players sustained. These differences between and among playing positions in injury sustenance were attributed to repetitive overuse of dominant body limbs during contact (opponent and equipment) and non-contact phases, leading to sprains, strains, muscle pulls and ligamental raptures. Other possible causative factors were mismatch of players (morphological and age variations), unfavourable playing surface and conditions, high frequencies of training and competition rates and poor body conditioning. More so, tight match schedules with insufficient regeneration and recovery
Periods in players might pave way for the provocation of index injuries and precipitate new cases, leading to those that are chronic and overuse in nature. The higher injury rate among males was an indication of high physical retrogressive contacts, speed and insistent nature entrenched in males than females.

This generally means that there is a significant relationship between external and internal risk factors with injury outcomes in relation to playing position. More so, this had negative impacts on player performance as noted from a record of 242 injuries incurred during the course of the study. Injury occurrence is, therefore dependent upon an array of internal and external variables.

Tables 4.23 and 4.24 below present cumulative summaries of injuries incurred with respect to position-specific roles of players over the two seasons correspondingly.

**TABLE 4.23: CUMULATIVE SUMMARIES OF INJURIES IN PLAYING POSITIONS (N = 153)**

<table>
<thead>
<tr>
<th>FIELD POSITION</th>
<th>NO OF PLAYERS (M &amp; L)</th>
<th>INJURED PLAYERS</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goalkeepers</td>
<td>20</td>
<td>11</td>
<td>55</td>
</tr>
<tr>
<td>Wing Players</td>
<td>40</td>
<td>32</td>
<td>80</td>
</tr>
<tr>
<td>Central Backcourt Players</td>
<td>20</td>
<td>12</td>
<td>60</td>
</tr>
<tr>
<td>Backcourt Players</td>
<td>30</td>
<td>16</td>
<td>53</td>
</tr>
<tr>
<td>Pivot/Centre Players</td>
<td>20</td>
<td>14</td>
<td>70</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>130</td>
<td>85</td>
<td>65</td>
</tr>
</tbody>
</table>
TABLE 4.24: CUMULATIVE SUMMARIES OF PERCENTAGE INJURIES IN PLAYING POSITIONS (N = 153)

<table>
<thead>
<tr>
<th>FIELD POSITION</th>
<th>MALES</th>
<th>FEMALES</th>
<th>TOTAL</th>
<th>TOTAL %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goalkeepers</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>13</td>
</tr>
<tr>
<td>Wing Players</td>
<td>20</td>
<td>12</td>
<td>32</td>
<td>38</td>
</tr>
<tr>
<td>Central Backcourt Players</td>
<td>8</td>
<td>4</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Backcourt Players</td>
<td>9</td>
<td>7</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Pivot/Centre Players</td>
<td>8</td>
<td>6</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>TOTAL</td>
<td>51 (60%)</td>
<td>34 (40%)</td>
<td>85</td>
<td>100</td>
</tr>
</tbody>
</table>

4.5 Relationship between intrinsic and extrinsic risk factors

4.5.1 Circumstantial contact and non-contact injuries

Table 4.25 below show results on circumstances that led to injury causes in training and matches among players during the study.

TABLE 4.25: CIRCUMSTANTIAL INJURIES DURING TRAINING AND COMPETITIONS (N = 153)

<table>
<thead>
<tr>
<th>CIRCUMSTANCE</th>
<th>MATCH INJURIES</th>
<th>TRAINING INJURIES</th>
<th>TOTAL INJURIES</th>
<th>% INJURED</th>
</tr>
</thead>
<tbody>
<tr>
<td>NON CONTACT</td>
<td>27 (26)</td>
<td>18 (19)</td>
<td>45</td>
<td>19%</td>
</tr>
<tr>
<td>CONTACT</td>
<td>52 (55)</td>
<td>43 (40)</td>
<td>95</td>
<td>39%</td>
</tr>
<tr>
<td>CONTACT &amp; FOUL</td>
<td>38 (37)</td>
<td>25 (26)</td>
<td>63</td>
<td>26%</td>
</tr>
<tr>
<td>SANCTIONED FOUL</td>
<td>24 (23)</td>
<td>15 (16)</td>
<td>39</td>
<td>16%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>141</td>
<td>101</td>
<td>242</td>
<td>100%</td>
</tr>
</tbody>
</table>

Pertaining to circumstantial injuries, results showed no significant differences in injury occurrence with respect to various circumstances as indicated by Chi-Square ($x^2 = 0.648$) which is below the critical value of 5.991. However, significant differences were noted between and among circumstances causing injuries. High figures were reported from contact injuries (95, 39%), followed by contact after foul (63, 26%), non-contact injuries (45, 19%)
and sanctioned fouls (39, 16%). A significant difference was observed between match (141, 58%) and training injuries (101, 42%). Results also indicated a significant difference between contact (95, 39%) and non-contact injuries (45, 19%) but with little significant differences between match and training contact injuries (52, 43%). The explanation to contact and non-contact injuries was attributed to external and internal risk factors such as footwear, equipment, condition of playing surface, environmental weather conditions, psychologically and physiologically-oriented risk factors.

Results also portrayed poor match officiating, too much physical contacts, aggressiveness of players coupled with heightened exposure hours, tight match schedules and mismatch of players. The general implication of these results is that they are indicative of lack of safety precautions, quality of officiating and adherence to fair play. Hence these internal and external risk factors precipitated psychological traumas that contributed to high prevalence rates of injuries among handball players during match and training situations. These precipitated high rates of contact situations which significantly contributed to different injury mechanisms that eventually led to severe, overuse and chronic injury cases. What is inherent in these results is their tendency to reinforce the need for match officials to pay particular attention to retaliatory faults so as to control the antagonism in order to protect players’ physical uprightness. This, at the same time, restores players and stakeholders inclination into the game.
4.6 Discussions

4.6.1 Relationship between intrinsic and extrinsic risk factors: Bio-data information of players

The age interval of players in this study shows a wide range (18-30). In general, results of the study indicated that the increase and prevalence of injuries was correlated to age and experience in both gender (54%, 63% for females and 61%, 66% for males). More injuries were observed in males than in females. However, results of this study showed a decline in injury rate in the age range 26-30 years and injury incidences being equally the same for (61% males and 62% females respectively). No significant difference in injury occurrence was observed for this age range for both sexes.

