A prospective study of injuries in professional Saudi Arabian footballers

By

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ABSTRACT

Sports injury registries have been used in a number of different sports to assess the injury rate, prevalence and type. This data is useful for assessing trends and injury "loads" that place a burden on players, coaches and medical support staff. This approach to injury description has been completed in the setting of professional football in a number of countries (e.g. UK, Australia, and Finland) but never in Saudi Arabia.

A data collection method proposed by FIFA and based on the principals of first hand injury observation, comprehensive and immediate recording of injuries and accurately timed exposure for both training and competitive matches was employed. In **Study 1** we prospectively evaluated the incidence (per 1000 hr of player exposure), severity and nature of injuries in professional Saudi Arabian football players competing in the Saudi Premier League over two competitive seasons (2010/11 and 2011/2012). We compared injury data during training and competitive match play as well as assessing the impact of weather variation on match play injury data. The key findings were; a) that a higher injury incidence was observed during match play, b) injury incidence was highest in prevailing environmental conditions of high temperature and low humidity (dry), and c) that the data compared favourably with elite football data from around the globe.

In **Study 2** we widened the structured approach to injury data collection to include a comparison with Saudi national team players thus evaluating the impact of player level upon injury incidence. The key findings were; a) players in the national team had a substantially greater injury incidence than players in the Saudi Premier League, b) injury incidence in national team players was higher during match play compared to training, and c) muscle and soft tissue injuries (contusions, strains, tears, cramp etc.) were, by far, the most common type of injury. These latter two points confirm data from Saudi Premier League players.

In **Study 3** we examined the prevalence and nature of injuries associated with playing football on 3G artificial turf compared with natural grass in the Saudi national football team. This was achieved in a quasi-experimental design involving data collection at two international football tournaments completed within a short time period and involving many of the same national team players. The key findings were; a) the frequency of injuries and the injury incidence rates were slightly higher on grass compared to 3G, b) most injuries sustained on both surfaces were at the lowest level of severity with no absence from football activity required, and c) on both surfaces, the most common injury site was the lower limb and the most common injury type was muscle and soft tissue injuries.

In **Study 4** we adopted a prospective intervention-based design to evaluate the effect of progressive lower limb, dynamic balance training programme on injury incidence in Saudi Premier League footballers. Baseline injury statistics were compiled over 2 seasons in 4 clubs. Two of these clubs then undertook a short, pre-season-based intervention that was focused on progressive dynamic balance training. Two clubs completed their normal pre-season training with no specific attention paid to balance training. All players at the 4 clubs were then followed prospectively for a further competitive season with injury and exposure data recorded as per the baseline period. The key findings were; a) adherence to the intervention balance training was excellent as it was integrated into the clubs pre-season training programme, b) injury incidence data were marginally reduced in the intervention group but the clinical significance of these data cannot be established, and c) small, and sporadic changes in injury incidence were noted in the control group that should be taken into account when making any interpretation in the intervention group.

Overall we adopted a standardised and detailed injury and exposure data collection process that yielded novel data with respect to Saudi Arabian Premier League and national team players playing on natural and synthetic surfaces as well as in relation to a specific balance intervention. These data will inform local clubs, medical staff, the Saudi FA and the broader football and sports medicine fraternity as well as acting as a springboard for further research.

DECLARATION

I declare that the work presented in this thesis is entirely my own. Some of this work has been published in European and International Journals and presented at National and International conferences.

PUBLICATIONS AND COMMUNICATIONS

This thesis has resulted in the following publications and conference communications:

1. M. Almutawa, M. Scott, K.P. George, B. Drust. (2013).The incidence and nature of injuries sustained on grass and 3rd generation artificial turf: A pilot study in elite Saudi National Team footballers. Physical Therapy in Sport, 1-6.

2. M. Almutawa, M. Scott, K.P. George, B. Drust. (2013). The incidence, severity and aetiology of injuries in players competing in the Saudi Premier League between 2010-2012. Saudi Journal of Sports Medicine. In press

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CHAPTER 3. The incidence, severity and aetiology of injuries in players competing in the Saudi Premier League between 2010-2012

CHAPTER 4. The incidence, severity and aetiology of injuries in players in the Saudi National Football team during training and competition.

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ABBREVIATIONS

°C	degrees Celsius
cm	centimetres
FIFA	Fédération Internationale de Football Association
h	hour(s)
kg	kilogram
m	metres
min	minute(s)
s	Second (s)
SEBT	Star Exertion Balance Test
wk	week(s)
y	years(s)
UEFA	Union of European Football Associations
<	less than
>	greater than
~	approximately
%	Percentage

CHAPTER 1. GENERAL INTRODUCTION

1.1.Background

Football is one of the most popular sports and is played globally (Stølen et al., 2005; Faunø and Jakobsen, 2006). Football refers to a number of sports that involve, to varying degrees, kicking a ball with the foot to score points or a "goal". The most popular of these sports worldwide is "Association Football", more commonly known as just "football" or "soccer". Unqualified, the word football applies to whichever form of football is the most popular in the regional context, including association football, as well as American Football, Australian Rules Football, Canadian Football, Gaelic Football, Rugby League, and Rugby Football Union (Reilly and Gilbourne, 2003).

One of the consequences of engaging in training and competitive football matches is the likelihood of injury (Hoy et al., 1992; Andersen et al, 2004a). Injuries, their nature and severity, have consequences for the player, the club, the governing body and the spectators. Knowledge of the risk of injuries in football has been a growing area of research over the last 40 years as various countries attempt to define the nature of the "injury load" in a range of football populations. To address this issue, sports injury registries have been used to assess trends and injury "loads" that place a burden on players, coaches and medical support staff (Junge & Dvorak, 2000; Fuller et al., 2006; Cumps et al., 2007). This approach to injury description has been attempted in a number of countries (such as the UK, Australia, Finland and Hong Kong) in relation to professional football (Ribeiro & Pena Costa, 2006; Orchard & Seward, 2001; Hagglund et al., 2005).

One criticism of the many descriptive sports injury studies is the limited geographical coverage of data collected to date. To date, no systematic collection of football injury data has been attempted in Saudi Arabia. This is despite the growing popularity of football in Saudi Arabia, and the Gulf region in general, and the fact that the Saudi football industry shifted to professionalism in 1993. With such fundamental changes in football organization, funding, and competition, it is ever more important to assess, understand and develop appropriate treatment strategies for football injuries in professional players to improve recovery, speed up the return to play and prolong career longevity.

The first step in the study of football injuries in Saud Arabia is to develop a comprehensive and consistent injury database. Despite continuing calls for common methodologies to be adopted in football injury research, fundamental differences in definitions and implementation strategies have persisted in published studies of football injuries (Ekstrand & Karlsson, 2003; Fuller et al., 2006). Consequently we have adopted data collection tools validated and supported by Football's governing bodies (FIFA, F-MARC, UEFA) that standardize recording of data to improve consistency and comparability with past work (Fuller et al., 2006).

It is hoped that the adoption of this approach to injury reporting in Saudi football will provide detailed and informative data related to the "injury load" in Saudi Professional football that has clear implications for players, coaches, medical staff and the governing bodies. If this work promotes preventative action in terms of player preparation, treatment regimens or rule changes then the impact will be that much greater (Mechelen et al., 1992). Further it is hoped that this structured research will provide a boost to the study of injuries in other team sports in the Kingdom of Saudi Arabia.

Specifically, the development of a football injury database in Saudi Arabia will cover a number of relevant issues within the following context; (1) injury prevalence in the Saudi Premier League, (2) a comparison of injury statistics in the Saudi Premier League and the Saudi national team, (3) a study evaluating the effects of the playing surface on football injuries sustained in Saudi national football team players, and (4) the impact of an "injury-prevention" intervention on injury statistics in Saudi Premier League footballers.

The primary focus of the thesis will be the collection of football injury data in Saudi Arabia. Regional or country-to-country differences in football injury data are poorly described and understood (Walton et al., 2005). Playing professional football in Saudi Arabia could lead to differences in overall injury incidence as well as the specific characteristics of injuries (type, severity etc.). This is not currently known but could be mediated by local approaches to training and/or the range of environmental conditions the players are exposed too. This combination of issues provides the focus and rationale for the first empirical study. To date only a few studies have been conducted to collect injury incidence data within national football teams. Ekstrand, Walde & Hagglund (2004a) studied the risk of injury when playing for the Swedish national team and they stated that the risk of injury when playing in a national team compares with previously reported figures for professional football at a high level. To date no injury data is available for the Saudi national team players and how this compares to data on injuries within the Premier League. This combination of issues provides the focus and rationale for the second empirical study. Football is played globally in a variety of environmental conditions and on many different playing surfaces (Ekstrand & Nigg, 1989). Most national and international football games (e.g. World Cup) are played on natural grass. With widening participation in football there are some social and environmental conditions that may preclude the use of such playing surfaces. In these cases football matches

can be played either indoors or outdoors on artificial surfaces. Whilst there are some data comparing football injuries on different surface, we are unaware of any data pertaining to natural grass versus 3rd generation (3G) artificial turf on football with respect to injuries in national football teams in Arab countries. This combination of issues provides the focus and rationale for the third empirical study.

For the final study, we will reflect on data collected in study one with Saudi Premier League teams. Injury data will have been collated and analyzed for 2 complete seasons (including pre-season and competitive seasons). This data collection will facilitate the emergence of injury-related issues that will require further study and prompt specific interventions. The intervention will be designed, implemented and assessed in Saudi Premier League teams over a further full competitive season. In this way the final study of the PhD will be responsive to the very specific data collected in the Kingdom of Saudi Arabia. Consequently, this drives the focus and rationale for the final empirical study.

1.2 Aims and objectives

The *overall aim* of this thesis is to determine the incidence and nature of injuries in professional Saudi footballers during training and competition.

This aim will be achieved through the resolution of 4 objectives linked to the completion of four studies.

The objective of the **first study** is to evaluate the incidence of injuries sustained by Saudi Premier League clubs over two consecutive competitive seasons (2010/11 and 2011/2012).

Specifically we compared injuries sustained in match play vs. training, and we provide an initial exploration of the impact of environmental conditions on match play injuries.

The objective of the **second study** is to determine the incidence and etiology of injuries in Saudi national football team players over two consecutive seasons (2010/11 and 2011/2012) and compare this to data collected in the Saudi Premier League.

The objective of the **third study** is to examine the prevalence and nature of injuries associated with playing football on 3G artificial turf compared with natural grass in the Saudi national football team. This was achieved in a quasi-experimental design involving data collection at two international football tournaments played on different surfaces involving many of the same national team players.

The objective of the **fourth study** is to determine the effect of progressive lower limb dynamic balance training programme on injury incidence in Saudi professional male soccer players.

CHAPTER 2. REVIEW OF LITERATURE

2.1. Contextual background to football

Football refers to a number of sports that involve, to varying degrees, kicking a ball with the foot to score points or a “goal”. The most popular of these sports worldwide is “Association Football”, more commonly known as just "football" or "soccer". Unqualified, the word *football* applies to whichever form of football is the most popular in the regional context, including Association Football, American Football, Australian Rules Football, Canadian Football, Gaelic Football, Rugby League and Rugby Football Union (Reilly and Gilbourne, 2003).

Various codes of football share the following common elements (Marples, 1954):

- Two teams of usually between 11 and 18 players; some variations that have fewer players (five or more per team) are also popular.
- A clearly defined area in which to play the game.
- Scoring goals or points, by moving the ball to an opposing team's end of the field and either into a goal area, between posts or over a line.
- The goal or line being defended by the opposing team.
- Players being required to move the ball, depending on the code, by kicking, carrying, or hand-passing the ball.

English public schools were the first to codify football games. Football was adopted by a number of public schools as a way of encouraging competitiveness and keeping youths fit. Each school drafted its own rules, which varied widely and were changed over time with each

new intake of pupils. The *modern* rules of many football codes were formulated during the mid- to late- 19th century and with "Association Football" the British again led the way. By the late 1850s, many football clubs had been formed throughout the English-speaking world, to play various codes of football. Sheffield Football Club, founded in 1857 by Nathaniel Creswick and William Prest, was later recognized as the world's oldest club playing Association Football. At the Freemasons' Tavern, Great Queen Street, London, in the evening of October 26, 1863, representatives of several football clubs in the London Metropolitan area met for the inaugural meeting of The Football Association (FA). The aim of the Association was to establish a single unifying code and regulate the playing of the game among its members. The FA published the "Laws of Football", the first comprehensive set of rules for the game later known as Association Football. The term "soccer", in use since the late 19th century, derives from an abbreviation of "Association".

In the late 19th Century due to; 1) the pre-eminent position of Britain and its "Empire", and 2) rapid developments in human transport and movement within and between continents; the popularity of football grew around the globe. At the turn of the 20th Century football, in some form, was being played on all 5 continents. The need for a single body to oversee Association Football around the world became apparent as there was an increasing popularity of, and demand for, international fixtures. The English Football Association had chaired many discussions on setting up an international body, but was perceived as making no progress. It fell to associations from seven other European countries: France, Belgium, Denmark, Netherlands, Spain, Sweden, and Switzerland, to form an international association. The *Fédération Internationale de Football Association* (FIFA) was founded in Paris on May 21, 1904. Its first president was Robert Guerin. The French name and acronym has remained, even outside French-speaking countries.

2.1.1. Football in Asia:

Cuttmann (1994) suggested that modern sports, most of which were institutionalized and organized in the 19th Century in Britain, began to spread into East Asia, Oceania and other regions of the world in the second half of the 19th Century. Vast areas of the world had become colonies under Western imperialism and this helped the spread of "European" sports. In places like Australia and New Zealand, that were part of the British Empire; Rugby Union, Rugby League, Cricket and Football, in particular, flourished. For independent nations like Japan and Thailand, traditional sports maintained their appeal and football became more popular a lot later in the 20th Century. The impact of "globalization" in the latter half of the 20th Century had a substantial impact on the popularity of football in many parts of Asia, such that football is now recognized as ***the*** "global game". In 1993, the J-League, a professional football league in Japan, was established. This was followed by the K-League (Korea) and the C-League (China) in 1994. European football coverage has established its status as the most popular TV program in Asia. Clubs like Manchester United and Real Madrid schedule 'summer tours' around Asia during the off-season attracting thousands of fans just to their training sessions.

The Asian Football Confederation (AFC) was founded in 1954 and is the governing body of Association Football in Asia. It has 46 member countries, mostly located on the Asian continent. The AFC is one of FIFA's six continental confederations. The AFC runs the Asian Cup; a competition for the national football teams of Asia held every four years, as well as the Asian World Cup Qualifying Tournament, the AFC Challenge Cup and Asian Olympics qualifying tournament. The AFC runs three levels of annual international club competitions. The most prestigious (and oldest of the current AFC club competitions) is the AFC Champions League tournament, based on the UEFA Champions League, formed in 2002/03.

Asian football is still developing and many national leagues have been targeted for reform and development, including Saudi Arabia.

2.1.2. Football in Saudi Arabia

Saudi Arabia was one of the last Asian nations to develop its own internal football competitions and a successful national team. The Saudi Football Association was set up in 1959 and a national league began in 1976. The first national game occurred in 1957 when Saudi Arabia played against Lebanon in Beirut. Saudi Arabia first appeared in the World Cup in 1978. Despite this “late start”, the Saudi Arabian national football team is very popular (known by its fans as Al-Saqour which means "The Falcons" or Al-Akhdar which means "The Green"). In recent times, Saudi Arabia has been considered one of Asia's most successful national teams having qualified for many World Cup final competitions since 1994 and having won the Asian Cup in 1984, 1988 and 1996.

Until the late seventies, football in Saudi Arabia was organised on a regional basis, with the only nationwide tournament being the King's Cup. In 1976, it was deemed that local football, and transportation links, has improved sufficiently to organize a national league. Hence the Saudi League was launched with 8 clubs participating. In 1981 the league increased the number of clubs and added a second division. The league competition for the 1981–82, known as the ranking league, featured 18 clubs with the top eight qualifying for the first division and the bottom ten placed in a new second division. The number of first division clubs was later increased to 12 in 1984–85. In 1990, local competitions were further altered and a full “professional” league was organised. A new league championship was formed called "The Custodian of The Two Holy Mosques League Cup", which was a two stage

championship. The first stage was a regular double round-robin league competition with the top 4 qualifying to the final knockout stage, called the golden square. Finally, in 2007 the league reverted to a standard double round-robin competition, and a new domestic competition cup competition called "The Custodian of The Two Holy Mosques Champions Cup". This cup features the top six finishers in the league plus the winners of the Crown Prince Cup and the Prince Faisal Cup.