Results of this study generally indicate that old age and more experience is associated with injury risk in players. This closely resembles results of a study by Dirx and Geus (1992) who reported that players above 20 years, in combination with growing experience, precipitated more injuries during competition and gained more significance with advanced age and level. Available literature indicates that injuries in competition gain more significance with advanced age and performance level (Luig and Henke, 2013). As age, experience and competition level increase, so does the risk of injury (Inkar, 1996; Koushki et al., 2011; Moller et al., 2012; Karanflici and Kabak, 2013). Results of this study closely related to these assertions. This is also in confirmation with an explanation by Dirx and Geus (1992) who further indicated that physical fitness increases with age and thus, the game is played with more speed and power which increases injury chances in players.
In this study, a significant statistical relationship between age and injury was observed as increase in the prevalence of injuries showed a strong correlation with these variables. The present study showed that 32/242 (13%) injuries were sustained on the ankle/foot during training and competition. This aligns well with literature from Tyler et al. (2006) and Walden et al. (2013) whose studies reported high prevalence rates of ankle/foot injuries as a result of being overweight. Results are greater than those reported by Langevoort et al. (2007) of 11% ankle injury among handball players during the Olympic tournament. However, results are below those announced by Luig and Henke (2010) of 18.6% and 22.1% among men and women among European handball players. Dick et al. (2007) reported the resurgence of ankle injury to be between 26% and 75% but results for this study fall far below this range. This was due to technical improvements and adherence to safety measures by players, coaches, team medics, and event organisers.

Furthermore, Faude et al. (2013) announced overuse and groin injuries among handball players due to overweight which closely resemble results of the present study. The average weight (72.5kg) indicated obesity and over weight for the general requirements of a handball player and an average height of 1.72 kg and both variables accounted for this injury rate. This association is also substantiated by studies from Nicholl (1992) who reported that athletes who are tall and overweight can increase the mechanical stress on the ankle causing injury during participation.

In relation to the nature of handball, Silvers et al. (2005) believe its repetitive jumping imposes recurring consistent vertical ground reaction forces up to 4 times body weight on the weight-bearing knee joint. Consequently, the neuromuscular system may be unable to
maintain knee stability and around-joint control, leading to forces above the physiological threshold, with inevitable injury to the knee joint structures (Omoeye et al., 2012). These assertions authenticate similar tendencies reported in this study of overweight to be a potential risk factor with reference to sudden directional changes, jump shots and unpredictable body feints and manoeuvres.

Sharp (1995), Riemmenich and Rogol (1995); Blanco (2004), Cavas et al., (2004) and Helsen et al. (2005) reported that there was an association between morphology and performance as well as anthropometric profile of players in handball based on height and weight. This is correlated with athletes’ speed, endurance and power. This compares well with demographic results of this study, nature and mechanisms of injuries incurred. This, tied together with the nature and demands of the game, accounted for high incidences (1.513 injuries/ 100 players) and prevalence (0.53 for females and 0.46 for males) rates of injuries during matches and training. These results are similar to those of Myklebust et al. (2005) which had 0.54 injuries/1000 match hours but far much greater than their 1998 study of 0.06 injuries/1000 match hours and Olsen et al.’s prospective 7 season study for men which reported 0.24 - 0.09 injuries/ 1000 match hours. Present results are below those from Bailasha et al.’s (2014) study which reported an average of 2.8 injuries/player for males and 2.5 injuries/player in females respectively. Study results, therefore, depicts a strong association between intrinsic and extrinsic-driven risk factors and injury incidence rates during training and match situations. This heavily impacted on player performances which addressed key objectives number two and three.
Part of the contribution to this upheaval was lack of technical awareness on safety and preventive measures on the part of event organisers, coaches, and sports directors. This was compounded by a myriad of challenges from the quality of training and officiating, tight match/tournament schedules, exposure hours and high workloads between bouts of activity as explained by Riodan et al. (2010), Cutter et al. (2011) and DiFlori et al. (2012).

4.6.2 Association between intrinsic risk factors and handball injury: Anatomical sites, prevalence and association of factors

Objective one of this study examined the association between intrinsic risk factors and handball injury outcomes during training and competition. Results of this study also revealed that most injuries were located in the lower limb (49%) than upper limb appendages (22%). Sixty four injuries (64) that occurred on the lower extremities were of overuse and traumatic types (54), while for upper extremities, overuse (30) were more (24). Injuries associated with the trunk accounted for 12% (28), most of them being contusions (13 injuries) followed by strains (7 injuries) and lacerations (2 injuries). The results also showed that shoulder injuries were prevalent (21 injuries), elbow injuries (13), hand and wrist (10), finger injuries (8) and dislocations (2). These results are a depiction of the inter-play that exists between athlete-triggered risk factors and that injury outcome is dependent upon an array of such variables. Hence they are potential risk factors in injury cause during sporting pursuits.

Traumatic incident injuries for this study were 30%, which is half of those announced by Moller et al. (2012) of 63%. This distribution indicates that the injury outcome is multifactorial in origin and can be attributed to a number of risk factors. This is in authentication

Results of this study for lower limb appendages are slightly above those reported by Langevoort et al. (2007) of 43%, Rasuli and Associates (2012) of 42.5%, who all announced similar findings of injuries that occurred in the lower extremities while this study had a record of 50%. Leidinger et al. (1990) had similar numbers of 46% lower extremities and 18% for upper extremities. The present study had a slightly lower rate than those reported by Langevoort et al. (2007) with 22% for upper extremities and 17% for head/neck respectively. Langevoort et al. (2007) reported that overuse injuries in handball range between 28% - 55% during training and competition. Results of this study (52%) are within this range though they are much above those reported by Cuff et al. (2010) of 42%, Moller and colleagues (2012) among Danish youths and senior elite handball players and Seil et al. (1998)’s studies on the Germany handball league.

Knee injuries were also prevalent in this study, with a record of 19% which is below those reported by Leidinger et al. (2000) on Germany senior handball players (30%), Gundersen and Myklebust (2009). Moller et al. (2012) reported overuse injuries in their study (37%) results of which have also been substantiated in this present study. Ankle injuries for this study were 13% which was above those reported by Langevoort and associates (2007) of 11%. The figure is slightly lower than those reported by Bailasha et al. (2014) of 13.68% for the same type of injury but falls within the range of 8% - 45% reported by Myklebust (2014). Leidinger et al. (2006), Piry et al. (2011) and Moller et al. (2012) reported 20.3%, 23.8% and 29% ankle injuries respectively but the figures are far greater than those reported in this
study. Current study results of knee overuse compare very well with literature from previous studies where the knee was a commonly affected area, given a substantial figure of players that experienced knee problems (Clarsen et al. 2010; de Bernado et al., 2012; Clarsen, 2015). These variations were attributed to the extent to which preventive measures were being adhered to during training and competition.