Like most Asian countries many aspects of football in Saudi Arabia are still developing. In the specific area of science and medicine support for player development, training, injury prevention, treatment and rehabilitation in Saudi Arabia has seen limited development compared to other countries in Europe, Oceania and the Americas. In the specific realm of football injury assessment, recording, treatment and staff development, Saudi Arabia has a limited scientific and medical infrastructure and little of its own empirical data. As countries around the globe understand the importance of science and medicine in supporting professional football players, teams and national governing bodies; it is pertinent and timely to develop a research database on football injuries in Saudi Arabia. The following sections critique football injury research methodology and data collection methods around the globe to contextualize current knowledge and to provide some focus for the specific studies proposed within this thesis.

2.2. Injury research in Football: Organization and methods.

2.2.1. FIFA and F-MARC

As noted previously, FIFA is the international governing body of association football, futsal and beach soccer. Its membership comprises 209 national associations. Its headquarter is in Zurich, Switzerland, and its president is Sepp Blatter. FIFA is responsible for the organization of football's major international tournaments, notably the World Cup.

The medical focus of FIFA is run by the Medical and Research Committee (F-MARC). F-MARC's primary task is to reduce the incidence of injury in football. In order to achieve this, it was first necessary to establish how often and why both elite and amateur players suffer injuries and whether there are differences between men, women and young players in this respect. This is not an easy task, but is an essential prerequisite for effective prevention of injuries. F-MARC have commissioned and conducted studies with male and female players at different levels of play.

2.2.2. Methodological issues

It is generally accepted that soccer has developed to become faster, more intense as well as with more contact than seen previously, especially at the professional level (Andersen et al., 2004a; Arnason et al., 2004a). Combined with increased participation rates (Dvorak and Junge, 2000) and the often tight scheduling of training sessions and matches (Hagglund et al, 2003) football injuries now account for 25-50% of all sport injuries (Hoy et al., 1992; Andersen et al., 2004a). The epidemiology and etiology of football injuries has therefore become the object of major scientific and medical investigations. Primarily, the aims of these studies have been to establish the extent of the injury load/problem in comparison with other

populations (Hoff and Martin, 1986; Poulsen et al., 1991; Inklaar et al., 1996; Hawkins and Fuller, 1999; Naunheim et al., 2000; Junge et al., 2004; Giza et al., 2005; Walden et al., 2005) as well as to monitor injury patterns in specific groups or across defined timescales (McGregor et al., 2000; Hagglund et al., 2003; Chougle et al., 2005). Identifying common pathologies and their risk factors has also been the focus of several studies (Ekstrand and Tropp, 1990; Hoy et al., 1992; Tucker, 1997; Witvrouw et al., 2003; Dabebo et al., 2004; Volpi et al., 2004; Woods et al., 2004) as well as investigating the complex interaction between these risk factors (Ekstrand et al., 1983a; Fuller et al., 2004a). Finally, some research has attempted to gauge the effectiveness of interventions designed to reduce the incidence of specific injuries (Ekstrand et al., 1983a; Pafis et al., 2005; Arnason et al., 2004a).

It has been well documented that variations in definitions and various methodological issues associated with injury data collection can create significant differences in the results and conclusions obtained from studies of injuries in football (Junge and Dvorak, 2000; Fuller et al., 2006). The plethora of potential methodological approaches can make it difficult to compare studies and draw coherent conclusions from the divergent data sets. Beyond data collection related specifically to the injury type, location (etc.) the accuracy of injury incidence reporting can also be problematic due to different approaches to the measurement of football exposure. If the methods for collecting/calculating exposure data used in an intervention study are not valid or reliable, any inferences as to the effectiveness of the intervention regarding risk per time exposure will be flawed. It is therefore important that the methodological foundations upon which football injury studies are built are sound and researchers can be confident that data interpretation is not compromised by inaccurate or incomplete data as well as inappropriate analysis.

Importantly they have developed and endorsed a standardized system for the registration of all injuries at football tournaments which has since been adapted for other sports and adopted by the International Olympic Committee. UEFA (Union des Associations Europee´nnes de Football), the governing body of football in Europe have also expressed concern over the demands being placed on modern footballers and the translation of these physical and mental demands into injuries. UEFA has also commissioned football injury research but largely adopts F-MARC methods.

Epidemiological research related to football injuries, therefore, requires a conceptual model based on sound methodological principles in order to be effective. Medical journals have developed strategies, such as the CONSORT statement (Altman, 1996) for randomized controlled trials, in order to address these problems and to improve the quality of published studies. However, despite continuing calls for common methodologies to be adopted, fundamental differences in definitions and implementation strategies have persisted in published studies of football injuries. This has partially been addressed by the F-MARC consensus statement which has largely been adopted in this thesis. Despite this, the following concepts are worth considering and/or debating before any study is undertaken.

2.2.3. Injury definition

The initial issue to consider is injury definition. It has been well documented that variations in the definition of injury, as well as sub-category questions like severity and injury type, may in and of themselves create significant differences in the results and conclusions obtained from studies of sports injuries (van Mechelen et al., 1992; Meeuwisse, 1994; Caine et al., 1996; de Loes, 1997; Finch, 1997; Junge & Dvorak, 2000; Ekstrand & Karlsson, 2003; Fuller & Drawer, 2004; Junge et al., 2004; Hagglund et al., 2005; Brooks & Fuller, 2006). In

response to these issues, specifically in football injury research, a FIFA-FMARC consensus statement was produced to establish definitions, methodology, implementation and reporting standards that should be adopted for studies of injuries in football and to provide the basis for studies of injuries in other team sports. With specific respect to injury definition, Fuller et al. (2006) stated that injury can be defined in a number of ways, with 3 noted as being commonly adopted. These definitions were;

Definition A: *"Any football related injury resulting in a player requiring medical treatment, irrespective of subsequent time absent"* (Luthje et al., 1996; Dvorak and Junge, 2000; Junge et al., 2004; Yoon et al., 2004).

Definition B: *"Any football related injury resulting in a player missing the next training session or match"* (Ekstrand and Gillquist, 1983b; Nielsen and Yde, 1989; Engstom et al., 1991; Lilley et al., 2002; Hugglund et al., 2003; Witvrouw et al., 2003; Ekstrand et al., 2004a; Arnason et al., 2004c; Hugglund et al., 2005).

Definition C: *"Any football related injury resulting in a player missing more than 48 h of football activity not including the day of injury"* (Lewin, 1989; Hawkins et al., 2001; Woods et al., 2003).

The most common criterion when defining a football injury is by relating the injury to some defined period of absence from football activity (training or match play) and this generally also gives some indication of severity (Dvorak and Junge, 2000). In the literature, confusion is generated by the adoption of absence criteria ranging from 1 session (Hagglund et al., 2005) through 1 day (Drawer and Fuller, 2002), 48 hours (Hawkins et al., 2001; Le Gall et

al., 2006), 3 days (Volpi et al., 2004) and periods between 1 (Junge et al., 2000) and 4 weeks (Chomiak el al., 2000). Although some of these variations in definition are based on a sound methodological rationale (Chomiak et al., 2000) such as a focus on specific or serious injuries, the inclusion of any 'time out of training/playing' criterion in the definition of 'injury' automatically excludes a stratum of data. This lack of consensus results in there being no universal definition of soccer injury in relation to the "time-lost" criteria (Dvorak and Junge, 2000). Whilst Fuller et al. (2006) again recognized the value of the "time-lost" approach this would have to be very clearly defined *a-priori* in any study.

Fuller et al. (2006) concluded that the most complete definition of injury was any physical complaint sustained by a player as a result of soccer participation, irrespective of the need for treatment or time absent. Whilst this is a precise definition of the word 'injury', it may be impractical to use in epidemiological investigations because of the difficulties associated with recording injuries that don't require medical attention. Consequently many have adopted a "medical attention" definition (Luthje et al., 1996; Yoon et al, 2004) and Fuller et al. (2006) recognized the value and practicality of this approach and was happy to support this approach as long as individual studies made it clear that this was the approach adopted.

Fuller et al. (2006) concluded that defining injury as "any soccer related incident resulting in medical attention" is the most comprehensive definition that is practicable in soccer injury epidemiology. The term 'medical attention' is preferred as using 'treatment' infers that a physical medical intervention occurred, which is not always the case. This definition however, requires a high level of conscientiousness from those responsible for collecting the data and the additional depth of data collected may be limiting (Fuller et al, 2006). Despite this latter concern this is the approach to injury definition adopted in this thesis.

2.2.4. Research design and study population

The epidemiological study of football injuries should be based on a prospective cohort design to minimize the occurrence of errors associated with recall, which is a problem with retrospective study designs. Further, prospective cohort studies that accurately record players' exposures (rather than using recall) enable relationships between the incidence of injury and risk factors within the study population to be explored. This is a key concept that has been adopted within this thesis.

Methods of data collection strongly influence the validity of incidence of injury (Inklaar, 1994a). Methods vary considerably ranging from a limited number of studies where one of the authors has daily contact with players (McMaster and Walter, 1978; Lewin, 1989), watching television and reading press reports (Hawkins and Fuller, 1998a), recording injuries treated in an hospital casualty or other medical department (Hay et al, 1992; Goga and Gongal, 2003), examining soccer injuries for which an insurance claim was made (Cumps et al, 2008) through to complex multi-centered trials recording data to specific definitions and methodological criteria (Fuller et al., 2006). The most popular method of collecting data from a number of different teams is to have a member of each club's medical team responsible for completing proforma's to record injuries and playing exposure on a regular basis (Poulsen et al, 1991; Luthje et al, 1996; Hawkins et al, 2001; Junge et al, 2004). Consequently, this means that the majority of investigations rely upon third party study detached volunteer recruits to diligently and regularly complete injury questionnaires or complete retrospective questionnaires (Ekstrand and Gillquist, 1982; Lilley et al, 2002). Each of the methods detailed above have inherent weaknesses. Using insurance or hospital records limits studies to the more serious injuries with less serious and overuse injuries likely to be missed (van Mechelen et al, 1992). Also in these investigations, the

population at risk is unknown. For example, the 715 injuries reported by Hay et al. (1992) may have been 1% of the playing population or 100%; the limitations of the study don't allow this information to be calculated. Using video analysis (Hawkins and Fuller, 1996; Hawkins and Fuller, 1998a; Rahnama et al, 2002; Arnason et al, 2004c; Fuller et al, 2004c) limits data to incidents that can be observed on the pitch during matches. Hawkins and Fuller (1996) estimated that due to the limitations of the cameras following the ball, at least 54 injuries were missed when using video footage to analyse the cause of injuries during the 1994 World Cup. Andersen et al. (2004b) supported these concerns stating that regardless of thorough video analysis, less than half of the injuries were identified using this method when compared with prospectively collected medical records. Therefore, when the video is used in isolation, under reporting of the injury frequency rate (IFR) would appear unavoidable and suggests that video is unsuitable for studies that require examination of all injuries requiring medical attention.

De Loës (1997) suggested that data collection could be a complex task with arduous access to data collection being a hindrance and even some simple methods being very time-consuming. This may be one reason why expecting third party study-detached volunteer data collectors should diligently complete questionnaires results which are potentially problematic (Twellaar et al, 1996). The response rate of data collectors has also been questioned. In their study of FIFA and Olympic soccer matches, Junge et al. (2004) reported an average response rate of 84% with an inter-team range from 47% to 100%. These findings are from the elite level of football teams which would be expected to employ numerous medical and backup staff. The response level from lower levels of professional football, where staffing levels may not be as high, may be even lower. The reliability of data extrapolated from the injury record sheets competed by volunteer data collectors has also been questioned (Lindenfeld et al,

1988; Twellaar et al, 1996). This is confirmed in a 10-season study of injuries in elite young French soccer players when no effort was made to record the cause of injuries and the time in a match that injuries occurred (Le Gall et al., 2006). The authors stated that this was because they could not be in attendance at all matches, and it was deemed too unreliable to ask coaching staff to record the data and report back. Third-party submission of data is always voluntary and, unfortunately, dropouts and insufficient data registration are common problems in epidemiological studies of soccer injuries (Hägglund et al, 2005).

Using retrospective questionnaires (Lilley et al, 2002) is another method of data collection that can be characterized by inaccurate injury recall and over-estimation of exposure (Nielsen and Yde, 1989; Hagglund et al, 2006). A month after injuries are sustained, under-reporting will start to occur due to recall bias (Inklaar, 1994a). Levy (1988) suggested that retrospective data collected at the end of the season was suspect at best. Junge and Dvorak (2000) quantified the effects of end-of-season retrospective data collection and found that the 1FR per player calculated retrospectively was only one third of that calculated on the basis of a weekly follow up. They suggested that the effects of memory as well as psychological defense mechanisms limited the value of retrospective evaluation. Although vulnerable to a number of biases, there are occasions when collecting data retrospectively is the only method available. In professional football, however, the medical staff has the opportunity to treat and record injuries from the moment they occur until the day the player is restored to full match fitness. This opportunity should be maximized to collect comprehensive prospective data.

Evidence suggests that population limiting methods of data collection such as video based, third party and retrospective data collection, have weaknesses. It would therefore be appropriate to suggest that the most accurate and precise collection of data can only be

obtained by direct supervision and examination of soccer injuries in the field (Poulsen et al, 1991). This approach therefore requires first-hand, prompt, data collection from suitably qualified researchers. This method may not always be feasible but, in the planning stage of the methodology, it should always be the first consideration and was largely adopted in the current thesis.

The study population should normally consist of more than one team of players and the study should, where possible, last for a minimum period of one season (including pre-season), 12 months or the duration of a tournament. Player's joining/leaving the cohort (e.g. through transfer into/out of a team) should be included/excluded from the date of joining/leaving. Injuries and exposures should be documented for every player within the cohort throughout the study period. Players who have an existing injury at the start of a study should not be excluded from the study but their existing injuries should not be included as part of the study.

Most football injury research almost always collects ancillary data describing the cohort(s). The exact nature of any baseline information required will depend on the purpose of the study; however, for surveillance studies, basic information, such as the player's age, gender, playing position, stature, and body-mass should be recorded as these parameters define the study population. For other studies, such as interventions and investigations of relationships between risk factors and the incidence of injury, more detailed baseline information may be required.

2.2.5 Technical issues

Multiple injuries sustained by a player in a single event should be recorded as one injury with multiple diagnoses. Injuries that are unrelated to football competition or training should not be recorded in studies of football injuries. Players may also experience problems other than physical complaints, such as illnesses, diseases and mental complaints, and it may be appropriate in specific studies to record these problems; however, their incidence should be reported separately from the incidence of physical complaints. Definitions for injury severity, type, location, mechanism (overuse/trauma) or other factors (e.g. contact vs. no contact) should follow the FIFA-FMARC consensus statement of Fuller et al. (2006).

2.2.6 Exposure

Exposure to football activity is a critical measurement in football injury research if meaningful data interpretation is to be completed. The collection of accurate exposure data (at the level of the individual where possible) allows the calculation of injury incidence. To facilitate this data collection process key definitions are required again. Match exposure is defined as “play between teams from different clubs”. Match exposure between teams from the same club should be regarded as training exposure. Any match activity that forms a part of a player's rehabilitation from injury should not be recorded as match exposure.

Training exposure is defined as “team-based and individual physical activities under the control or guidance of the team's coaching or fitness staff that are aimed at maintaining or improving players' football skills or physical condition”. Pre-match warm-up and post-match cool-down sessions should be recorded as training exposure. Motivational team talks,

classroom discussions about tactics, sessions with sports psychologists, nutritionists, etc. should not be recorded as training exposure. Personal training activities undertaken by players away from their team and which are not planned by the team's coaching or fitness staff should not be recorded as training exposure. Any training activity forming a part of an individual player's rehabilitation from injury (before return to play and training) should not be recorded as training exposure.

2.3. Football injury research

Football injury research databases have been compiled by a number of different research groups, in varied populations, in a range of geographic locations and with a focus on broad aspects of the total injury load presented to football club medical staff (severity, location etc.). Any single thesis or research study cannot address all issues related to football injuries, but must be located within a specific context that drives a focused rationale and underpins research questions and hypotheses. Given the geographic location of this work (Saudi Arabia) there is a necessity to assess the background to potential geographic and/or regional differences in football injuries as a primary focus. From this initial concept the thesis will evolve to a study of playing level and injury load, playing surface and injury load as well as finally the impact of an injury prevention strategy and injury load. All of these topics will be introduced briefly in order to discuss and critique relevant past research to provide specific points of rationale for the thesis as a whole, as well as each specific study.