Regardless of gender and age, results of this study confirmed a high prevalence rate of injury occurrences in lower limb appendages, which corroborates well with literature from Koren (2010); Wedderkopp et al. (1999, 2003); Petersen et al. (2002) and Reckling et al. (2003). However, they differ from those currently reported by Bailasha and associates (2014) who reported more upper limb appendage injuries than lower limb cases. This indicates that injury outcome during training and competition can be triggered, not only by a single risk or inciting factor, but by different variables as advocated from various schools of thought in epidemiological injury research (Meeuwisse, 1994; Finch, 1996; Gissane, 2001; Bahr and Holme, 2003, 2005; Bahr et al. 2003; Van Mechelen, 2005; Henke and Luig, 2013). Results of this study roped in work of the aforementioned authorities.

Injury occurrence, according to results of this study, is multi-factorial in origin as implied by injuries located on various body appendages. This also revealed the validity and reliability of the instrument (injury report schedule) used to gather data during the study whose results analysis had similar bearings with studies contacted in different settings of European, Asian and African countries. The same instrument has been seen to yield results from different sport codes from international matches in studies conducted by Langevoort (2007), Junge et al. (2004 a, b, 2006, and 2008), International Olympic Committee (2009), Yoon et al. (2007) and
Assembo and Wekesa (1995). Validity and reliability of these instruments is further supported by its wide adoption by several organisations and research institutes world-wide. These include the Sports Injury Research Centre-Canada, Clinical Sports and Exercise Medicine Centre-South Africa, Oslo Trauma Research Centre-Norway, Australian Centre for Research into Injury in Sport and Prevention Sevim (2002; F-MARC, 2007; Clarsen, 2013, 2015). Despite the differences in research settings, the present study has been able to replicate similar results under different conditions, which in itself, is contributory to the field of research.

This study showed that players sustained upper extremity injuries (22.3%) and accounted for a total of 39% shoulder problems, a number which is lower than results reported by Clarsen and associates (2014) of 28% and Gohlke et al., (1993) who had a slightly higher record of 40%. Bailasha et al. (2014) reported a figure of 13.82% upper limb appendages, which is below those of the present study of 22.3%, but is double the results of Rasuli et al. (2012) of 42.52% reported among Iranian female handball players. Studies by Myklebust et al. (2013), Prestkvern (2013), Van den Tillaar and Cabri (2012) and Clarsen (2015) also indicated that shoulder pains were a major problem among handball players which has been substantiated by the present study. The view of this study is that these differences are due to diverse research settings as well as variable changes during the course of study in terms of improved safety measures adopted. These assertions also confirm that shoulder injuries are a common site in handball since it is a throwing game. These study results are in accordance with previous results by Fargeli et al. (1990); Seil et al. (1998); Wedderkopp et al. (1997) and Langevoort et al. (2007) whose figures ranged between 7% - 50% injury on upper body extremities.
Pertaining to head and neck injuries, this study reported a figure of 17.3%, which is above results of Bailasha et al. (2014) of 13.2% but are three fold those of Rasuli and associates (2012) of 42.52%. However, present these results differ from those by Oehlert et al. (2004) of 34% and Langevoort et al. (2007) of 29%, 31% for the 2003 World Cup and 2004 Olympic Games as well as Assembo and Wekesa’s (1995) East and Central Africa Men Senior Handball Challenge Cup. Myklebust (2004) recorded a range of 2% - 68% strains and 2% - 36% contusions, while the results of this study recorded 52% contusions and 29% strains and falls within range despite differences in research settings.

4.6.3 Impact of risk factors in terms of incidence and severity of injury

The third objective of this study assessed the impact of risk factors and injury outcomes on player performance during training and match situations. Pertaining to injury incidence, more injuries were sustained during matches than training in both sexes. Injury occurrence during matches (73%) and training (57%) for 560 hours and 1344 hours exposure was greater in females than in males (68% and 44%) for the same exposure hours respectively. Match results of the present study compare well with Engerbretsen et al. s’ (2013) results on the 2004 London Olympic Games which reported a figure of 75% match injuries and 25% in training.

Conversely, the present study results on training injuries were two and half times higher than Engerbretsen and colleagues (2013) of 25% in the same study. Kabak and Karanflici (2013) in their study of Turkish male and female national team players reported 65% match injuries and 35% in training. Present study match results are higher than those announced by Kabak
and Karanflici (2013). However, they differ in that they reported more training injuries than match injuries as opposed to the present study which had more match than training injuries. The explanation to this difference is linked to the injury definition and tight match schedules that did not provide sufficient rehabilitation for injured players.

Incidence rates differed respectively for the two groups and consequently, incidence rate per 1000 playing hours stood at 1.513 during the study. This differs from high injury incidence rates of 23.5 and 15.1 announced by Moller et al. (2012) for match and training respectively. Research findings by Koushki et al. (2011), Marquez et al. (2012) Bere et al. (2014) attributed high injury rates to playing intensity, increased illegal and legal physical contact and exposure to high risk activities. These results are in compliance with literature from Meeuwisse et al. (2003) and Ferretti (1992) who concurred that the frequency and prevalence of injuries in games was attributed to high intensity level of competition, maximum effort expended during the games and maximum risk which made athletes to be more vulnerable to injury. As well, higher injury incidence might be due to higher severity cases during the matches, which reflects the nature of competition as reported by Marquez et al. (2012). This indicates that the injury incidence rate and occurrence significantly rises as competition levels increase. It also correlates well with the interaction between extrinsic and intrinsic risk factors. The greater prevalence injury rate of 82% on time-loss injuries showed that most players missed games and training between 1-21 days in relation to severity of the injury as classified by Fuller et al. (2007; 2010) and Junge et al. (2008). This had negative impacts on player performance as some risked re-entry into playing when they were still recovering from incurred injuries for fear of losing their positions in teams or the love for the game. This re-ignited injuries among them. Other reasons for such a large figure were due to lack of proficiency, mis-match of players, wet and slippery surfaces as it was a rainy season. Hard
surfaces with increased coefficient of friction, poor body mechanics and conditioning, poor officiating, too much player contact and non-contact situations and being novice in the sport by most players, also significantly contributed to high prevalence of injury.