Within all of the studies, and consequently all of the “major” research questions addressed, there are “minor” or secondary research questions. In all studies there are elements of reflection on injury incidence in training compared to match-play. In all studies data related

to injury severity, location, type, (etc.) is cross-tabulated with the primary research focus. In the first study, a preliminary assessment of environmental conditions and their relationship with injury incidence is undertaken. These secondary issues will not be developed in any specific or distinct section of the literature review but will infuse all of the major questions and will also be developed within study-specific introductions.

2.3.1. Regional or geographic differences in football injuries.

Several studies have investigated the risk of injury in football (Fuller et al., 2006). When comparing individual studies, beyond the initial discussion of similar definitions and methodologies, (Ekstrand & Gillquist, 1983a, Poulsen et al., 1991; Hawkins & Fuller, 1998a), one of the most obvious and interesting debates is whether Football injury data are consistent between the many countries and cultures that play the sport. It is interesting to note that many of the early original research databases on football injuries came from Europe and did not involve direct comparison of different countries or regions. This is despite the fact that there are generally held beliefs that player level, coaching, tactics and/or environmental conditions can be very different between countries.

Of some interest in this regard is the paper by Walden et al. (2004). Walden and colleagues (2004) investigated the risk exposure, risk of injury, and injury pattern of footballers involved in Union des Associations Europennes de Football (UEFA) Champions League and international matches during a full football season. This involved players and clubs/teams from a range of different regions within Europe. Key findings from the study was a very high risk of injury in European professional football. The most common injury was a thigh strain often typically involving the hamstrings. Interestingly, the results suggested that regional differences were apparent in injury epidemiology and traumatology, with Northern European

teams having the greatest injury incidence. As this was a descriptive study the factors involved in differential injury risk and data between countries were unclear. A couple of other studies added some interesting insight to fuel this issue. In junior footballers in Germany, France and the Czech republic no differences in injury data were observed (Junge et al., 2000). Conversely, in a recent study on male adult footballers in the Swedish and Danish top divisions noted that the risk of injury during training and risk of major injury were significantly higher among the Danish teams (Hagglund et al., 2005).

Despite this suggestion that regional or country to country differences may exist in football injury risk, there has been a relative lack of comparative study. Indeed there has been little expansion of football injury data-basing even in single countries outside of Western Europe, North America and Australasia (see Table 2.3.1.). Data in Asia is limited despite the fact that this is a growing sphere of world influence in football and that there is a larger football playing and supporting population in Asia than any other continent.

Table 2.3.1. An exemplar list of football injury studies from different countries

Author	*REGION*	*Study population*	*Study duration*	*Training or match play*	*Injury incidence*
Ekstrand, et al., 2011	European teams.	European professional men's football.	2001 to 2008	match	8.0 injuries/1000 h
Hägglund et al., 2005a	Denmark and Sweden	The Danish and Swedish male top football divisions	January to June 2001	Training	28.2 vs. 26.2 per 1000 h
(Waldén et al., 2005).	UEFA Champions League.	UEFA Champions	2001-2002	Match	30.5 injuries per 1000 match hours
(Waldén et al., 2013).	Europe	men's professional football in Europe	2001-2002 and 2009-2010	Match and Training	25.7 injuries/1000 hours of match time 3.5 injuries/1000 hours of training time

To date we are aware of only two substantive studies of Asian football injuries (Yoon et al., 2004; Eirale et al., 2010). According to Yoon et al., (2004) the overall injury frequency rate was 45.8 out of 1000 hours. As the tournaments progressed into the knockout stages, the incidence and severity of the injuries increased. The most common sites of injuries were the knees (18.5%), lower legs (17.3%), and ankles (14.2%). Although most injuries were diagnosed as contusions, the more serious injuries were those diagnosed as sprains (especially concerning the knee and ankle) or strains (thigh and back).

Yoon et al. (2004) found that the incidences of injuries to Asian football players were higher than those to European players, but the patterns of the injuries showed no major differences.

Within the Arabic region Eirale et al. (2010) is the only notable study of football injuries. Eirale et al. (2010) reported on football injuries in Qatar and noted lower injury incidence compared to past European studies but also confirmed a pattern of higher injury incidence during match play compared to training. Interestingly injuries to the upper leg again dominated although no accurate exposure and thus incidence data was reported (see Table 2.3.2). Unfortunately, no such studies have been conducted in Saudi Arabia and this represents a much bigger national league and elite player participation number. The larger country (Saudi Arabia compared to Qatar) also involves great travel, level of competition and much greater environmental extremes.

Table 2.3.2. Frequency and severity of football injuries among Qatar national football team players.

	n (%)	Severity of injury (days)					
		Mean ± SD*	Median	1–3	4–7	8–28	>28
Injury location							
Thigh	26(33.3)	11.8 ± 12.2	8.0	6	6	11	3
Knee	13(16.7)	16.5 ± 24.2	7.0	1	5	3	4
Leg	8(10.3)	9.4 ± 10.4	5.5	3	3	1	1
Ankle	7(9.0)	6.0 ± 4.9	4.0	3	2	2	0
Pelvis	5(6.4)	14.4 ± 25.5	4.0	2	2	0	1
Hand	4(5.1)	3.5 ± 2.5	3.0	3	1	0	0
Calf	3(3.8)	8 ± 8.7	3.0	2	0	1	0
Face	2(2.6)	5 ± 2.8	5.0	1	1	0	0
Foot	2(2.6)	1.5 ± 0.7	1.5	2	0	0	0
Pubis	2(2.6)	7.5 ± 3.5	7.5	0	1	1	0
Cranium	1(1.3)	15	15.0	0	0	1	0
Elbow	1(1.3)	2	2.0	1	0	0	0
Hip	1(1.3)	3	3.0	1	0	0	0
Low back	1(1.3)	2	2.0	1	0	0	0
Shoulder	1(1.3)	20	20.0	0	0	1	0
Spine	1(1.3)	7	7.0	0	1	0	0

*Mean ± SD is replaced by individual values when $n = 1$.

The lack of a detailed and accurate Saudi-specific football injury database limits knowledge of players, medical staff and governing bodies. A clear indication of the "medical load", common injuries etc. is absent and clearly drives the rationale for studying football injuries in Saudi Arabia.

Of further interest in a study of Saudi football injuries is the comparison of match and training injuries as well as the potential impact of playing environmental stress. Environmental extremes may mediate changes in physiological load, fatigue and cognitive function, all of which may impact injury risk (Orchard et al. 2001). Few previous studies have investigated the association between football injury data and prevailing environmental conditions (Woods et al., 2002). In this study the investigators described a greater injury risk in pre-season when warmer temperatures and harder ground conditions occur although no formal link to temperature and humidity were assessed directly. The varied and often extreme environmental conditions in Saudi Arabia which is a result of the country's geographic topography would seem to provide a unique opportunity to provide an initial exploration of the impact that environmental condition on football injuries during match play.

The risk of injury during a match has been reported to be greater than during training (Ekstrand et al., 1983b; Nielsen & Yde, 1989; Ekstrand & Tropp. 1990; Engstrom et al., 1990; Poulsen et al., 1991; Arnason et al., 1996; Luthje et al., 1996) and the risk for being injured during a match is reported to be greater, the higher the level of play (Nielsen & Yde, 1989; Ekstrand & Tropp. 1990; Inklaar et al., 1996). Higher risk in match play probably reflects the increased load, intensity and more aggressive playing style. Few studies have examined training load as a potential risk factor for injuries in football. In the Saudi professional game there is a tendency to reduce the exposure and risk in training with short

and often technical and non-competitive training sessions. Whether this reduces injury risk has not been quantified previously.

2.3.2. The impact of player level on football injury data

Again when looking at the many and varied studies of football injuries around the globe very few have directly assessed, by means of a specific research design, the influence of player level on football injury incidence. A few notable studies have assessed football injuries in the highest competitive level (national teams) and this has started to spread to non-European countries in recent years (see Table. 2.3.3.).

Table 2.3.3. Exemplar injury studies in National Teams from different countries

Author	*NATIONAL TEAM*	*Match number/sample size*	*Study duration*	*Training or match play*	*Injury incidence*
Ekstrand et al., 2004a	The Swedish male senior national football team	73 official matches	1991-1997	Training	2.1–2.9 per 1000 h
Eirale et al. (2010)	Qatar National team	36	17 months	Training and Match	65.9 and 4.3 per 1000 h exposure
Bayraktar et al., 2011	Turky national team	577	2000-2005	Training and Match	60.6 and for training sessions was 8.08 1000 h exposure
Wekesa, (1995)	Kenyon national team	18 match	1992-1993	Match	1.78 per match

Ekstrand et al., (2004) followed the Swedish male senior national football team prospectively between 1991 and 1997. During these 6 years the team played 73 official matches and had 3 training camps. The senior author (JE) attended 57 of these matches and the 3 training camps and these matches and training camps are included in the present study. Exposure to football was recorded individually for each player. The team physician examined all injuries. Total exposure was 7245 hours (6235 training and 1010 match hours) and there were 71 injuries (40 training and 31 match injuries). Five (16%) of the match injuries were major with more than four weeks absence from football. The injury incidence during training was 6.5/1000 hours and the injury risk during match play was 30.3/1000 hours. A significantly higher injury incidence was found for matches lost compared to matches won or drawn (52.5 vs. 22.7/1000 hours, p=0.026). No statistically significant difference for injury was found between competitive matches and friendly matches. No difference was found between home and away matches or matches on neutral ground. The risk of injury when playing in a national team compares with previously reported figures for professional football at a high level.

Wekesa (1995) found a total of 32 injuries in the study period. The incidence of lesions was 1.78 per match or 1.1 per player. 43.75% were contusions, 31.25% overuse and 25% sprains. 34.38% of the injuries affected the groin/thigh, 28.13% the knee and 25% the ankle. The right side of the body (65.63%) suffered more injuries. The opponent (60%), ball (12%) and the ground (10%) were the major causes. The activities during injury were running/dribbling (43.8%), tackling (18.8%) and heading (9.4%).

Bayraktar et al. (2011) reported that Turkish national team played 52 official and friendly games, and 208 training sessions were conducted. The total number of injuries recorded in

this period was 108, and the averages per match and training were 1.0 and 0.27, respectively. The most commonly affected anatomic site was the thigh (25%), the most common injury type was contusion (32%) and the most common applied treatment procedure was physical therapy and rehabilitation (89.8%). Bayraktar et al. (2011) found valuable information about the incidence, affected anatomical site, and type and severity of injuries in football. This study can serve as reference data for future scientific studies in the field, and also provides information regarding the prevention of injuries.

Despite the lack of definitive data on the impact of level of play on football injuries there has been plenty of speculation. Indeed many authors have made this exact statement that the level of play is an important factor when studying the exposure factor and injury risk in football (Inklaar, 1994, 1995; Inklaar et al., 1996; Ekstrand et al., 2003). Ekstrand & Tropp (1990) studied the difference in exposure between divisions in Swedish male senior football. The authors found that exposure to football (training and match play) increases with an increase in the level of play although definitive data on injury incidence was not clear on a "level" effect.

In a review, Ekstrand et al. (2003) indicated that the risk for injury during training is approximately the same regardless of the level of play but that some evidence existed that match play injuries were influenced by player level (Nielsen & Yde. 1989; Ekstrand & Tropp. 1990). These studies found an increasing risk for injury with increasing level of play (Nielsen & Yde. 1989; Ekstrand & Tropp, 1990). However, in contradiction, another study found no difference in injury incidence at different levels of play (Poulsen et al., 1991). Ekstrand et al. (1983a) reported a match injury incidence of 16.9/1000 h for male amateur players, Ekstrand & Tropp (1990) and Engstrom et al. (1990) found incidences of 21.8/1000 h and 13/1000 h, respectively, for male semi-professional elite players. All these studies used

the same methodological design. However, it must be kept in mind that these studies were carried out at amateur and semi-professional levels.

One of the larger more detailed and controlled studies was that by Ekstrand et al. (2004) who followed the Swedish male senior national football team prospectively between 1991 and 1997. During these 6 years, the team played 73 official matches and had three training camps. The senior author attended 57 of these matches and the three training camps. Exposure to football was recorded individually for each player. The team physician examined all injuries. Total exposure was 7245 h (6235 training and 1010 match hours) and there were 71 injuries (40 training and 31 match injuries). Five (16%) of the match injuries were major, with more than 4 weeks of absence from football. The injury incidence during training was 6.5/1000 h and the injury risk during match play was 30.3/1000h. A significantly higher injury incidence was found for matches lost compared to matches won or drawn (52.5vs. 22.7/1000h, P = 0.026). Despite this, there was no statistically significant difference in injury incidence between competitive matches and friendly matches. No difference was found between home and away matches or matches on neutral ground. The risk for injury when playing in a national team compared favourably with previously reported figures for professional football at a high level. Consequently the issue of player level remains controversial and poorly evaluated in terms of specific study design.

Data from Asian national teams are very limited and none are available within Saudi Arabia. No specific study has looked a direct comparison of professional league players with regards to the rationale for the second study in the thesis.

2.3.3 The impact of Playing surface and football injuries.

Football is usually played on natural grass, but during the last fifteen to twenty years the use of artificial turf has increased, while use of gravel fields has decreased (Williams et al., 2012). A similar pattern has emerged in other competitive team sports like American football where the transition to play on artificial turf began in the 1960s. In the past few years Rugby Union and Rugby League have begun to experiment with artificial or mixed natural and artificial playing surfaces. The initial response of players, medics and governing bodies was that artificial surfaces could increase injury risk and at best significantly alter injury risk for specific types of injuries. Indeed, two studies reported higher injury rate on artificial turf than on natural grass (Stevenson and Anderson 1981; Powell 1987). Nigg and Segesser (1988) reported in their review article that most studies seem to indicate that a high shoe-surface friction and ground hardness increase injury risk, and more injuries occur on artificial turf than on natural grass, especially knee and ankle injuries. However, as technology has advanced so has the presentation and physical properties of artificial surfaces.

The quality of artificial turf has improved through the years, with attention on optimal hardness (the ability to absorb impact energy) and shoe-surface friction (the footing or grip provided between surface and shoe), which are the two main surface-related risk factors documented (Ekstrand and Nigg 1989; Inklaar 1994b; Milburn and Barry 1998; Orchard 2002). To allow high-intensity movements in football such as sprinting, rapid acceleration and deceleration, cutting, pivoting and gliding for example in tackling, the translational (sliding) and rotational friction between shoe and surface must be suitable. If the translational or rotational friction is too high, the players can run a higher risk of injuries such as ligament sprains in ankle and knee or even fractures because the high friction does not allow sufficient movement between the surface and the shoe. If the friction is too low, it can decrease the

players' maximal speed and their ability to accelerate and decelerate or turn quickly, and the players can slip and even fall when it is not wanted (Ekstrand and Nigg 1989). Under such circumstances injuries such as groin strains can easily occur. Hard surfaces increase impact forces and can possibly result in overload of tissues because of a large single impact or repeated sub maximal impact forces (Ekstrand and Nigg 1989; Inklaar 1994b). Studies from Australian Rules Football indicate that playing on harder surface will increase match speed, which again can increase the risk of injuries (Norton et al. 2001; Orchard 2002).

Current 3rd generation artificial surfaces are now common across the globe and a small but significant database with respect to football injuries and surface has now been produced and reviewed (see Table 2.3.4. to 2.3.6. and the Williams et al., 2012 review).

Studies passing the F-MARC quality criteria and reflecting professional or elite Football data have been reproduced in the following tables. Direct comparison of overall injury incidence, severity and injury location are paraphrased and adapted from Williams et al. (2012).

Table **2.3.4. The incidence of injuries on 3rd generation artificial turf and natural grass in Football (adapted from Williams et al., 2012).**

Study	No. of subjects or teams, gender and age (mean –SD or range y)	Level of Performance	Training or match injuries	Incidence (n/1000 h exposure)	
				natural turf	artificial turf
Soccer Ekstrand et al.[2010]	613 males Age 25 y	Elite	Match	21.72	22.37
Soligard et al.[2010	~60 000 players (~one-third were female) Age 13–19 y	Regional	Match	39.70	34.20
Steffen et al.[2007]	2020 females Age 15 y	Regional	Match	8.30	8.70
Bjorneboe et al.[2010]	Males 14 teams No age data	Elite	Match	17.00	17.60
Ekstrand et al.[2006]	492 males Age 25 y	Elite	Match	21.48	19.60
Bjorneboe et al.[2010]	Males 14 teams No age data	Elite	Training	1.80	1.90
Ekstrand et al.[2010]	613 males Age 25 –5y	Elite	Training	3.47	3.52
Ekstrand et al.[2006]	290 males Age 25 –5y	Elite	Training	2.94	2.42

Table 2.3.4 shows the injuries by playing in natural turf and artificial turf for the elite football players through the match and training which shows little difference in injury incidence 1000 h exposure.

Although many authors propose that high shoe-surface friction and increased hardness of the playing ground increase the injury risk, no study is available where friction of natural grass and artificial turf has been measured and compared to injury rate in football (Orchard 2002). However, Orchard (2001) measured ground hardness of natural grass fields before matches in the Australian Football League and found a non-significant trend to a higher risk of ACL injuries on harder fields.

Two cohort studies (Steffen, et al.2007; Ekstrand, et al. 2006) showed some beneficial influence of artificial surfaces on muscle injuries in footballers, and perhaps the surface is straight and shock absorbent (See table 2.3,4 to 2.3.6).

Table 2.3.5. The severity of injury on artificial turf and natural grass in elite level footballers (adapted from Williams et al., 2012).

Study	**No. of subjects or teams, gender and age (mean –SD or range y)**	**Level of Performance**	**Training or match injuries**	**Injury severity**	**Incidence (n/1000 h exposure)**	
					natural turf	artificial turf
Soccer Ekstrand et al.[2006]	492 males Age 25 –5y	Elite	Match	Slight (1–3) Minor (4–7) Moderate (8–28) Severe (>28	1.09 0.54 1.09 0.22	0.74 0.64 0.68 0.35
Soligard et al.[2010	~60 000 players (~one-third were female) Age 13–19 y	Regional	Match	Slight (1–3) Minor (4–7) Moderate (8–28) Severe (>28)	2.70 0.70 0.70 0.40	2.80 1.00 0.20 0.20
Bjorneboe et al.[2010]	Males 14 teams No age data	Elite	Match	Slight (1–3) Minor (4–7) Moderate (8–28) Severe (>28)	8.50 4.90 3.60	8.00 4.80 4.80
Ekstrand et al.[2010]	613 males Age 25 –5y	Elite	Training	Slight (1–3) Minor (4–7) Moderate (8–28) Severe (>28)	1.08 0.88 0.98 0.49	1.16 0.80 1.08 0.40

Table 2.3.5 shows the severity of injury on artificial turf and natural grass in elite level footballers which shows little difference between the natural turf and artificial turf in injury incidence 1000 h exposure during training and match in elite football players.

Table 2.3.6. Incidence of **i**njured body part or injury type on artificial turf and natural grass in footballers (adapted from Williams et al., 2012).

Study	No. of subjects or teams, gender and age (mean –SD or range y)	Level of Performance	Training or match injuries	Injured body part or injury type	Incidence (n/1000 h exposure)	
					natural turf	artificial turf
Soccer Ekstrand et al.[2006]	492 males Age 25 –5y	Elite	Match	Ankle Knee Muscle strain	2.66 2.66 6.16	4.83 2.07 3.76
Soligard et al.[2010	~60 000 players (~one-third were female) Age 13–19 y	Regional	Match	Ankle Knee Muscle strain	8.40 5.60 3.00	4.30 4.60 2.20
Steffen et al.[2007]	2020 females Age 15 –1y	Regional	Match	Ankle Knee Muscle strain	3.00 1.10 1.50	4.00 1.90 0.60
Bjorneboe et al.[2010]	Males 14 teams No age data	Elite	Match	Ankle Knee Muscle strain	2.20 2.00 5.10	3.10 3.00 4.50
Ekstrand et al.[2006]	154 females Age 23 –4y	Elite	Match	Ankle Knee Muscle strain	2.63 2.30 2.96	2.89 3.55 3.55
Ekstrand et al.[2006]	492 males Age 25 –5y	Elite	Training	Ankle Knee Muscle strain	0.33 0.33 1.31	0.53 0.31 0.62

Table 2.3.6 shows Incidence of **i**njured body part or injury type on artificial turf and natural grass in elite level footballers which shows little difference between the natural turf and artificial turf in injury incidence 1000 h exposure during training and match.

Although a number of studies have now attempted to quantify and describe differences between surfaces with regards to the varying degrees of injury risk, severity and type (see table 2.6.3), few are in elite players, few are in quasi-experimental designs and none have been generated from Saudi Arabia.

2.3.4. Prospective intervention studies related to football injuries.

Several studies have demonstrated that injury is the major cause of professional football players being absent from training and competitive play. These absences have an effect on team selection which may, in turn, have a significant effect on team performance and results. As well as the effects on team success, the financial implications of injury in respect of players being unavailable to compete can run into many millions of Euros (Hawkins et al., 2001). A reduction in injury rate would therefore not only have a positive effect on player welfare but also on the financial wellbeing of professional soccer clubs.

In professional soccer, it is normally the role of the physiotherapist or sports rehabilitator to ensure that players returning from injury are sufficiently rehabilitated to withstand the stresses of training and competition. One of the major difficulties encountered during rehabilitation is the necessity to adapt training due to the high proportion of injuries being sustained to the lower limbs (Chomiak et al., 2000). As soccer-specific training is normally characterized by running exercises, the enforced alteration to habitual training patterns may lead to a change in specificity and a reduction in the training load that may lead to inadequate rehabilitation. These modifications may be specific to individual pathologies as a direct consequence of the inter-relationship between the specific restraints of the injury. No studies can be found that describe the incidence of injuries in terms of their impact on a player's ability to perform soccer-specific training such as small-sided games and directional fitness drills.

In general, a distinction has been made between so-called intrinsic (person related) and extrinsic (environment related) risk factors for sports injuries (Inklaar 1996; van Mechelen *et al.,* 1992; Taimela *et al.,* 1990). Intrinsic risk factors relate to the individual biological and

psychosocial characteristics of a person, such as age, joint instability, muscle strength, muscle tightness, muscle strength and symmetry, previous injuries, adequacy of rehabilitation, and psychosocial stress (Dvorak *et al.*, 2000). Extrinsic risk factors relate to environmental variables such as the level of play; exercise load (amount of competition and practice); amounts and standard of training; position played; equipment such as shin guards, taping, and shoes; playing field conditions; rules; and foul play. Both intrinsic and extrinsic factors can partially influence each other and are therefore not independent of each other (Dvorak *et al.*, 2000). For example, a player who straps an ankle in an effort to reduce the intrinsic risk of a chronically unstable ankle joint may be more prone to ankle injury from extrinsic factors such as being tackled by an opponent.

Investigations have identified chronic joint instability, muscle strength imbalance and muscle flexibility asymmetry as risk factors for injury and re-injury (Ekstrand and Gillquist, 1983a) as well as inadequate rehabilitation (Dvorak et al., 2000) as a risk factor for re-injury. Although the identification of individual risk factors for re-injury is a fairly straight forward process, the identification of individual risk factors can only partially begin to address the question of injury prevention. It is clear that football injuries result from a complex interaction of risk factors (Hagglund et al., 2007) and preventing re-injury is therefore a multifaceted task.

Although injuries in football are common, it has been considered that many injuries could be prevented (Junge et al., 2002) by manipulating either intrinsic or extrinsic risk both before an injury has occurred (prevention or prehabilitation) or after an injury (rehabilitation). There have been limited numbers of studies that have specifically identified interventions to reduce injury in a football setting. Few of these have been in a professional environment where time

and logistical constraints may be difficult to overcome. To this end sports medicine staff have developed interventions such as strengthening exercises to correct muscle imbalances, stretching exercises to increase flexibility/decrease muscle stiffness, and balance programs to promote proprioceptive ability (Caraffa et al., 1996; Askling et al., 2003; Malliou et al., 2004; Gioftsidou & Malliou, 2006).

Balance exercise programs that improve proprioception are commonly employed during rehabilitation from injury (Hale, et al. 2007), to promote recovery and reduce the risk of re-injury (Herrington, et al. 2009). The use of such interventions to prevent injury in healthy groups is a logical development of this work (Hoffman & Payne, 1995; Hrysomallis, 2007; McHugh et al., 2007). Many groups have promoted the use of balance training in an athlete's daily training (Bahr et al., 1997; Caraffa, et al., 1996; Wedderkopp et al., 1999; Soderman, et al., 2000; Malliou, et al., 2004; Gioftsidou, et al., 2006). There are a few empirical studies that have suggested that balance training may reduce musculoskeletal injuries (Caraffa, et al., 1996; Wedderkopp, et al., 1999). Caraffa, et al. (1996) prospectively studied the impact of a 6 week (3 times per week) balance-training program on ACL injuries in 600 soccer players. The training group (n=300) performed a balance-intervention program of gradually increasing difficulty and reported a significant reduction in injuries compared to the control group. Wedderkopp et al. (1999) also reported a decrease in lower limb injury frequency after the application of a balance board training programme in healthy female handball players.

The major focus of an intervention is that there must be a plausible rationale and the target or focus must already be highlighted as a meaningful risk. Consequently for the final study it will not be determined what the nature of the intervention is until the initial descriptive

studies have been completed. The final study returns to the Saudi Premier League and details the feasibility of a simple balance training intervention during pre-season training and then details the efficacy of this intervention on football injury incidence in the following season. Once exposure data has been appropriately collected then the incidence of injury should be defined per 1000 h or player exposure. This can be calculated separately for training and match play as well as all football exposure combined. These approaches were adopted through the thesis.

2.4. Summary and Study Hypotheses.

The football injury literature clearly support the conclusion that injuries are common with the risk of injury many times that of recognised high-risk industries (Fuller et al., 2006). Despite this there are still significant areas for development of the football injury database. There is a clear rationale from a practical perspective to develop region or country-specific databases as this will inform local support and sports medicine practice. It may uncover regional differences in injury incidence and other aspects of injury data. This could have important local impact. Football injury databases are sparse in Asia and non-existent in Saudi Arabia which is the overarching rationale for this thesis. In study one we describe injury load on sports medicine support to professional teams in the Saudi Premier League. Secondary aims relate to the differentiation of injury data during training and match-play and an exploratory approach to the link between environmental conditions and football injuries. The second study builds on the first by comparing the football injuries in higher level player; specifically the Saudi national team and this data is compared to Saudi Premier League data. The third study follows the Saudi national team in two international competitions and details injury incidence and related injury data when games and training were completed on two different surfaces (natural grass and artificial 3rd generation turf).

Our aims and hypotheses are stated by study;

Study 1: Aim: To determine the incidence, severity and nature of injuries in players in the Saudi Premier league players during training and competition.

Hypotheses – injury incidence is similar in Saudi professional footballers when compared to literature from other countries; injury incidence is higher during match play than training; and injury incidence is highest during the greatest environmental stress during match play.

Study 2: Aim: To determine the incidence, severity and nature of injuries in players in the Saudi national team players during training and competition and compare this data to Saudi Premier League Players.

Hypothesis – injury incidence is higher in national team players during training and match play when compared to Premier League players.

Study 3: Aim: To determine the incidence, severity and nature of injuries in Saudi national team players during training and match play on natural grass vs. artificial 3G turf.

Hypothesis – Injury incidence during match play and training will be similar on both playing surfaces.

Study 4: Aim: The feasibility and efficacy of a progressive lower limb balance training intervention on football injury prevention in Saudi Premier League players.

Hypothesis – injury incidence will be reduced after a progressive, lower limb balance training programme in Saudi Premier League players.

CHAPTER 3.

This study: The incidence, severity and etiology of injuries in players competing in the Saudi Premier League between 2010-2012, are published in Saudi Journal of Sports Medicine.

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CHAPTER 4. The incidence, severity and aetiology of injuries in players in the Saudi national football team during training and competition.

4.1. Introduction:

In the previous Chapter (3) we assessed injury data in Saudi Premier League footballers. This information will contribute to local knowledge related to injury monitoring and the load placed on medical staff at professional football clubs in Saudi Arabia. This data also adds to a very small football injury database in Asia (Yoon et al. 2004). High injury incidence in footballers (Chaper 3; Hawkins and Fuller, 1999; Ekstrand, 1982) can impact on an individual's playing time resulting in important socio-economic and financial consequences for both the professional game and the wider society. The personal consequences of any football injury are greater the higher the performance playing level. Despite this concept little attention has been given to the issue of injury incidence at different levels of football competition, with no prior studies comparing playing levels in Saudi Arabia.

When playing at different levels (Premier League vs. international duty) there will be a range of differences in the football exposure experienced by the players. Obviously there will be a different coaching team and the nature of preparation at international training and games is much more orientated to match readiness. This means the coaches concentrate on game/match scenarios rather than fitness or technical drills. This elevated level of competition and contact may alter injury exposure.

Previous studies, in other parts of the world, have investigated the incidence of football injuries in clubs and national teams (Hagglund et al., 2005b; Walden et al., 2005a; Hagglund et al.; 2006, Eirale, et al., (2010), as well as at continental competitions (Walden et al.,

2005b) but rarely directly together in the same study or country. Football injury databases have been implemented for national teams during sanctioned international competitions for many years (Junge et al., 2004b; Walden et al., 2007; Dvorak et al., 2011; Bayraktar et al., 2011), but again rarely has the competitive level been specifically investigated in any study. It has been suggested that the level of play is an important risk factor for football injuries (Engebretsen et al., 2008), with injury rates increasing with the level of competition (Hagglund et al., 2005a; Walden et al., 2005b). Contradictory data was, however, noted in a study of factors related to severe injury in 398 male soccer players (Chomiak et al., 2000). Chomiak et al. (2000) reported that athletes in lower skill level groups had a twofold increase in incidence compared with the higher skill level populations. This finding could be attributed but not limited to: lower body fat percentage, higher score of pain in joints, less training exposure during the preseason period and the season, lower score of technique (self-rating), longer reaction time after 12 min runs. These contradictory findings also help prompt the current research.

Given that the Saudi Football Federation shifted to professionalism in 1993 and the Saudi national team has been competitive on a regional and world stage since the 1990s, it would seem pertinent to extend the monitoring of football injuries in Saudi Arabia to the highest level of the game in the country, the national team. This will also add an extra level to the developing database of football injuries in the region that may be a valuable reference for football players, staff and officials.

Consequently, the overarching aim of this study was to evaluate the incidence, severity and a etiology of injuries in Saudi national football players during training and match play. We sought to compare injury data with injuries in professional Saudi Arabian football players

competing in the Saudi Premier League during training and competitive match play (data reported in the total sample from the previous Chapter). We hypothesise that a higher injury rate occurs during international match and training exposure when compared to data from the Saudi Premier League.

4.2. Methods

4.2.1. *Subjects*

We recruited 92 Saudi National Team professional players who took part in training or match play at specific national team training camps, games or competitions over two competitive seasons 2010-11 and 2011/12. The 92 national team players (mean±SD; age 26.6±4.1 yr; height 176.5±5.8 cm; weight 70.2±6.7 kg; body mass index 22.5±1.6 kg/m2) gave written informed consent.

The high number of players in the international team over a short period (2 years) is attributed to the fact that the national team coach wanted to see, and work with, a large number of eligible players as he was new to Saudi Arabia and the PL. In the Saudi national team the use of training camps tend to occur more frequently than in Europe and this process allowed the coach to see a larger number of players. It is worth mentioning that there were a large number of players whose data contributed to the Saudi Premier league data as well as the national team. The issue of whether we reduced the sample to just those compating in both the Premier League and the National team was discussed but we decided to maintain the highest number in the Premier League database to give the most robust (largest absolute and relative sample size) for this dataset. In the National team we had a sample that represented 100% of the population and in the Premier League the larger sample represented c. 50% of the population.

The Saudi FA provided gatekeeper agreement to complete the study. Local institutional ethics approval was also obtained prior to the study. Data was compared to 198 professional footballers who competed at six clubs in the Saudi Premier League over the same time period (see chapter 3; (mean±SD; age 28.2±1.8 yr; height 177.3±1.0 cm; weight 71.6±1.4 kg; body mass index 22.8±0.3 kg.m^2). There were no exclusion criteria, as players with current injuries were not playing or training until appropriately rehabilitated/recovered.

4.2.2. *Design*

A prospective cohort design was used to investigate the incidence, nature and severity of injuries sustained during training and games in the Saudi national football team and in the comparison group of Saudi Premier League players. Over the study period, injury and exposure data were collected to allow injury incidence calculations.