The study also confirmed results reported in similar studies conducted by Murphy et al. (2002) and Koushki et al. (2011) who observed that heightened match intensities could foster high speeds and high impact collisions, situations that result in severe injuries more frequently than the lower impact, controlled contact found more in practice. As well, high competition levels and immense pressure on the desire to win and avoid losing precipitated high stress and anxiety levels causing ineffective muscular synergies leading to injury sustenance.

In relation to the age factor, results of this study showed that both men and women were at risk of traumatic and overuse injuries which mostly affected the head and neck (17%), hand and wrist (19%) and knee (44%). This strongly aligns with Luig and Henke s’ (2010) study of men and women (14 - 45 years) who reported similar results of 17.4% for men, 13.2% for women (wrist injuries), 19.8% for men and 19.6% for women (knee injuries), 23% for men and 31% for women. These results are also related to studies by Tabernero and Marquez (1993) who indicated some linkages between injury occurrence and competitive trait anxiety as men have lower cognitive anxiety than women moments before the competitions as well decreased self-confidence and stress (Anderson and Williams, 2007; Iverson et al. 2013). This, collectively with other variables, affects player’s locus of control affecting neuromuscular activity which then increases player’s chances of injury in match or training situations.
The reason for a high record of overuse (52%) and traumatic (48%) injuries during matches in this study is strongly aligned to recent works by Singh and Rathore (2012) and McDermott (2013). They attributed this to the importance attached to matches, great demands placed upon players, stressful competitive situations, increased intensity, as well as over exertion on players. Frey (2001) related this injury occurrence to “the culture of risk” in sport where athletes are socialised into accepting the physical risks of participation as “part of the game” which, in this case, has a strong attachment to results of the present study.

Literature from Watson (1995) further indicated that this acceptance by players included playing with pain and injuries and linking pain tolerance (psychological and physical) with desirable characteristics. Verhagen et al. (2004) related the injury occurrence to the high exposure time which also has links with results of this study. Wedderkopp et al. (2003), on the other hand, found out that there was a much higher relationship between previous injuries and new ones. In compliance to this issue, Rogalski et al. (2013) recommended the need for full assessment of players before returning to participation. This minimised injury risks and further explains the high injury incidence reported in the present study. Results of this study also showed that overuse injuries were higher than traumatic injuries and have been reported to be common in previous studies by Olsen and associates (2005); Cuff et al. (2010; Clarsen, 2015). The explanation to this is attributed to retrogressive acts on fair play, match rules and regulations as announced by Olsen et al. (2003).
Pertaining to severity of injuries, this study showed that most of them were moderate (139, 57%), while those reported to be mild were (52%). Those in the slight category had a 12% record. Only 22% of the injuries reported required medical treatment and prevented players from participating for more than 21 days which greatly affected player participation in games and training. This compares well with Papacostas et al. s’ (2001) results whose characteristics were similar in nature with this study (51%, 24% and 11% respectively).

Another principal finding from this study is the strength and clarity attached to the injury report system in relation to its nature for generalisation of results (slight, mild, moderate and severe) which explains the high injury incidence reported in this study. This consistency was previously announced from similar studies by Cumps et al. (2007) and Papacostas et al. (2001). The present study showed that a number of players (139, 57%) missed training and competition for more than 7 days, which was lower than results of Lindbland et al.’s (2008) record of 68%. The possible explanation might be the improvement of training facilities, quality of training as well as officiating during matches and training in tertiary handball. Seil et al. (2000) proposed on the inclusion of appropriate sport-related tasks during training sessions. The possibility of injury reduction in severity of 9% suggests that implementation of preventive programmes during training and competitions can be effective. The 87% (mild, moderate and severe) of injuries reported and 17% non contact injuries noted from the results of this study indicated that each player sustained at least one or more injuries during matches or training sessions. This impacted negatively on player performance and suggested that most players participated in training and competitions before they fully recovered from sustained injuries.
DiFlori et al. (2014) explained that repeated overuse chronic injuries may occur as a result of inadequate rehabilitation of the index injury and/or a failure to recognise and correct the risk factors that contributed to the original injury. Demographic results of this study showed that the majority of players (male and female) had a traceable history of more than one injury, possibly from one or more disciplines, which they brought along into the field of handball. This is even substantiated by the figure of 52% overuse chronic injuries reported in this study which is slightly above the figure of 47.1% resurfing injury and 52.9% new cases confirmed by Cumps et al. (2007). On the other hand, Marquez et al. (2012) agree that incomplete recovery leads to re-injury. Taken together, with the high prevalence rate of injury shown, as well as nature of the game, re-injury chances and the possibility of more new injuries was inevitable. This is in agreement with studies from Arnason et al. (2004) and Moller et al. (2012). Literature from studies by McKay et al. (2001); Hatzimanoal et al. (2005); Luig and Henke (2010); Moller et al. (2012); Karanflici and Kabak (2013) also indicated that a correlation between previous injury and a number of injuries increased chances of new injuries and recurrence. This shows there is a significant association between intrinsic and extrinsic risk factors with injury occurrence and outcomes during training and match situations. This is in harmony with literature from Meeuwisse (1997); Murphy et al. (2007) and Langevoort et al. (2007) and also takes into account pre-stated objectives and assumptions of this research which have been realised.

Concerning the incidence of injuries in different playing positions, this study showed that most injuries were greater in offensive positions: wing players (80%) which is double the record by Piry et al. (2011) of 41%, pivot players (70%) with defensive positions recording 60% (centre back players), 53% (back court players) while 55% were for goalkeepers. The figure for goalkeepers is higher than that recorded in the study by Tyrdal and Bahr (1996) of
41%. Results on offensive players are consistent with those reported by Seil et al. (1998) who indicated a high incidence rate for left and right wings, which, in this case, was because players were non professionals who lacked skills and proficiency in the game. More so, research findings from studies by Olsen et al. (2006) and Piry et al. (2011) strongly confirm that injuries sustained by line players and back court players during attack emanate from plant and cutting manoeuvres, sudden turning and change of direction as well as landing. This risk of injury in different playing positions has also been documented in similar handball studies by Wedderkopp et al. (1999) and Oehlert et al. (2004). The high incidence injury rate shown in the present study on different body parts accounted for different factors. High knee injury rate (47), lower leg (24) and ankle/ foot (32) were due to plant and cutting movements that wing players, back court and pivot players performed during defensive and attack manoeuvres against the opponents’ defensive walls. In addition, rotary motions produced from the dominant throwing arm and landing leg, in turn, led to chronic overuse injuries.