4.2.3. *Data Collection*

This study extended the methods adopted in the Chapter 3 to the Saudi national team. Specifically the same injury definition was adopted and the same approach and exposure recording were maintained. All injury and exposure data were recorded during national team training camps and competitive tournaments by the lead researcher using an F-MARC endorsed process (Fuller et al., 2006).

All individual exposures to training and matches were recorded on a daily basis during the data collection period by the senior author. The team completed 192 training sessions over the two years with a mean duration of 64 min in training. The Saudi national team played 33 preparation and competitive games that were allocated a standard 90 min exposure. Consequently, training exposure was 150 080 min, game exposure was 32 670 min and total

exposure was 248 410 min. Match and training exposure for the Saudi Premier League footballers was as described in Chapter 3 (Table 4.1).

4.2.4. *Data analysis*

We collated data and reported, descriptively, the frequency of injuries as well as injury incidence per 1000 h of player exposure. Primarily, in the Saudi national team players we compared injury incidence in training and match play. Secondly, we compared injury incidence between national team and Saudi Premier League players. Due to the quasi repeated measures design employed the assumption of independence of observations (players and injuries) could not be met; therefore, inferential statistics (e.g. chi-squared analyses) were not conducted in this study.

4.3. Results

4.3.1. *Players' Exposure and Injury Incidence*

Players' exposure, injury frequency and incidence for the Saudi national team players are presented in **Table 4.1** alongside comparative data presented from the Saudi Premier League players. A total of 387 injuries were sustained by Saudi national team players over the two seasons of the study. This is fewer than the 617 from the Saudi Premier League over the same time period. Despite this, the smaller number of players in the national team and much reduced exposure resulted in much higher (often by a factor of between 5 and 10 fold) injury incidence (per 1000 h of player exposure) in all categories for national team players.

Table 4.1. Training, game and total player exposure as well as injury frequency and injury incidence in Saudi national and Premier League footballers.

	National	Premier
Players (n)	92	198
Total number of training sessions	192	2823
Average Training Duration (min)	64	42
Total Training Exposure (min)	282 624	3 908 520
Training Injuries (n)	241	355
Training Injury Incidence (per 1000 h exposure)	51.2	5.5
Games (n)	33	312
Average Game Duration (min)	90	90
Total Game Exposure (min)	32 670	308 880
Game Injuries (n)	146	262
Game Injury Incidence (per 1000 h exposure)	268.1	51.0
Total Exposure (min)	315 294	4 217 400
Total Injury (n)	387	617
Total Injury Incidence (per 1000 h exposure)	73.7	8.8

4.3.2. *Injury Severity*

In both the Saudi national team and Premier League players, the majority of injuries were of the lowest level of severity with no training and/or match play exposure lost (**Table 4.2.**). Injury incidence was higher in national team players across all severity categories by a factor of 2-20.

Table 4.2. Injury frequency and data for severity categories in Saudi National and Premier League footballers.

Severity	**National**			**Premier**		
	Total	**Game**	**Train**	**Total**	**Game**	**Train**
None (0 days; n)	293	120	173	198	88	110
(per 1000 h exposure)	55.8	220.5	36.8	2.8	17.3	1.7
Slight (1-3 days; n)	57	21	36	206	85	121
(per 1000 h exposure)	10.8	38.9	7.6	2.9	16.7	2.0
Minor (4-7 days; n)	10	4	6	78	25	53
(per 1000 h exposure)	2	7.4	1.3	1.1	5.0	0.9
Major (8-28 days; n)	19	1	18	102	44	58
(per 1000 h exposure)	3.6	1.8	3.8	1.5	8.7	0.9
Severe (28+ days; n)	6	0	6	29	20	9
(per 1000 h exposure)	1.1	-	1.3	0.4	4.0	0.1

4.3.3. *Injury Location*

In Saudi national team players, lower limb injuries were more frequent with the incidence being higher in match play. In most categories upper and lower limb injury incidence was noticeably higher in national compared to Premier League players (**Table 4.3a; 4.3b**). In national and Premier League players, the most common lower limb injury site was the thigh.

Table 4.3a. Injury frequency and incidence data for injury location in the upper limb in Saudi national and Premier League players.

Location	**National**			**Premier**		
	Total	**Game**	**Train**	**Total**	**Game**	**Train**
Shoulder / cervical (n)	14	8	6	34	12	22
(per 1000 h exposure)	2.7	14.8	1.3	0.5	4.3	0.3
Upper arm	1	0	1	15	6	9
(per 1000 h exposure)	0.2	-	0.2	0.2	1.2	0.1
Elbow (n)	1	1	0	12	7	5
(per 1000 h exposure)	0.2	1.8	-	0.2	1.4	0.1
Forearm (n)	2	1	1	15	2	13
(per 1000 h exposure)	0.4	1.8	0.2	0.2	0.4	0.2
Wrist (n)	1	1	0	13	4	9
(per 1000 h exposure)	0.2	1.8	-	0.2	0.8	0.1
Hand/ Fingers / Thumb (n)	8	5	3	31	5	26
(per 1000 h exposure)	1.5	9.2	0.6	0.4	1.0	0.4

Table 4.3b. Injury frequency and incidence data for injury location in the lower limb of Saudi national and Premier League players.

Location	National			Premier		
	Total	**Game**	**Train**	**Total**	**Game**	**Train**
Hip and Groin (n)	37	18	19	49	17	32
(per 1000 h exposure)	7.0	33.3	4.1	0.7	3.3	0.5
Thigh (n)	69	40	29	192	65	127
(per 1000 h exposure)	13.1	74	6.1	2.8	12.8	2.0
Knee (n)	63	29	34	122	72	50
(per 1000 h exposure)	12.0	53.7	7.2	1.8	14.1	0.8
Lower Leg/Achilles tendon (n)	63	29	34	129	65	64
(per 1000 h exposure)	12.0	53.7	7.2	2.0	12.8	1.0
Ankle (n)	62	36	26	137	70	67
(per 1000 h exposure)	11.8	66.6	5.5	2.1	13.8	1.0
Foot and Toe (n)	30	14	16	61	30	31
(per 1000 h exposure)	5.7	25.9	3.4	1.0	6.1	0.5

4.3.4. *Injury Type*

Data for injury type in Saudi national and Premier League players are presented in **Table 4.4**. Muscle and soft tissue injuries (contusions, strains, tears, cramp etc.) were, by far, the most common type of injury in both groups. Incidence rates were higher in match play in both groups with overall incidence higher in Saudi national team players by a factor of 5-10.

Table 4.4. Injury frequency and incidence data for injury type in Saudi national and Premier League players.

Diagnosis	National			Premier		
	Total	**Game**	**Train**	**Total**	**Game**	**Train**
Joint/ non-bone & Ligament/ (n)	45	23	22	120	49	151
(per 1000 h exposure)	8.5	42.5	4.6	1.8	9.7	2.3
Fractures and bone stress / (n)	3	2	1	6	2	4
(per 1000 h exposure)	0.6	3.7	0.2	0.1	0.4	0.1
Muscle and Tendon (n)	133	72	61	360	253	320
(per 1000 h exposure)	25.3	133.3	13.0	5.0	49.6	5.0
Contusions (n)	153	87	66	305	162	143
(per 1000 h exposure)	29.1	161.1	13.9	4.3	31.8	2.2
Lacerations and skin lesion (n)	27	16	11	37	21	16
(per 1000 h exposure)	5.1	29.6	2.3	0.5	4.0	0.2
Other (n)	20	11	9	76	17	59
(per 1000 h exposure)	3.8	20.3	2.0	1.1	3.3	1.0

4.3.5. *Recurrence*

Data for injury recurrence are reported in **Table 4.5**. It is important to note that the total number on injuries analysed was reduced due to some cases where a full injury history was unclear. Recurrent injuries were less frequent than new injuries in both training and match-play. As with other injury categories the incidence was substantially higher in national team players. Since there is no form of data registry for injuries among Saudi players, this noted

reduction of injuries recurrence could be explained by: humble injury screening tools of medical teams in Premier League clubs compared to national teams.

Table 4.5. Injury frequency and incidence data for injury recurrence in Saudi national and Premier League players.

Recurrence	**National**			**Premier**		
	Total	**Game**	**Train**	**Total**	**Game**	**Train**
Yes (n)	146	47	99	121	34	87
(per 1000 h exposure)	27.8	87.1	21.0	1.8	7.1	1.3
No (n)	241	103	138	266	128	138
(per 1000 h exposure)	45.9	190.7	29.3	4.0	25.1	2.1

4.3.6. *Mechanism*

Trauma injuries were slightly more frequent than injuries due to overuse (**Table 4.6.**). The incidence of both types of injury were higher in match play and the incidence data for national team players was greater 10 fold higher than in Saudi Premier League players.

Table 4.6. Injury frequency and incidence data for overuse and trauma injuries in Saudi national and Premier League players.

Mechanism	**National**			**Premier**		
	Total	**Game**	**Train**	**Total**	**Game**	**Train**
Overuse (n)	146	64	82	352	135	217
(per 1000 h exposure)	87.3	118.5	17.4	5.0	26.5	3.3
Trauma (n)	241	110	131	259	127	132
(per 1000 h exposure)	45.9	203.7	27.8	3.7	25.1	2.0

4.3.7. *Contact vs. Non-contact Injuries*

Injuries associated with contact or non-contact situations are presented in **Table 4.7**. In national team players, the frequency and incidence rates were very similar between contact and non-contact injuries (87.3 to 45.5 per 1000 h of exposure). This pattern was similar to Premier League data but at a substantially higher incidence rate.

Table 4.7. Injury frequency and incidence data for contact vs. non-contact injuries in Saudi national and Premier League players.

Contact vs. Non-contact Injuries	**National**			**Premier**		
	Total	**Game**	**Train**	**Total**	**Game**	**Train**
Yes (n)	146	98	48	283	165	118
(per 1000 h exposure)	87.3	181.4	10.2	3.6	18.7	1.9
No (n)	240	112	129	328	97	231
(per 1000 h exposure)	45.5	207.4	33.8	4.4	11.0	3.5

4.4. Discussion

The key finding from this study was that injury incidence when playing for the Saudi national team was substantially higher, across all categories, than data collected in Saudi Premier League players using the same tools and injury descriptors. Further, in Saudi national team players this study confirmed that a higher injury incidence was associated with match play compared to training. Finally, injury data related to severity, location, type etc. in the Saudi national team were largely confirmatory of what has been reported in this thesis for Saudi Premier League players. This finding supports the need for a well-structured system of football injuries registry which in return will guide any initiatives of developing injury prevention programs. Additionally, the primary investigator was the sole injury data recorder for national team players compared to many individuals in the premier league clubs.

4.4.1 National vs. Premier League

The most obvious outcome from the current study is the substantially higher injury incidence in Saudi national footballers. This higher incidence is apparent in both training (51.2 vs. 5.5) and match play (268.1 vs. 29.7) 7 (per 1000 h of exposure), when compared to the Saudi Premier League play. These differences seem to be observed consistently across most sub-category injury questions (e.g. severity, location, type, etc.) in this investigation. The exact reasons for the stark difference between injury incidence in National Team vs. Saudi Premier League exposure is likely multi-factorial and, in a descriptive study such as this, is almost impossible to exactly determine. We would make the following speculative observations that should be followed up with further research. Firstly, it can be argued that the importance on international matches, especially when qualifying for regional and/or international tournaments, as well as actually competing at these tournaments, produces a great intensity of effort, a greater commitment to winning, higher levels of fatigue and stress and consequently

higher level of risk taking activity, (McSharry,.2007). The combination of these activities may increase injury incidence (Ekstrand, et al. 2012). Further because of the perceived honour and importance of representing your country players may actually attend training and match play for national teams in non-optimal physical states (often minor prior injuries) and then compete when normally they might have rested. This could expose the players to greater injury risk. The data were collected exclusively during play level, separating the data from tournament and regular play was not taken into consideration at the beginning as it was not given a higher priority then.

Other unique circumstances of international play may increase injury risk. Long periods of overseas travel, with concomitant issues such as jet lag (for example in Asian competitions travel to Japan or South Korea) may occur even in close proximity to Premier League games. The challenge of overcoming jet-lag and adapting to new climates may provide significant physical and psychological stress such that injury risk is increased. In tournament play it is not unheard of with practice games to play 5-9 competitive games, at the highest level, with no more than 3 days rest and recovery between exposures. This intensity of competition may increase injury risk. Whilst we have limited data related to any of these specific issues they have all been alluded to in comments by players, managers and support/medical staff. The exact role of each factor, independently or in conjunction with other factors, is likely complex and requires further study (Lee, et al., 2012).

Finally, because of the systematic difference in injury incidence across all subcategories of injury type, as well as for training and match-play, we cannot rule out a consistent and much more sensitive attention of medical staff and recording process. A more sensitive approach (by players or medical staff) to injury reporting has not been noted before in previous research but could again reflect the perceived need for higher levels of care in the national

team and concern about not reporting injuries when players return to their premier league clubs (Bjørneboe, et al. 2011). In the current study we adopted the same definition of injury and the same reporting tools.

Ekstrand et al. (2003) indicated that the risk for injury during training is approximately the same regardless of the level of play but that the risk for injury increased while at training camps compared to regular training. It is very common that football players will join the national team in competition/training camps immediately after participating with their teams in a usually tight matched schedule. The results of a tight match schedule for top players have been evaluated in a study on the World Cup tournament in Korea/Japan 2002 (Ekstrand et al. 2004). In this study the authors reported no higher risk of injury in World Cup play than in other areas. The fact that level of play (National vs. Premier League) did alter injury incidence is not entirely at odds with past work, although the research outcomes in this area are far from consistent. . The level of play has been suggested as an important factor when studying exposure and injury risk in football by a number of previous authors (Inklaar et al., 1996). In two Dutch non-professional soccer clubs (senior players and junior) higher level of play was associated with increased injury risk (Inklaar et al., 1996). Conversely, Ekstrand et al. (2003) indicated that the risk of injury during training is approximately the same regardless of the level of play.

4.4.2. Training vs. Match Play

The higher incidence of injury during international matches in the current study (268.1 per 1000 h exposure) than during training sessions (51.2 per 1000 h of exposure) confirmed the trend for higher risk in match-play that has been reported in previous studies as well as in the 3 earlier Chapters of this thesis (Ekstrand et al., 1983; Nielsen & Yde, 1989; Engstrom et al., 1990; Arnason et al., 1996; Walden et al., 2005a). In the Arab region, Eirale et al. (2010) also

noted higher injury incidence in match play compared to training in Qatar. This pattern of higher injury incidence in match play is similar to data reported in other regions around the world (.Ekstrand et al., 2004; Dvorak et al., 2007; Walden et al., 2007; Hawkins & Fuller, 1999; Hagglund et al., 2003; Hagglund et al., 2005b; Walden et al., 2005a, b; Arnason et al., 2008; Ekstrand et al., 2010).

Any subtle differences in incidence rates between studies is likely a complex combination of issues already speculated and the veracity of study definitions and data collection methods in a range of difference countries. The higher incidence rate for injury in match-play vs. training is highly consistent and is likely easier to explain in relation to the intensity of the activity, the risk taking undertaken by the players and the greater amount of contact in real-play as opposed to preparatory training. Higher injury incidence in matches compared to training sessions was also found for most subcategories assessed (contact and non-contact injuries, primary and recurrent injuries, traumatic injuries, injuries at all severity levels, lower limb injuries and muscular strains) and are likely explained by the same issues highlighted above. This difference does highlight the importance of focused injury support and prevention strategies in relation to match-play addressing overall risk factors for all positions and scenarios

4.4.3. Injury sub-categories.

Data from the current study of Saudi national team players confirm common injury trends from this thesis and previous football injury literature from around the world. Specifically, the most common injury site was the lower limb (Hagglund et al., 2003a; Walden et al., 2005a) and reflects the bipedal, contact and invasive nature of professional football. In other areas data falls in line with past reports, for example overuse injuries accounted for 37.7% of

total injury count. Previous authors report an overuse injury incidence of between 2% and 39% in footballers (Nielsen & Yde, 1989; Hawkins & Fuller, 1999; Hawkins et al., 2001; Hagglund et al., 2005b).

4.4.4. Implications

The impact of this data will serve as a valuable reference for football staff and officials attached to the Saudi national team to review the injury history of players, look for emerging injury trends, assess causative factors and where relevant use this data to introduce appropriate interventions (pre-habilitation etc.). Given the high incidence rates in national team exposure it is vitally important that the appropriate level of medical coverage and support is in place for training and match-play during international get-togethers.