In relation to injury sites in the sport, there was a significant difference in injuries on the lower limb appendage, head/neck, upper limb appendage and trunk. As well, a significant difference was observed within overuse injury types for lower limb appendage, head and neck. A trend of similar nature was also noted for the traumatic injury types, between the trunk and lower limb appendage. These findings were in confirmation with previous assertions that the site of a sport injury was closely aligned to the characteristics of a sport and gender (Bailasha, 2013; Fisch et al., 2011).

With regard to the game of handball, the pattern of injuries in the present study showed that playing handball increased injury risks on lower and upper body extremities in players. This
scenario was also replicated in the current study results despite the existing variations in injury incidences in both genders. These results are indicative of a combination of externally triggered factors (such as equipment, facility, weather conditions,) and internally triggered factors (such as fitness condition, psychological factors, height, weight,) (Clarsen, 2015; Luig and Henke, 2013; Barani et al., 2010). Injury occurrence, therefore, cannot be attributed to a single inciting event, but a blend of factors (Meeuwisse, 1997; Bahr, 2009; Luig and Henke, 2013; Myklebust et al., 2014).

4.7 Impact of risk factors on player performance

4.7.1 The nature and mechanisms of injury

An assessment on the impact of risk factors and injury outcomes on player performance in this study showed that contact injuries were far much greater (81%) than non contact injuries (19%) during competitions and training (objective three). This indicates a high degree of interaction between athlete and environmentally-oriented risk factors in producing injury outcomes (objective two). This closely aligns with study results of Wedderkopp et al. (1997); Petersen et al. (2005) and Olsen et al. (2003). Contact mechanisms with opponents were reportedly more common as a cause of injury than non-contact mechanisms. This is in concurrence with results from studies by Meeuwisse et al. (2003) whose studies in handball reported high prevalent rates of injuries caused by contact with another player. Results of the present study show that 81% of injuries incurred were due to contact with players or equipment. However, this figure is slightly less than that of Langevoort et al. (2007) whose record was 84%. Hence, such a high figure of injury prevalence had a burdensome effect on player performance with implicated extra budgetary medical costs in injury management.
As well, similar results were also reported from studies by Assembo and Wekesa (1998) and Oehlert et al. (2004). Estriga et al. (2010) reported high transgressive contacts during matches, leading to high injury rates in training and match situations. Similarly, the present study reported a total of 16% training and matches injuries that were sanctioned by the referee. The same trend was also noted from studies by Assembo and Wekesa (1995) who reported 50% of injuries sanctioned from fouls during major handball tournaments for East and Central Africa Mans’ Handball tournament. Langevoort et al. (2007) reportedly had 45% (167/310) and 60% (98/167) from the 2003 and 2004 World Cup and Olympic Games respectively. Results are, however, greater than those of the present study due to variations in populations involved and environmental circumstances.

Despite notable variations in figures with results of the present study, the common principal finding intrinsic to them is the existence of lack of quality officiating and implementation of fair play, resulting in high injury rates among players. Compounded with a myriad of other internal and external risk factors, this high incidence of injuries among players was inevitable. Results of this study positively confirm those from Kamran (2011) who also reported that loss of fair play spirit, high degrees of psychological pressures on players, excessive forces used to disable opponents at any cost, are among variables that contribute to injury cause on players during matches and training.
4.7.2 Effects of training quality

The high injury incidence reported in this study also indicates poor training quality which did not take into consideration appropriate athlete conditioning for the general physical demands of handball. This relates well with study results of Watson (1995) and Marquez et al. (2012) who found that introducing changes in the overall training regime, too sharp and abrupt increments of training intensity or load, and too much mileage on training duration, are contributory training errors to overuse and over stress as injuries tend to manifest in underdeveloped locomotion devices from unvaried and unbalanced sports practices. Available literature from Wen (2007) indicates that the volume and intensity of training is correlated with overuse injury risk which might explain why this study reported 50% overuse cases.

The major mechanisms attached to injury causes during this study were highest during planting and cutting manoeuvres (31%), blocking (21%), turning (19%) and landing (65%), with the least number of injuries being reported during dribbling moves (1%). Results reinforce the effect of biomechanical and kinematic moments of forces that, when combined with externally-triggered risk factors, are sufficient enough to cause injury during transitional phases of the game. These results are similar in characteristics to those reported by Piry et al. (2011) who announced 28.5% plant and cutting injuries, and 22.2% blocking injuries respectively. Injury incidence of 65% during landing is attributed to stress placed upon weight bearing structures (knee, ankle, and elbow joints) and their inability to absorb shock in repetitive landing phases during blockings, dive shots and conduct of dominant leg(s) with the ground, which makes them prone to multiple injuries. The types of injury mechanisms experienced by players portray that different body sites/limbs were susceptible to injury
during training and match situations (head, hand/wrist, elbow, neck, shoulder, hip/groin, knee, and ankle/foot). This relates to objective four of the study.

4.8 Chapter Summary

This Chapter presented data from 160 handball players and team officials in Masvingo Province. A total of 153 players consented to take part in the study and were in the age range of 18-30 years. The study found that the major mechanisms which significantly contributed to injury occurrences were: plant and cutting (30.60%), shooting (21.85%), and blocking with dribbling accounting for the least numbers. Injury patterns were noted from all playing positions, wing players clearly accounting for the highest casualties (80%), while back court players recorded the lowest (53%).

Injury prevalence and incidence were greater in matches than training. Male players tended to be more vulnerable to injuries than their female counterparts. More contact injuries (81%) were experienced during competitions than training (19%) with less being reported in non – contact situations. Upper limp appendage injuries were greater than those reported for lower limb appendage most of which were overuse and traumatic in nature. More sanctioned fouls were reported in matches than training. High prevalence rates were indicative of interactive effects and association of internal and external factors with injury outcomes. The next chapter presents the thesis summary, conclusions and recommendations in view of the findings made in this study.
CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This Chapter provides a summary of the major issues established in the study in relation to critical factors contributing to injury causes in handball among players in Masvingo tertiary institutes, including preventive measures that should be adhered to in order to provide palatable and safe playing environments for the game of handball. The Chapter ends by making some suggestions on grey areas that still need to be addressed in future research in handball.

5.2 Summary

This study aimed at determining the prevalence of injuries in handball in tertiary institutions of Masvingo Province during two consecutive seasons. It looked at the associations of internal and external factors, and injury outcomes on players during training and match situations. The study also set out to identify and examine how each of these factors contributed to injury among players. Focus was also made on the nature, mechanisms, severity and anatomical sites that were commonly prone to injury during handball activities. Owing to the high influx of people and their inclination into sport for competition, personal and recreational reasons (Bailasha, 2014), available literature has demonstrated that this increased trend, increases exposure to risk factors associated with injury sustenance in participants (Van Mechelen, 1992; Gissane, 2001; Murphy et al. 2003; Bahr and Holme, 2007; Hasslan and Bahr, 2013; Clarsen, 2014). Alongside this upheaval, is the injury burden...
and rise in health and medical costs placed upon players, the government ministry and World Health Organisation in reducing injury impact (Krisci, 2010; Junge et al. 2013). Contemporary injury research trends have indicated that epidemiological research on the aetiology of injury should take prevention and intervention as focal points for clinicians and researchers to establish risk factors (Meeuwisse, 1994, 2007; Bahr and Holme, 2003, 2005; Luig and Henke, 2013). Despite lack of injury research trends in Masvingo tertiary handball, this study serves to enlighten sport researchers in the province to “a culture of epidemiological injury research”. Though injury onset might appear to be caused by a single inciting event, admittedly, it may result from a complex interface and sum total of internally and externally triggered mechanisms.

In alignment to the above issue, there is need to factor in a complete understanding on injury cause and identify mechanisms by which they occur. Situational risk factors and injury trends need to be identified with regards to athlete and environmentally-related variables. This serves to provide gateways to better preventive and injury management during training and match situations. The use of a multi-variate approach in prospective epidemiological injury research studies should constitute the mainstay of contemporary methodological trends unlike the univariate approach which factors in only on a single variable. The use of a self-reported injury form whose design allows for the recording of multiple injuries prospectively in training and competition situations, should be adopted in injury research in handball since injury is multi-factorial in nature. Since this study’s main purpose was to determine injury causes, this instrument neatly fitted into this purpose and yielded positive results in data collection. Hence it showed its validity, expicability and repeatability and reliability in gathering quantifiable data for analysis at the end of this study.
The study showed that injury prevalence and incidences were high and were characteristic of similar handball studies conducted in different countries in epidemiological injury researches. It was observed that injury incidences were higher in competitions than training with females accounting for the highest rates which are in tandem with results of Engerbretsen, 2013, Kabak and Karanflici, 2013, and Moller et al. 2012). The most affected body parts were upper extremities than lower extremities which are in confirmation with findings from Myklebust et al. (2013) and Bailasha (2014). More overuse and traumatic injuries were experienced in all playing positions, with wing and back court players reporting the highest prevalence rates. The major mechanisms of injury were plant and cutting manoeuvres which resulted in players sustaining high injury rates of overuse and traumatic injuries during matches than was in training. The study concluded that the severity of injuries was related to the level of competition and injury cause was triggered by interplay of internal and external factors. This association resulted in sustenance of more injuries which were multi – factorial in nature. It was also noted from results of the study that some players rejoined playing before they had fully recovered resulting in re-injury and creation of new cases of injuries. As a result players’ absence from matches or training had variations that were related to rehabilitation periods they underwent.

After receiving approval and permission from relevant authorities, data was collected from handball players in Masvingo tertiary institutions during the 2014 and 2015 seasons. A sport injury observation schedule based on the conceptual model for the causation and management of sports injuries was used (Meeuwisse et al. 2007; McIntosh, 2005; Junge et al. 2008). This instrument had been previously used during World international games and tournaments by Junge et al. (2006) and Langevoort et al. (2007) currently adopted world-wide for its validity and reliability in sport injury research by International Olympic Committee (Engerbretsen et
al., 2014). Several international research institutes have also adopted it (Canadian Inter-Collegiate Sport Injury Registry (CISIR); Clinical Sports and Exercise Medicine Centre (South Africa); Oslo Sports Trauma Research Centre (Norway) and Sports Injury Research Centre (Canada). Coaches and team physiotherapists assisted during the filling in of players’ demographic information after the researcher had conducted an off-season meeting with them. A pilot study was used to test and improve the validity and reliability of the instrument which underwent scrutiny from professionals in the same field of sport. It was observed that the instrument was valid and reliable in data collection.

The study involved non-professional academic students who only participated in sport after lectures as co-curricular activities. This meant that the quality of training received prior to competitions was inadequate for the game demands. It was also observed that tournaments for handball had tight match schedules which stretched for five consecutive days, giving little time for players to recover from fatigue. This heightened intensity fostered unfavourable conditions which were contributory to high injury rates as injured players returned to participation even when they were still nursing their injuries (rehabilitation). This shows that handball players in tertiary institutions are at high risk of injuries during training and competition, with little attention being taken to avert situations of this nature.

5.3 Conclusions

From results of the study the following conclusions were made;

It was established that:
• There is an association between intrinsic risk factors and collegiate handball injury outcomes during training and competitions as reflected by high injury rates among handball players in Masvingo tertiary institutes.

• There is a correlation between injury incidence rates with intrinsic and extrinsic risk factors indicating that injury outcome is not attributed to only a single “trigger event” but is multi-factorial in origin. This, therefore, resulted in players sustaining substantial numbers of injuries on different anatomical regions of the body from contact and non-contact situations.

• Both internal and external risk factors and injury outcomes were seen to pause threatening impacts on player performance as a substantial number of players missed training and competition or risked re-entry into participation when they were still serving the injury rehabilitation period. This is reflected by a high figure of 85% injury prevalence reported among handball players.

• Prior and partly treated injuries resulted in their re-ignition or aggravation that led to surfacing of multiple chronic overuse and traumatic cases. This imposed much burden on the skeletal system which, therefore, increased injury pandemic with ruinous impact on player performance.

• Proficiency and adherence to rules and regulations of handball was only confined to an elite group of players in most tertiary institutions of Masvingo as opposed to the greater majority. This led to high prevalence rates of injuries among most players.

• Injury prevalence rates in tertiary institutions varied greatly in relation to quality, intensity, frequency of training regimes experienced, exposure hours, state of facilities and prevailing weather conditions as noted from results of the study. More so, most players are amateurs and not professionals on full time basis in the sport, but are
academic-oriented students. This resulted in a number of non-contact and contact injuries among players.

- A linear relationship between sex and injury occurrence exists as female players tended to be more vulnerable to injuries than their male counterparts. This was shown by the prevalence rates of 53% and 46% respectively. This is attributed to differences in anatomical structures in terms of distal, proximal, physical structures, anthropometric characteristics, anterior and posterior kinematic chains. Therefore, this accounted for differences in injury prevalence on both gender.