In this chapter, and the last, we reported that that lower limb muscle and soft tissue injuries were the most common type of injury in Saudi footballers. Multiple explanations have been suggested to explain this high injury incidence including the competitive and contact nature of the game as well as muscle tightness, weakness or imbalances, inadequate warm-up, scar formation in the muscle tissue, poor biomechanics and movement patterns, poor balance and proprioception, lack of prevention programs and previous injury history (Orchard, 2001; Goldman & Jones, 2010). Future research could design intervention programs and analyse the impact of such intervention programmes on injury reduction strategies.

The comparatively compact data collection period and the rotation of players in and out of the national squad are limitations of this paper as this produces a small number from a single "team". An additional limitation was not being able to collect data on injuries sustained during club training and fixtures just prior to national Team duty. This is an issue in many countries where there is often a conflict between the needs of professional football clubs and the national associations. The clubs own the player's contracts and pay their salaries.

Consequently the clubs are concerned about players getting new, or worsening existing, injuries when attending national team gatherings. The national teams, on the other hand, want the best players to be able to participate and to be at the peak of their performance. FIFA and UEFA have tried to resolve this by introducing international weeks during which all national teams have the right to play matches and the participation of selected players is mandatory unless they have injuries. In Saudi, however, the majority of national team players play in the Saudi National League, thereby making it possible to gather the players for more national team training sessions throughout the year. Moreover, the geographical proximity and the good connection contact between the clubs and the national team medical staff are advantageous for the clinical management and tracking of national team players.

4.4.5. Conclusion

The present study is the first injury epidemiological study performed in Saudi Arabia with reference to the national team. This chapter highlights a higher injury incidence during national team exposure compared to when playing and training in the Saudi Premier League. Further, the data confirms the higher injury incidence during match-play compared to training observed in this thesis and in other studies. Data patterns (severity, type, location etc.) also confirm previous studies and the analysis of Saudi Premier League players earlier in the thesis.

CHAPTER 5. This study: The incidence and nature of injuries sustained on grass and 3rd generation artificial turf: A pilot study in elite Saudi National Team football is published in Physical Therapy in Sport.

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Chapter 6. The impact of a lower limb, dynamic balance intervention programme during pre-season training on injuries in Saudi Premier League footballers: A preliminary feasibility study.

6.1. Introduction

In the current thesis we have described football injury data for Saudi Premier League and Saudi national team footballers as well as looking at the influence of factors such as training/game, environmental conditions and playing surface upon injury incidence. Consistently, within our data is the observation of the lower limb as the most common site of injury in Saudi footballers and this confirms data from other countries (e.g. Drawer and Fuller, 2002). Likewise soft tissue injuries (muscle, tendon, ligaments) were more common than other injury categories. Many lower limb soft tissue injuries included ligament and muscle damage to the knee, lower leg and ankle. When injury patterns emerge it is, perhaps, pertinent to consider if the occurrence and burden of these injuries could be reduced.

The focus of the thesis to this point has been to describe injury patterns and occurrence facing the athlete and medical support staff associated with professional football in Saudi Arabia. The insight into these patterns permit the development and evaluation of strategies and/or interventions that have the potential to reduce the incidence of specific injuries. To this end, sports medicine staffs have developed interventions such as strengthening exercises to correct muscle imbalances, stretching exercises to increase flexibility/decrease muscle stiffness, and balance programs to promote proprioceptive ability (Caraffa et al., 1996; Askling et al., 2003; Malliou et al., 2004; Gioftsidou & Malliou, 2006).

Balance exercise programs that improve proprioception are commonly employed during rehabilitation from injury (Hale, et al. 2007), to promote recovery and reduce the risk of re-

injury (Herrington, et al. 2009). The use of such interventions to prevent injury in healthy groups is a logical development of this work (Hoffman & Payne, 1995; Hrysomallis, 2007; McHugh et al., 2007). Many groups have promoted the use of balance training in an athlete's daily training (Bahr et al., 1997; Caraffa, et al., 1996; Wedderkopp et al., 1999; Soderman, et al., 2000; Malliou, et al., 2004; Gioftsidou, et al., 2006). There are a few empirical studies that have suggested that balance training may reduce musculoskeletal injuries (Caraffa, et al., 1996; Wedderkopp, et al., 1999). Caraffa, et al. (1996) prospectively studied the impact of a 6 week (3 times per week) balance-training program on ACL injuries in 600 soccer players. The training group (n=300) performed a balance-intervention program of gradually increasing difficulty and reported a significant reduction in injuries compared to the control group. Wedderkopp, et al. (1999) also reported a decrease in lower limb injury frequency after the application of a balance board training programme in healthy female handball players.

To the best of our knowledge there is limited evidence of the efficacy of balance training interventions on broader (than just ACL) sports injury incidence in professional footballers and no data associated with the ongoing data basing of football injuries in the Saudi Premier League. Given the data patterns from the previous descriptive studies (chapters 3-5), e.g. the predominance of lower limb soft tissue injuries, the aim of the current preliminary (pilot) study was to determine the feasibility and effect of progressive lower limb, dynamic balance training programme on injury incidence in Saudi professional Premier League footballers. The hypotheses of this study are:1) the intervention program will reduce the reported injuries in players in the premier league, and 2) reported injury incidence will be higher at match level compared to training.

6.2. Methods

6.2.1. Participants

We recruited, by direct invitation, 4 Saudi Premier League clubs to take part in this study. Data collection took place over two distinct periods in all four clubs. A preliminary baseline injury data collection took place over 2 seasons and involved 127 players at the 4 clubs (in line with chapter 3). For the intervention phase the same 4 clubs were followed prospectively for a single season immediately after the intervention (2 clubs) or control-normal pre-season training (2 clubs) and involved 135 players at the 4 clubs. Descriptive data for the professional players at baseline were age (mean±SD) 30.6 ±4.3 yr; height 170.7±3.3 m; weight 69.9±11.0 kg; body mass index 21.0±5.5 kg.m2, (Intervention Group: age (mean±SD) 30.7±4.4; height 170.8±3.1; weight 70.0±11.0 kg; body mass index 21.1±5.55 kg.m2; Control Group: age (mean±SD) 27.6±4.0; height 177.6±3.0; weight 70.0±11.0 kg; body mass index 21.1±5.55 kg.m2) These parameters were not different in the players in the intervention group and control group. Nor did demographic data change markedly after the intervention or control period (age 30.5±4.4 yr; height 170.8 ±2.9 cm; weight 71.0±11.0 kg; and body mass index 24.8 ±11.7 kg.m2). This is largely due to the fact that many players were studied at baseline and after the intervention which was a relatively short period of time to reflect any differences. All players gave written informed consent. The Saudi Premier League, Saudi FA and individual clubs provided gatekeeper agreement to complete the study. Local institutional ethics approval was also obtained prior to the study. The only inclusion criterion was selection of the player to a club's squad for a competitive season.

6 2.2. Design

Injury data collection, using standard procedures (see Chapters 3-5) occurred in all players in all 4 clubs for two seasons. This data constituted the baseline data collection for this study. At the end of the baseline data collection the 4 Premier League clubs were then randomly allocated to an intervention arm (3 week lower limb balance training and normal pre-season training) and a control arm (normal pre-season training). All 4 clubs then collected injury incidence data for the remainder of the 2012/13 season using standard recording procedures.

6.2.3. Injury and exposure data collection

The Medical Assessment and Research Centre of FIFA (F-MARC) support the use of standard player information, injury reporting and exposure tools and these were adopted for the current study (Fuller et al., 2006).

Data were collected by medical staff located within each of the 4 professional clubs on a daily basis. Information was recorded and coded in relation to a number of injury characteristics as described by Fuller et al. (2006). Full details are provided in Chapter 3.

Over the entire study period training and match-play exposure were recorded by medical staff as noted in Chapter 3. Match play exposure included all Saudi Premier League games, all Saudi Cup matches, Asian competition games and practice/warm-up matches.

6.2.4. Intervention

We designed a short-term training intervention of progressive, dynamic single-leg balance training (see Table 1). This has direct application to a number of sporting and clinical scenarios when working with athletes (e.g. pre-season training). Evidence suggests that as little as 2-4 weeks of static and dynamic balance training significantly improved static balance performance in subjects with functionally unstable ankles (Rozzi et al., 1999) or normal healthy athletes (Rasool and George, 2007). This provided a scientific rationale and

allowed sensitivity to individual rates of change. Although both legs were trained during the intervention we assessed only the dominant leg during pre and post-intervention balance tests. The balance groups performed a range of manoeuvres that progressed from simple static balance exercises to more complex and challenging dynamic balance exercises. Progression was developed individually by performing balance exercises with eyes open and closed on a solid gym floor and soft surfaces (thick gym mat) and with a range of contra-lateral limb and trunk movements performed whilst in a single-leg balance position (Table 6.1. Rasool and George, 2007). The balance group performed the exercises 3 days a week for 3 weeks commencing each workout with a 10 min general cardiovascular warm-up. All training was organized in group sessions in the gymnasium at each club and completed an initial training programme. All club medical and training staff performed an initial development programme with the lead author to familiarize all staff with the progressive exercises available, the nature and timing of progression on an individual basis and how balance was assessed.

This overload process was adopted and adapted from a previous paper in Saudi subjects undertaken by a Saudi investigator that had resulted in change in performance – suggesting that overload had been applied and had worked (Rasool and George, 2007). This provided a scientific rationale and allowed sensitivity to individual rates of change. The test used, SEBT, seemed to be popular and well known in Saudi physiotherapy. It is easy to use, standardise and apply to the athlete group. All club medical staff were familiar with the test and reported no problems with athlete testing as well as good compliance with the balance training programme.

Table 6.1.Progression details for the dynamic single-leg balance training.

Floor	Eyes	Exercise
Gymnasium floor	Open	60s exercise trial in single-leg balance position. The contra-lateral leg was held in a relaxed position with minor knee and hip flexion by the side of the test leg. Five trails with 30s rest in between trials.
Gymnasium floor Soft gymnasium mat Soft gymnasium mat	Closed Open Closed	Same Same Same
Gymnasium floor	Open	60s exercise trial in single-leg balance position. The contra-lateral leg held in a comfortable relaxed position with minor knee and hip flexion. The trunk was then rotated smoothly to the end of range in both directions. Five trials with 30s rest in between trials.
Gymnasium floor Soft gymnasium mat Soft gymnasium mat	Closed Open Closed	Same Same Same
Gymnasium floor	Open	60s exercise trial in single-leg balance position. The contra-lateral leg held in 90° hip and knee flexion. The trunk is then rotated smoothly to the end of range in both directions. Five trials with 30s rest in between trials.
Gymnasium floor Soft gymnasium mat Soft gymnasium mat	Closed Open Closed	Same Same Same

Although the intervention was performed in only two clubs we assessed balance performance over the same period in all players in both the intervention and control clubs. We employed the Star Excursion Balance Test (SEBT; Hertel et al., 2000) as a validated measure of dynamic balance ability which, unlike force plates or electronically controlled balance platforms, is a simple and highly portable test that can be employed in a range of sporting and clinical environments. The SEBT was completed by all players before and immediately after the intervention (or control) period. The SEBT test was performed under standard conditions; in a quiet, well illuminated and well ventilated room inside each club. The SEBT was performed on a solid floor. The subject stood barefoot at the centre of a grid laid on the floor with 8 lines extending at 45° increments from the centre of the grid. The 8 lines positioned on the grid were labelled according to the direction of excursion relative to the stance leg: antero-lateral, anterior, antero-medial, medial, postero-medial, posterior, postero-lateral and lateral (**see Figure 6.1**.). A verbal and visual demonstration of the testing procedure was given to each subject by the examiner. Each subject performed six training trails on all lines. Subjects were asked to maintain a single-leg stance while reaching with the contra lateral leg to touch as far as possible along the chosen line. Subjects then returned to a bilateral stance while maintaining their equilibrium. The point touched along the line was marked and then the distance in cm from the centre of the grid was manually measured. Three reaches in each direction were recorded and 1-min rest between reaches was allowed. The average of the three reaches for each leg in each direction was taken. The direction of each excursion tested was counter-balanced to control any learning effect. Trials were discarded and repeated if the subject did not touch the line with the reach foot while maintaining weight bearing on the stance leg, lifted the stance foot from the centre of the grid, lost balance at any point or did not maintain start and return positions for one full

second (Rasool and George, 2007). Test re-test reliability data were not collected directly in this thesis but have been reported before as (ICC= 0.78–0.96), (Hertel et al., 2000).

Figure 6.1. A participant performing the lateral reach component of the Star Excursion Balance Test.

6.2.5. Data analysis

We collated data and reported, descriptively, the frequency of injuries as well as injury incidence per 1000 h of player exposure for training, match-play and total exposure in the control and intervention clubs at baseline and after the intervention period. Consequently, we cross-tabulated data for all injuries (training and match play combined) against; severity, location, type, recurrence, diagnosis and involvement of contact. Due to the quasi repeated measures design employed the assumption of independence of observations (players and injuries) could not be met; therefore, inferential statistics (e.g. chi-squared analyses) were not conducted in this study.

6.3. Results

6.3.1 Intervention

All players completed the intervention period and pre and post-intervention SEBT tests. Adherence to the intervention balance training was excellent as it was integrated into the clubs pre-season training programme, with a compliance rate of >90% reported at all clubs.

Neither of the control clubs instigated any specific balance training sessions during pre-season training. Group mean data for the SEBT was not different between control and intervention clubs before training. Despite excellent adherence and individual progression within the lower limb balance drills SEBT performance did not change with the training intervention. A non-significant and clinically meaningless increase in reach distance of c.1-2 cm in each direction was noted for both intervention and control clubs that probably reflected a small learning effect in all players, (**Figure 6.3.1**.).

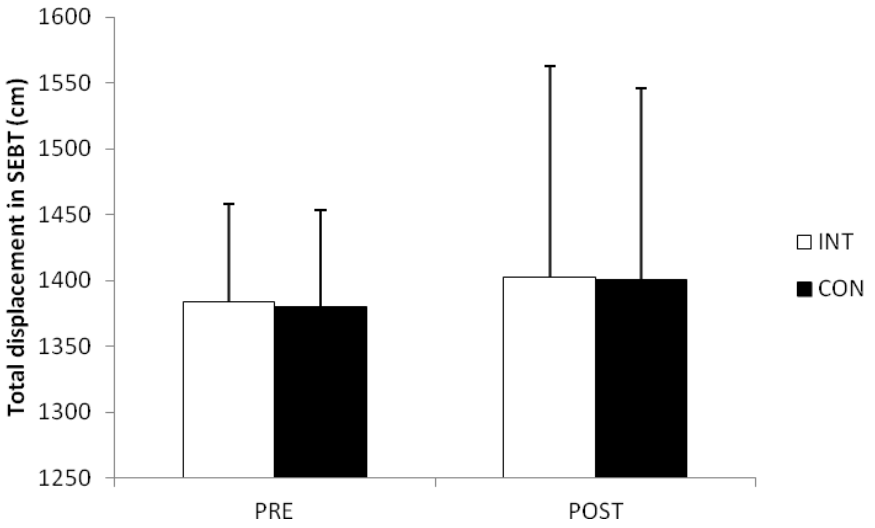

Figure 6.3.1 The SEBT overall performance change.

6.3.2. Exposure and Overall Injury Incidence:

Players' exposure, injury frequency and incidence for training, match and overall football play are presented in **Table 6.2**. Injury frequency was greater during training compared to game play as well as during baseline compared to follow-up data collection. The discrepancy in injury incidence and frequency between baseline and follow up was due to the difference in time frame of collecting data.

Specifically, injury incidence was much higher in match-play than training. The impact of the intervention on training, match-play and total injury incidence was small. Small decreases were noted for the intervention teams with small increases observed for the control teams. The differences, however, were generally smaller than any baseline difference between the control and intervention teams and likely (partially) represents random variation in such data and does not point unequivocally to a meaningful intervention effect. There are significant limitations to the use of inferential statistics. It is important to note that inferential statistics are only one way to interpret data and practical and ecological interpretation is also valid.

Table 6.2. Game, training and total football exposure, injury frequency and injury incidence in intervention and control clubs pre (baseline) and post (follow up) progressive lower limb balance training.