- Age, experience, weight and psychological variables are potential predictive risk factors as noted from results of the study, hence are contributory to injury occurrence. This is especially true during contact/collision situations where there is mismatch of players with respect to age and experience levels. More so, heavy bodies put more stress on weight bearing structures such as knee and ankles, making them more prone to knee tendonitis, osteoarthritis, ACL injuries and ligamental tears. This is true especially when unduly workload demands are put on the body beyond its normal capacity during high intensity training bouts and competition.

- Injury types were related to playing positions and zones as wing players were the most vulnerable group than other positions in most teams. This implies that injury types or mechanisms are associated with the pre-dominant movement patterns that are position specific during transitional phases of defence and offence, the effects of which are directly linked to biomechanical and kinematic aspects.

- It was hypothesized that handball players in tertiary institutions are exposed to a host of internal and external risk factors which predisposed them to injuries during training and competition. This is attested to results of this study which indicated that injury occurrence is multi-factorial in origin as it affected different anatomical sites of the
body precipitating different injury types/forms. It was also hypothesised that injury pattern between and within genders would not be significantly different. However, some significant differences could be noted between and within genders in relation to morphological and biological make-ups, though, to some extent, no major significant differences were reported between genders and ages.

It has, therefore, been ascertained from the results of this study that team handball belongs to the category of high risk sports due to the incidence and severity of injuries reported. The principal findings of this study are that incidence and prevalent rates of injuries in Masvingo tertiary institutions are similar to those reported in other countries in injury epidemiological research studies.

5.4 Recommendations

The following recommendations are suggested based on the results of this study:

- Training programs should be periodised to wholesomely develop basic precepts of fitness components of endurance, speed, agility, strength, flexibility and balance that are handball oriented all year round. This reduces the impact of risk factors associated with injury occurrence on player performance.

- Coaches in Masvingo tertiary institutions and associations need to co-opt basic motoric and movement qualities that are handball-specific as the mainstay of handball training regimes. This reduces risks that are associated with intrinsic and extrinsic risk factors among players during competitions and training.
• Injury training and prevention prescriptions in handball should take into cognizance awareness of position specific injury risks and co-opt preventive ideas into training programs. This minimizes injury risks paving way for better player performance.

• The issuance of licenses through Zimbabwe Handball Federation to be set at a tender age of eight in order to develop players’ functional abilities and capacities in future competitions.

• Planning of proprioceptive training programmes that address frequently injured body limbs and joints during handball training and competition. These should be prescribed and adhered to by coaches and players in Masvingo tertiary institutes. This reduces injury nature, frequency, impact and severity among players. This restores the image of the game and attracts participation and spectatorship.

• Coaching clinics, seminars, symposiums and sports medicine programs on handball injuries should be conducted and reviewed for handball technical staff in Masvingo tertiary institutions on a regular basis through experts from Zimbabwe Handball Federation.

• Pre-participatory medical examination checks should be frequently carried out for each handball player in Masvingo tertiary institutes at subsided costs by qualified medical personnel. As a monitoring exercise, it ascertains coaches on the players’ health history status and physical qualities they would bring into the game. This, as well, assists them in identifying the technical flaws that might pre-dispose players to injuries thereby arresting deep-seated problems in their physical integrities.

• Players for Masvingo tertiary handball teams should be encouraged to participate in competitive matches having fully served the prescribed injury rehabilitation
period. Re-entry into the participation cycle should be done with the consent of the team physiotherapist and team coach as this serves to eliminate possibilities of injury recurrences.

- Event organizers, coaches, team physiotherapists and sports directors of every tertiary institution in Masvingo Province should re-define their positions and jointly assess situational risk factors (facilities). Best preventive methods should be recommended and adhered to so as to reduce injury outcomes caused by the interface between athlete and environmentally-triggered risk factors in handball.

- Coaches, team medics and physiotherapists in Masvingo tertiary institutes need improved education and team work on the aetiology and cause of chronic overuse and traumatic incident injuries to minimise their occurrence. Knowledgeable on clinical and biomechanical prediction of potential injuries in handball should be part of their education as this reduces injury impact on player performance.

- The information of players is a crucial injury prevention factor. Coaches and team managers in Masvingo tertiary institutes need to create objective student-player profiles for a better understanding of their various aspects of lives, illnesses, physical cycles and social lives so as to monitor levels of training and competition trends more efficiently. More so, players should know more about injury, the risks, consequences and predisposing factors as this is also critical to obtain their dedication in prevention programmes.

- Coaches and managers should avoid unduly demands for positive match results on players but create environments void of high levels of stress, anxiety and psychological traumas that make them more prone to injury in competitive fora. This reduces the effects brought along by intrinsic and extrinsic risk factors on injury cause/prevalence.
• The essence of fair play and officiating should be highly honoured and ingrained among coaches, players, and team managers in Masvingo tertiary handball to safeguard players’ physical integrities during training and matches. This creates safe playing environments for players.

• Facilities with suitable floor types for handball should be put in place in tertiary institutions of Masvingo and have the game played indoors to avoid bad weather conditions during which tertiary sports calendar falls in. This reduces injury outcomes caused by the environment in which players are operating.

• Handball trainers in Masvingo tertiary institutes should develop and implement macro and micro cycle handball training programmes with competition-specific formats that are within players’ maturational lines. Programmes to be interspaced with recovery days/periods prior to next bouts of activities or games to avoid overloading, overstretching and overworking players.

• A similar study should be replicated in other tertiary institutes, clubs, academies and schools of this country to strengthen the reliability and validity of results unearthed here.

The fact that handball is characterised by speed, sudden change of direction, fast outbursts of sprinting actions, versatility and physical contacts, implies that more injuries are incurred in players in training and matches. With regards to this, future epidemiological injury research needs to develop deeper insights into the scientific nature of the game, focusing on the physiology and aetiology of injury in relation to other internal and external variables. Future researches also need to focus on modern scientific training and coaching approaches addressing biomechanical and kinematic aspects related to movement qualities and the effects produced thereafter that are
contributory to injury occurrence. There is need for more research focusing on greater detail on additional variables such as quadriceps, adductor/abductor, biceps as separate entities as they also serve as gateways to a better understanding of biomechanical and physiological factors that relate to injury cause. This might pave way to injury reduction in terms of number, severity and medical costs thereby restoring the good image of the sport as well as attracting membership, participation and spectatorship.