	INTERVENTION TEAMS		CONTROL TEAMS	
	PRE	**POST**	**PRE**	**POST**
Players (n)	63	70	64	65
Training sessions (n)	933	478	987	543
Training duration (min)	45	44	42	42
Training Exposure (min)	2 645 055	1 472 240	2 653 056	1 482 390
Training Injuries (n)	169	69	114	76
Injury Incidence (per 1000 h exposure)	3.8	2.8	2.6	3.1
Games(n)	185	96	187	93
Game Duration (min)	90	90	90	90
Total Game Exposure (min)	183 150	95 040	185 130	92 070
Game Injuries (n)	124	52	116	63
Injury Incidence (per 1000 h exposure)	40.0	32.5	37.4	41.8
Total Exposure (min)	2 828 205	1 567 280	2 838 186	1 574 460
Total Injury (n)	293	121	230	139
Injury Incidence (per 1000 h exposure)	6.2	4.6	4.9	5.3

6.3.3. Injury Severity:

The majority of injuries that occurred in both the intervention and control teams were at the lowest levels of severity and resulted in either no or minimal loss of football exposure time (**Table 6.3**). As injury severity increased the frequency and incidence declined. The change

in injury incidence post-intervention was generally small in both groups but varied to a small extent between injury severity categories.

Table 6.3. Frequency and incidence data for injury severity in intervention and control clubs pre (baseline) and post (follow up) progressive lower limb balance training.

Severity	**INTERVENTION**		**CONTROL**	
	PRE	**POST**	**PRE**	**POST**
None (0 days; n)	93	24	90	52
(per 1000 h exposure)	15.0	9.2	18.3	20.0
Slight (1-3 days; n)	104	50	87	53
(per 1000 h exposure)	16.8	19.2	17.7	20.3
Minor (4-7 days; n)	31	11	26	19
(per 1000 h exposure)	5.0	4.2	5.3	7.3
Major (8-28 days; n)	47	26	24	14
(per 1000 h exposure)	7.5	10.1	4.9	5.3
Severe (28+ days; n)	18	10	3	1
(per 1000 h exposure)	3.0	3.8	0.2	0.4

6.3.4. Injury Location:

Most injuries involved the lower body in the pre and post-intervention periods in both groups (**Table 6.4**). Any change, post-intervention, in incidence rate for any injury location was relatively small. For example in the intervention group, the incidence of lower body injuries increased in the post-intervention period from 40.1 to 46.0 but decreased for upper body injuries from 7.3 to 5.7.

Table 6.4. Frequency and incidence data for injury location in intervention and control clubs pre (baseline) and post (follow up) progressive lower limb balance training

Location	**INTERVENTION**		**CONTROL**	
	PRE	**POST**	**PRE**	**POST**
Lower Body Total (n)	248	106	182	103
(per 1000 h exposure)	40.1	46.0	37.1	39.6
Upper Body Total (n)	45	15	48	36
(per 1000 h exposure)	7.3	5.7	9.8	13.8

6.3.5. Injury Type:

Injury type categories were, by necessity, broad (**Table 6.5**). Muscle and tendon injuries were the most common injuries in both groups pre and post-intervention. The impact of the intervention was minimal in terms of injury incidence rates, although joint, non-bone and ligament injuries decreased from 11.0 injuries per 1000 h exposure to 6.9. Notably the incidence rate for muscle and tendon injuries was largely unaltered by the intervention process.

Table 6.5. Frequency and incidence data for injury type in intervention and control clubs pre (baseline) and post (follow up) progressive lower limb balance training.

Type	INTERVENTION		CONTROL	
	PRE	POST	PRE	POST
Joint, non-bone & Ligament/ (n)	68	18	53	23
(per 1000 h exposure)	11.0	6.9	10.8	8.8
Fractures and bone stress / (n)	-	1	7	1
(per 1000 h exposure)		0.4	1.4	0.4
Muscle and Tendon (n)	190	73	147	52
(per 1000 h exposure)	30.6	28.1	30.0	20.2
Contusions (n)	35	20	23	40
(per 1000 h exposure)	5.6	7.7	4.7	15.4
Lacerations and skin lesion (n)	-	-	-	6
(per 1000 h exposure)				2.3
Other (n)	-	9	-	17
(per 1000 h exposure)		3.4		6.5

6.3.6. Mechanism of injury

Most injuries (182 vs. 111) in the intervention group at baseline were overuse in nature. In the control group over the same period injuries were roughly split equally between overuse and trauma (**Table 6.6**). The impact of the intervention was small with incidence data staying relatively stable in both groups over the second data collection period.

Table 6.6. Frequency and incidence data for overuse and trauma injuries in intervention and control clubs pre (baseline) and post (follow up) progressive lower limb balance training.

Mechanism	**INTERVENTION**		**CONTROL**	
	PRE	**POST**	**PRE**	**POST**
Overuse (n)	182	80	118	65
(per 1000 h exposure)	29.3	30.7	24.0	25.1
Trauma (n)	111	41	112	74
(per 1000 h exposure)	18.1	15.7	22.8	28.4

6.3.7. Recurrence of injury:

Whilst it is noteworthy that many injuries were such that an informed and accurate decision on recurrence could not be made, more injuries were not recurrent when information was available in both groups (**Table 6.7**). The injury incidence data for each category were quite stable pre and post-intervention.

Table 6.7. Frequency and incidence data for injury recurrence in intervention and control clubs pre (baseline) and post (follow up) progressive lower limb balance training.

Recurrence	**INTERVENTION**		**CONTROL**	
	PRE	**POST**	**PRE**	**POST**
Yes (n)	29	21	56	37
(per 1000 h exposure)	4.7	8.0	11.4	14.2
No (n)	128	50	73	73
(per 1000 h exposure)	20.6	19.2	14.9	28.1
Unknown (n)	136	50	101	29
(per 1000 h exposure)	22.0	19.2	20.6	11.2

6.3.8. Contact vs. Non-contact injuries:

The frequency and incidence of contact and non-contact injuries in both groups are presented in **Table 6.7**. Slightly more non-contact injuries were recorded in both groups pre- and post-intervention. Again incidence data changed only to a small extent from baseline to post-intervention periods. For example there was a slight drop for contact injuries (21.7 to 15.3 per 1000 h) and a small increase for non-contact injuries (25.5 to 31.1 per 1000 h) in the intervention group.

Table 6.8. Frequency and incidence data for contact & non-contact injuries in intervention and control clubs pre (baseline) and post (follow up) progressive lower limb balance training.

Contact	**INTERVENTION**		**CONTROL**	
	PRE	**POST**	**PRE**	**POST**
Yes (n)	135	40	105	60
(per 1000 h exposure)	21.7	15.3	21.4	23.0
No (n)	158	81	125	79
(per 1000 h exposure)	25.5	31.1	25.5	30.3

6.4. Discussion

Within this feasibility intervention study (which was simple, low cost and practical) we investigated whether a short-term (3 weeks) lower limb dynamic balance intervention programme in professional football players would impact overall injury incidence data in the Saudi Arabian Premier League.

The key findings were; a) the intervention was easily administered and was completed with excellent compliance within the chosen football clubs during pre-season training, b) the impact upon injury incidence in training and match-play was small and any reduction in injury incidence was likely within study-study limits of normal variation in injury data, c) sub-components of injury data (e.g. severity) were only marginally and not consistently

altered by the intervention. This feasibility study shared some of the common components of injury prevention programs recommended by FIFA.

If we take this conservative interpretation of all data sets, minimal changes in injury incidence with the lower limb balance training intervention, then two questions arise. Firstly is this consistent with available comparative data where intervention programmes have been adopted in an attempt to reduce injury? Secondly, why did the intervention not work? We have alluded to the fact that there are few intervention-based studies in professional footballers (and in Saudi Arabia in particular) but there are some investigations worthy of comparison.

Some of the main factors that helped the primary investigator to conduct this study were the strong and consistent support from the clubs management, fitness trainers and physiotherapists, to the running and completion of this intervention was a key to the relative success of the application, uptake and adherence to the programme. Since the intervention programme was aimed at injury reduction, it is likely to be an incentive for clubs to take part and a motivator to the players to conform, progress and adhere to the programme. Novelty may have been important as well as it was recorded that this was the first specific injury-intervention used by the clubs with an aim to help players avoid injuries. The success of the application of the programme and the reception of the players suggest that other targeted interventions could be adopted in Saudi Arabian Premier League football clubs with some success.

It is important to mention that the use of a more sensitive outcome measurement or tool might be worth investigating. Although SEBT scores have been shown to improve with balance training in some studies (Rasool and George, 2007) other outcome measures like forceplate or balance board indices may be more sensitive and responsive to interventions. Indeed, a key facet in the lack of any meaningful effect of the intervention on injury incidence could relate to the fact that data for the SEBT test did not change markedly after the 3 week intervention period. Whilst some have reported rapid changes in balance ability with training interventions (Rasool and George, 2007) specific aspects of the intervention and testing may partially explain the lack of change in SEBT scores and injury incidence. Specifically, the slow speed during the execution of the injury prevention programme and the SEBT testing may not reflect possible improvements seen during more dynamic movements observed in football training and match play due to the concept of training specificity (Vescovi & Van Heest, 2010). It is also possible to question the ecological validity of the SEBT and training programme with respect to highly dynamic football players and the movement/control patterns used during play.

Despite the relative success, from a feasibility perspective, of the lower-limb balance training, there were only small changes in injury incidence between the pre-and post-intervention data collection period for most categories of injuries. For example the overall injury incidence data in the intervention clubs was 6.2 and 4.6 per 1000 h of player exposure, before and after the intervention respectively. This contrasts with incidence rates of 4.9 and 5.3 per 1000 h of exposure in the control clubs. The small drop in the overall injury incidence data in the intervention clubs reflected similar and small changes in both the training and match-play injury incidence data. The meaningfulness and interpretation of such small changes are difficult to deduce in a limited (sample size and scope) feasibility study. A

drop of 1.6 injuries per 1000 h of exposure would equate to a total reduction in injury frequency of c.40 injuries over the period of a single season exposure (based on current data from the Saudi Premier League clubs studied). Clearly this drop in incidence and total number of injuries is positive in the sense of player health and the draw on medical services at any given football club but the full interpretation, extrapolation and validity of these changes (reflecting only the intervention) must consider the potential variability in this type of data. For example, the control clubs had a lower injury incidence during the pre-intervention data collection period. This difference 6.2 to 4.9 is almost as large as the change in the intervention group. This lower figure in the control clubs occurred despite the fact that the clubs had similar player numbers, similar exposure time, played in the same competitive league and had very compatible medical service support and injury reporting mechanisms. This suggests that "natural" variability in overall injury data may be as large as the impact of the intervention and as such we must interpret the impact of the intervention cautiously and follow-up with further research. Finally, in terms of other input to the interpretation process, we cannot determine if the change in injury incidence between the intervention and control clubs is statistically significant because of the inability, with this data, to run inferential statistics. Some of the anticipated limitation to this study was the short period of time and small number of studied clubs.

If we move onto the injury incidence data for specific sub categories (e.g. severity, location, type etc.) a similar pattern emerges. There are small and often inconsistent changes in injury incidence between the pre- and post-intervention data collection in both arms of the feasibility trial. There are occasional categories where a drop in injury incidence occurs in the intervention group; for example a reduction from 11.0 to 6.9 joint/non-bone/ligament injuries per 1000 h of exposure. There are, however, other examples where incidence rates

increased somewhat in the intervention clubs; for example the incidence of contusions increased from 5.6 to 7.7 per 1000 h of exposure after the intervention period. Also of some interest was the drop, post-intervention, in the incidence of the least serious injury category (no loss of playing/training time) that changed from 15.0 to 9.2 per 1000 h exposure. Taken together, with the inherent variability of football injury data (year-to-year and club-to-club) as well as the lack of consistency in categories and study groups, there is no overwhelming evidence from our data to suggest a real or meaningful decrease in injury incidence in the current study.

In contrast to the current study, Chong et al. (2001) applied a balance training program in healthy people using the balance board approach (3 times per week for 4 weeks) and at the end of the program the participants had improved their balance ability. Rasool and George (2007) mentioned that assessing the effect of strength training using elastic band on ankle dynamic stability and by examining the effect of balance and strength training for longer time (6 weeks vs. 4 weeks), in healthy male athletes, which improve the dynamic stability_.These findings can defend the argument of the short time period of the intervention.

Gioftsidou et al. (2012) also reported improved balance in soccer players irrespective of the frequency of their training intervention. Finally, Steffen et al. (2013) reported that a 20 min neuromuscular injury prevention warm-up programme improved dynamic and functional balance performance among 13-18 year-old female football players. Taken together these findings are important for the promotion, acceptance and adoption of intervention programs based around balance training, The outcomes are, however, at odds with the outcome of the current study on balance ability.

Why the current study resulted in no meaningful improvement in balance ability (despite similar training intervention times and sporting background compared to past literature) is not immediately obvious or easy to deduce. The lack of change could reflect differences in the intensity or difficulty of the exercises, the speed of progression of the intervention and/or the potential for high baseline ability (ceiling effect) of professional football players who engage in complex balance movements during training and playing. Likewise the slow speed adopted during the execution of the injury prevention programme and the SEBT testing may not reflect possible improvements seen during more dynamic movements observed in football training and match play due to the concept of training specificity (Vescovi & Van Heest, 2010). Consequently it is possible to question the ecological validity of the SEBT and training programme in respect to highly dynamic football players and the movement/control patterns used during play. Alternatively, the use of a more sensitive outcome measurement or tool might be worth investigating. Although SEBT scores have been shown to improve with balance training in some studies (Rasool and George, 2007) other outcome measures such as forceplate or balance board indices may be more sensitive and responsive to interventions.

Taken together these factors likely contributed to reduce the impact of the intervention in the current setting. This would suggest that a much more aggressive intervention, possibly over a longer timescale, with the incorporation of more dynamic and ecologically valid movements may be worthwhile. It might be worth to deeply investigate the design of such intervention program taking into consideration a group of factors. These factors may include the cultural lifestyle and beliefs, environmental conditions, training plans of clubs and national teams, gender and application and/or adherence to the intervention program from two prospective; the medical /fitness team as well as the athlete. The fact that there is a lack of studies that looked into these factors among Saudi footballers will provide starting points for more researchers to conduct further studies in this direction.

A limitation of this study was the small sample size, the short nature of the intervention, the limited time period post-intervention to collect injury data and the possible limitations of the SEBT test. The intensity and dynamic nature of any future intervention in elite football players should be reviewed as should the involvement of dynamic activities in the assessment process. Future studies may wish to extend the number of clubs and players recruited as well as the time period over which injury data is collected. Finally a combination of field (e.g. SEBT) and laboratory-based assessments of dynamic balance ability might be informative in future studies.

6.4.1. Conclusions

The findings from the current feasibility study demonstrate that intervention studies of this nature can be accomplished in a professional football setting and thus supports the idea of ongoing research into injury prevention. Despite this positive reflection on the feasibility of the training programme, the current intervention (3 weeks of progressive, lower-limb, dynamic balance training) did not produce a consistent or meaningful reduction in total injury incidence in professional football players. Further the impact on specific categories of football injuries (severity, location, type etc.) lacked a clear, consistent and positive reduction on injury incidence in Saudi professional footballers.

Chapter 7 SYNTHESIS OF FINDINGS

7.1. Introduction

The aim of this chapter is to combine the experimental findings from studies 1-4 and identify overarching issues for further discussion. This chapter will start with a brief recap on the key findings from each study and then will move to a broader discussion. The chapter will then focus on limitations and ideas for further research before concluding with an evaluation of the initial aims and objectives of the thesis.

7.2 Brief summary of key findings

The studies undertaken in this thesis were designed to investigate injury incidence in Saudi Arabian professional footballers and detail the injury load placed on medical support staff. Other aims of this investigation were to attempt to understand factors associated with injury (training vs. match exposure; artificial vs. natural turf etc.) as well as to design and implement an intervention targeted at reducing injury incidence in football. Before this could be undertaken, a robust and comprehensive method of accurately recording injuries and player exposure was designed and implemented.

Study 1 (Chapter 3) assessed the impact of training vs. match play on injury incidence in Saudi Arabian Premier League professional footballers. A secondary aim was to assess the relationship between environmental conditions and injury incidence. injury incidence rate was only 5.5 per 1000 h of exposure for training compared to 29.7 per 1000 h of exposure during match play. Higher injury incidence was observed during match play in hot and dry

weather conditions. The lowest injury incidence data were in hot and wet environmental conditions.