5.5 Chapter Summary

This Chapter provided a summary of the major issues that were established during the course of the study. These were related to the critical factors (internal and external risk factors) that contributed to injury causes among handball players in Masvingo Province tertiary institutes. The Chapter also provided recommendations and preventive measures that could be implemented in order to reduce severity and prevalence of injury during training and competition situations with the aim to ensuring safe playing conditions. This would also restore pride in handball enthusiasts, increase spectatorship as well as creating and nurturing of “safety ambassadors” who have an inclination in the sport. Suggestions on gray areas that still need further research in handball injuries were also provided.
Study Contributions

1. Equipping coaches, team medics and physiotherapists with targeted, evidence-based interventions needed to reduce injury prevalence and severity during training and competition.

2. Correctional concerns to institute age-appropriate and handball-specific training regimes for specialisation at tender ages. These assist in developing sport-specific movement qualities delved to produce proficient handball players.

3. Prospective studies in injury research wholly ensure perceptive insights into the individuals’ capacities that might threaten their participation; hence implementation of this information might greatly assist in effective injury reduction. The results of this study might lay the groundwork for enhancing teamwork, the roles of coaches, team medics and rehabilitation technicians in preventing handball injuries in tertiary institutes of Zimbabwe. This methodology should also be functional across all sports codes in injury research.
REFERENCES


APPENDIX A: INJURY REPORT FORM FOR HANDBALL

INSTRUCTIONS

ANSWER TRUTHFULLY BY PUTTING A TICK IN THE APPROPRIATE BOX PROVIDED

SECTION A: DEMOGRAPHIC INFORMATION

PLAYER’S NAME: 

SEX ☐ FEMALE ☐ MALE ☐

252
### AGE CATEGORY
- 18-21 yrs
- 22-25 years
- 26-30 years

### HEIGHT
- 1.5-1.6 m
- 1.61-1.69 m
- 1.7 m and above

### PLAYING EXPERIENCE
- Less than 1 year
- 1-3 years
- 4 years +

### PREVIOUS INJURY
- 0 injuries
- One injury
- Two injuries
- Three injuries +

### SECTION B: INJURY REGISTRATION (INJURIES INCURRED)

#### INJURED BODY PART: ON WHICH PART OF THE BODY DID THE INJURY OCCUR?

<table>
<thead>
<tr>
<th>Injured Body Part</th>
<th>Hip/Groin</th>
<th>Shoulder/Upper Arm</th>
<th>Elbow/Upper Arm</th>
<th>Knee</th>
<th>Hand/Wrist</th>
<th>Lower Extremity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strain</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contusion</td>
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<td></td>
</tr>
<tr>
<td>Fingers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dislocation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Nature of Injury: What was the nature of the injury?

<table>
<thead>
<tr>
<th>Nature of Injury</th>
<th>Non-Contact</th>
<th>Contact and Foul</th>
<th>Dislocation</th>
<th>Fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strain</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact (Opponent, Equipment etc)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sanctioned Foul (Violation of Rules)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Classification of Injury: In what form was the injury?

<table>
<thead>
<tr>
<th>Classification</th>
<th>Overuse</th>
<th>Re-Injury</th>
<th>Traumatic</th>
<th>Complication of Prior Injury</th>
<th>New Injury</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

#### Circumstances

**What were you doing when injury occurred?**

- Training
- Competing/Playing

253
MECHANISM OF INJURY: WHAT WAS THE CAUSE OF THE INJURY?

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shooting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dribbling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plant and Cutting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landing</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

POSITION OF PLAYER WHEN INJURED: WHAT POSITION DID YOU PLAY WHEN THE INJURY OCCURRED?

<table>
<thead>
<tr>
<th>Position</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goalkeeper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central Backcourt Player</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backcourt Player</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central/Pivot Player</td>
<td></td>
<td></td>
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</tbody>
</table>

SEVERITY OF INJURY: FOR HOW LONG WERE YOU ABSENT FROM TRAINING AND COMPETITION?

<table>
<thead>
<tr>
<th>Severity</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Days</td>
<td></td>
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<tr>
<td>1-7 Days</td>
<td></td>
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<tr>
<td>8-21 Days</td>
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<tr>
<td>21 Days+</td>
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APPENDIX B: PERMISSION LETTER TO CONDUCT RESEARCH

Department of Physical Education and Sport
Morgenster Teachers’ College
P O Morgenster
Masvingo
The Principals
ZITCOSA ZONE A Colleges (Morgenster, Masvingo, Bondolfi, Mutare, Mary Mount)
REF: PERMISSION TO CONDUCT A RESEARCH STUDY IN SPORT

I am a postgraduate student with Zimbabwe Open University conducting a research study in Physical Education and Sport. The title of my study is “Factors contributing to injuries among handball players in tertiary institutes: A Case Study of Masvingo Province”.

The study aims to describe the relationships between externally-triggered and athlete-triggered risk factors and injury outcomes in collegiate handball. Data collection will be done by the researcher with the assistance of team coaches and medics. The research will be carried out with the view to reduction of injury prevalence and ensure safe participatory environments for players during training and competition fora. I would hereby wish to request permission to conduct the study among handball teams at the college. I will be grateful to you if you will allow carrying on with my study during the handball seasons of 2014-2015.

Thank you for your attention and cooperation.

Yours sincerely

Chimonero Prince

MPhil PE and Sport (Pin No: 1144514 E).

APPENDIX C: LETTER TO COACHES, TEAM MEDICS AND PLAYERS

Department of Physical Education

Morgenster Teachers’ College

P O Morgenster

Masvingo

Dear Coach/Medic/Player
I am a post graduate with Zimbabwe Open University conducting a Masters of Philosophy in Physical Education and Sport. The title of study is “Factors contributing to injuries among handball players in tertiary institutes: A Case Study of Masvingo Province”.

The study aims to describe the relationships between externally-triggered and athlete-triggered risk factors and injury outcomes in collegiate handball. Data collection will be done by the researcher assisted by coaches and team medics. At the start of the season all players will complete a questionnaire on demographic variables and an injury report form used for registration of any subsequent injury occurring during training and matches. It will provide information on injury location, types and causes. You are assured that all the information will be confidential and anonymous. You have the right to withdraw from the study at any time.

Thank you for your attention and cooperation.

Yours sincerely

Sign........................................... Sign...........................................

Chimonero Prince Prof Shehu
M.Phil in PE and Sport (Pin No: P1144514 E) Supervisor