Study 2 (Chapter 4) determined the importance of player level on injury incidence by comparing prospective data collected in Saudi national team players over two seasons with data from the Saudi Premier League. We observed substantially higher levels of injury incidence in Saudi national team players during both training and match play and this was consistent for other facets of injury data (severity, type, location etc.). This higher incidence was apparent for national team players in both training (51.2 vs. 5.5) and match play (268.1 vs. 29.7) (per 1000 h of exposure) when compared to Premier League play.

Study 3 (Chapter 5) examined the incidence of injuries associated with playing football on 3G artificial turf compared with natural grass in the Saudi national football team competing at international tournaments in a quasi-repeated measures experimental design. The injury incidence rates were largely similar between surfaces with some evidence of slightly lower incidence data on 3G artificial surfaces.

Study 4 (Chapter 6) assessed the feasibility and effect of a short (3 week; pre-season) progressive lower limb, dynamic balance training intervention programme on injury incidence in Saudi professional male soccer players and may have been related to the lack of change in balance ability after the intervention.

7.3. Overarching discussion

7.3.1. *Methodological considerations*

At the time of conception of this thesis, the methods of collecting epidemiological data in professional football were many and varied, with no consensus as to definition of injury, the type of data to be collected and/or the methods for its collection. This was recognised by researchers from the Fédération Internationale de Football Association Medical Assessment and Research Centre (F-MARC). They suggested that variations in the definitions and methodologies across studies had created differences in the results and conclusions obtained from the data. A group of researchers recognised as the world's leading authorities in this field were therefore brought together with an aim to establish a consensus on definitions and methodology and implementation and reporting standards for investigations into the epidemiology of injuries in soccer. This culminated in the 2006 consensus statement, published by Fuller *et al.* (2006). The methods used in this thesis meet the various criterion outlined in this consensus statement. It could also be argued that the current studies extended the proposed strategies by collecting additional data such as the precise timing of individual exposure. As a result, we believe that the methods used throughout this thesis are amongst the most comprehensive and accurate records of injury that have been attempted in this research area, and clearly the most comprehensive in the Asian/Arab geographical region. These methods were, however, very time intensive and required first-hand attendance by the researcher (National Team) or support staff (Premier League) at all training sessions and attendance at all first team matches. This commitment is probably beyond the scope of the majority of medical staff investigating the incidence of injury at a single club. This may make them less appropriate for investigations that seek to investigate the incidence of injury in very specific locations. For that reason, we developed an on-line injury report form to be used by one of the medical staff in each club (physician or physiotherapist) taking into consideration a

simple, user friendly approach of this report form. Each one had a specific password and username and was followed/supervised by the primary investigator at regular intervals. In a few cases the investigator provided mobile internet devices for clubs that did not have direct access to the service. A trial period of four weeks was used to evaluate the consistency and feasibility of injury data collection at each club with support from the principal investigator, we trained the medical team in a clear and practical manner.

It is our belief that these methods could be rolled out by appropriate federations and/or clubs if staff and IT support are in place. This would provide rich and detailed injury data for internal and external comparison. Despite this we should note that a small by systematic difference may occur, even when using the same procedures, when multiple different staff are included in a range of clubs, teams who undertake a range of different roles etc. Diligence to all players, scenarios, injuries is tested much more in a club setting where potentially the medical staff have multiple roles to perform at the same time. The greater focus of the study author in the National Team situation should be noted but this again has logistical costs for any future studies.

7.3.2. The regional context

The primary overarching aim of this thesis was the detailed and accurate collection of football injury data in Saudi Arabia. This is something that had not been done before and had rarely been attempted and achieved in Asia. This focus had a specific emphasis on detailed injury load on Saudi sports medicine teams but was also predicated on the fact that there may be substantive regional or geographic differences in football injury incidence. For example

Yoon et al. 2004 suggested that the incidences of injuries in Asian football players was higher than that observed in European players, despite the fact that the pattern of type of injuries did not demonstrate major region-to-region differences. Other unique circumstances of international play may increase injury risk. Long periods of oversee travel, with concomitant issues such as jet lag (for example in Asian competitions travel to Japan or South Korea) may occur even in close proximity to Premier League games. The challenge of overcoming jet-lag and adapting to new climates may provide significant physical and psychological stress such that injury risk is increased. With respect to overall injury incidence in Professional Saudi footballers, the current thesis does not conclusively support the findings of Yoon et al. (2004). Whilst data from the Saudi Premier League support a comparable pattern of injury type and location to that reported by Yoon et al. (2004), the overall injury incidence was very similar to data reported in multiple European studies. This suggests a globalisation of multiple facets of the game that may contribute to similar injury data (training, competition, laws, coaching etc.). Of interest was the very high injury incidence reported in the Saudi national team players that was higher than data reported in the Premier League Players and greater than comparable data from other countries. Again as noted above, whether this reflected a "real" increase in injury risk and incidence at this elite player level or simply the overly detailed attention of a single dedicated member of the medical staff (who was also the author of this thesis) in this setting cannot be fully deduced.

The overarching conclusion from the 4 studies contained in this thesis is that whilst there still remains some local "unique" qualities of football in Saudi Arabia, not least the environmental stress, patterns of football injury are not substantially different to similar data sets completed around the globe. The presence of foreign players/coaches from different developed countries in the field of football will contribute to the development of professional culture among Saudi footballers.

7.3.3. Training vs. match-play

Data in all studies of this thesis clearly support the notion that injury risk is greater during match play than training. Study 1 confirmed that in Saudi Premier League players. The higher incidence of injury during international matches in the national team study (study 2) confirmed the trend in Premier League players as well as supporting previous studies (Ekstrand et al., 1983; Nielsen & Yde, 1989; Engstrom et al., 1990; Arnason et al., 1996; Walden et al., 2005a). The more focused studies in Chapter 5 (surface) and Chapter 6 (specifically the post-interevention data collection) again supported a greater injury risk during match play.

The reasons for the increased injury risk during match play have been discussed in various chapters and are largely intuitive. The key issue for Saudi medical support teams in professional football is to have more support and closer scrutiny of events during match play scenarios.

7.3.4. Other Facets of football injuries

Data for most injury categories (severity, location, etc.) where largely predictable, comparable between studies and supportive of past work (Walton et al., 2005). The bigger picture here is that football in Saudi Arabia doesn't represent a unique situation and risk for football injuries compared to most countries where professional football is played. Transfer of players, coaches, training, tactics, competitions, laws, rewards etc. truly reflect a "global" game and this means that the preparation and development of sports medicine staff in Saudi Arabian football can mirror those processes occurring elsewhere in the world.

In conclusion the data presented in this thesis are generally consistent with previous findings; (1) most injuries are minor with limited time lost to play or training (e.g. Junge et al., 2004), (2) injuries to the lower limb are more frequent (e.g. Drawer and Fuller, 2002), and (3) muscle injuries (e.g. contusions, strains) are the most common type of injury (e.g. Junge et al., 2004).

7.3.5 Other factors influencing injury incidence in football

There is limited data studying the direct changes in match-play environmental exposure on football injuries and we can only speculate as to why risk is enhanced in hot and dry environmental conditions as reported in Study 1. The combination of increased physiological and cognitive stress induced by the temperature rise and the harder pitch conditions when the weather is dry (as well as hot), likely represents a "perfect storm" for injury risk. Given the prevailing climactic conditions in Saudi Arabia, detailed knowledge and risk related to environmental and weather changes should be carefully monitored and recognised by sports medicine staff.

One might argue that a combination of hot and humid conditions would represent the greatest physiological and psychological stress to the players and consequently result in more injuries. Counter intuitively, hot and humid conditions resulted in a lower injury risk. We could speculate that represents an a-priori awareness of risk by coaches and players that then results in a change in tactical play patterns. Whether hot and humid conditions results in lower total activity and match analysis indices is worthy of specific study but may match anecdotal suggestions from coaches and players.

7.4. Limitations

It is acknowledged that study 1 (Chapter 3) was limited to only 6 professional football clubs in the Saudi Premier League and subsequent studies had smaller focus populations. It is acknowledged that studies employing limited numbers of clubs/players may lead to problems in the generalisation of the data as the specific circumstances that lead to the injury pattern observed at one club, country, surface or intervention may not be similar to that observed in other scenarios. This is a pertinent issue but the nature of the research questions, research design and logistical constraints within this these mean that optimal data collection was attempted in all specific studies.

It is also relevant to note that improved study control and consistency of injury recording, when a third party is charged with data collection is attained only after adequate training/familiarisation and pilot work (Twellaar et al., 1996). This could have influenced data in the current study (especially in relation to the Saudi Premier League data collection in studies 1 and 4) but every effort was made to prepare and train medical staff in the Saudi Premier League and make them cognisant of F-MARC guidelines.

Other aspects of specific studies can be developed. The preliminary study of the effects of environment and weather (Study 1) were quite insensitive (large temperature and humidity categorisations *a-posteriori*). Further work with detailed recording of temperature, humidity, wind and pitch hardness, also in combination with match analysis data, would be valuable. The study of pitch surface (Chapter 5) is clearly limited by small playing numbers and exposure time and should be followed up in this region with larger sample size and data collection periods.

7.5 Recommendations for future research

There are several potential areas of future research which have become apparent as a consequence of critically analysing the experimental chapters in this thesis. These are outlined briefly below:

7.5.1 *Setting up a FULL Saudi Premier League database with regard to injuries and exposure.*

If mandated by the Saudi FA it would be possible to recruit all clubs to complete an exhaustive longitudinal study using data collectors who share a common desire to produce research of the highest standards. Centralised training, preparation, logistical support and guidance would improve the validity and value of this data. This would produce a piece of epidemiological research of which the accuracy and wide ranging implications and value to Saudi football which has not been previously attempted.

7.5.2. *Environmental stress and concerns related to injury risk*

Saudi Arabia as a geographical region is large and presents various environmental stressors to professional football players that have already been alluded too. Greater detail of study related to temperature and humidity as well as pitch hardness during game and training exposure would be valuable to guide and support player preparation.

Saudi Arabia is a large country and when competing in Asia, players face significant stress from issues like jet-lag. Travel, fitness, physiological and cognitive function and their relation to injury risk are all worthy of on-going study.

Finally, Ramadan is a period of daylight abstention from liquid or solid nutrients. As sports continue to be scheduled, an understanding of the effects of Ramadan on Saudi athletes is warranted. The phase shift of food intake and disruption of sleep patterns affect actual and perceived physical performance. Saudi Islamic athletes need to explore strategies that will maximise performance during Ramadan.

7.6. Conclusions

Below are a brief summary and an overview of the aims for the thesis set out in the introduction.

Aim 1: To evaluate the incidence of injuries sustained by Saudi Premier League clubs over two consecutive competitive seasons (2010/11 and 2011/2012).

Chapter 3 evaluated the incidence, severity and nature of injuries in professional Saudi Arabian football players competing in the Saudi Premier League in 2010/11 and 2011/2012. We sought to compare injury data during training and competitive match play as well as assessing the impact of weather variation on match play injury data. Higher injury rates occurred during match play compared to training and higher environmental temperatures compared with low humidity (dry) was associated with higher injury incidence during match play. This aim was successfully achieved.

Aim 2: To evaluate the incidence, severity and aetiology of injuries in Saudi national football players.

Chapter 4 compared injury data in the Saudi national football team with data collected on professional Saudi Arabian football players (Premier League – Chapter 3) during training and competitive match play. Despite smaller numbers of players and lower levels of total exposure time in the national team injury incidence data was increased compared to Premier League players. The suggestion that playing level mediated injury incidence rates was supported but requires further study. This aim was successfully achieved.

Aim 3: To determine the impact of playing surface (3G artificial turf vs. natural grass) on injury incidence in Saudi national football team players.

Chapter 5 determined that overall injury incidence was similar when playing on both surfaces and if anything there was a trend in some injury categories for lower injury incidence when training and playing on 3G artificial turf. Other key findings were that most injuries were of the lowest level of severity requiring no absence from training and playing. This aim was successfully achieved.

Aim 4: To investigate the effect of progressive lower limb, dynamic balance training programme on injury incidence in Saudi professional male soccer players.

In Chapter 6 all players in the intervention "arm" completed a programme of progressive lower limb balance training during pre-season training and were compared to a control "arm". Despite excellent adherence and individual progression group mean data for balance ability was not different between control and intervention clubs and did not change with the training intervention. Injury incidence was only marginally influenced by the intervention. This study confirmed that injury incidence was higher during match play and that soft tissue injuries to the lower limb predominated, this aim was successfully achieved.

References.

Al-Hazzaa, H.., Almuzaini, K. and Al-Refaee, S. (2001). Aerobic and anaerobic power characteristics of Saudi elite football players. *Journal of Sports Medicine and Physical Fitness.* **41**, 54–61.

Andersen, M. and Williams, J. (1999). Athletic injury, psychosocial factors, and perceptual changes during stress. *Journal of Sports Sciences.* **17**, 735-741.

Andersen, T., Larsen, O., Tenga, A., Engebresten, L. and Bahr, R. (2004a). Video analysis of injuries and incidents in Norwegian professional football. *British Journal of Sports Medicine*, **38**, 626-631.

Andersen, T., Larsen, O., Tenga, A., Engebresten, L. and Bahr, R. (2004a). Video analysis of injuries and incidents in Norwegian professional football. *British Journal of Sports* Medicine. **38**, 626-631.

Aoki, H., Kohno, T., Fujiya, H., Kato H., Yatabe, K., Morikawa, T. and Seki. J. (2010). Incidence of injury among adolescent soccer players: a comparative study of artificial and natural grass turfs. *Clinical Journal of Sport Medicine.* **20**(1), 1-7.

Arnason, A., Andersen, T., Holme, I., Engebretsen, L. and Bahr, R. (2008). Prevention of hamstring strains in elite soccer: an intervention study. *Scandinavian Journal of Science and Medicine in Sports.* **18**, 40–48.

Árnason, Á., Gudmundsson, Á., Dahl, H.A. and Jóhannsson, E. (1996). Soccer injuries in Iceland. *Scandinavian Journal of Science and Medicine in Sports.* **6**, 40-45.

Árnason, A., Sigurdsson, S.B., Gudmundsson, A., Holme, I., Engebretsen, L. and Bahr, R. (2004a). Physical fitness, injuries, and team performance in soccer. *Medicine and Science in Sports and Exercise.* **36**, 278-285.

Árnason, A., Tenga, A., Engerbretsen, L. and Bahr, R. (2004c). A prospective video-based analysis of injury situations in elite male football: football incident analysis. *American Journal of Sports Medicine.* **32**, 1459-1465.

Askling, C., Karlsson, J. and Thorstensson, A. (2003). Hamstring injury occurrence in elite soccer players after preseason strength training with eccentric overload. *Scandinavian Journal of Medicine and Science in Sports.* **13**(4), 244-250.

Backous, D., Friedl, K., Smith, N., Parr, T. and Carpine, W.(1988). Soccer injuries and their relation to physical maturity. *the american journal of diseases of children*, **142**(8),839-42.

Backous. D., Friedl, K., Smith N., Parr, T. and Carpine, W. (1988). Soccer injuries and their relation to physical maturity. *American Journal of Disease of Children*, **142**, 839–842.

Bahr, R. & Holme, I. (2003). Risk factors for sports injuries-a methodological approach, review. *British Journal of Sports Medicine* **37,**384-392.

Bahr, R., Lian, O. and Bahr, A. (1997). A twofold reduction in the incidence of acute ankle sprains in volleyball after the introduction of an injury prevention program: a prospective cohort study. *Scandinavian Journal of Medicine and Science in Sports.* **7**(3), 172-177.

Baumhauer, J., Alosa ,D., Renstrom, P,, Trevino, S. and Beynnon ,B. (1995). A prospective study of ankle injury risk factors. *American Journal of Sports Medicine*,**23**(5),564–570.

Bayraktar, B., Dinç, C., Yücesir, I. and Evin, A. (2011). Injury evaluation of the Turkish national football team over six consecutive seasons. *Turkish Journal of Trauma & Emergency Surgery*. **17** (4),313-317.

Beynnon, B. , Renström, P., Alosa, D., Baumhauer, J. and Vacek, P. (2001). Ankle ligament injury risk factors: a prospective study of college athletes. *Journal of Orthopaedic Researc* ,**19**:213–220.

Bjordal, J., Arnły F., Hannestad B. and Strand, T. (1997). Epidemiology of anterior cruciate ligament injuries in soccer. *American Journal of Sports Medicine* ,**25**(3),341-5.

Bjørneboe J., Flørenes, T., Bahr, R. and Anderson, T. (2010). Injury surveillance in male professional football; is medical staff reporting complete and accurate? *Scandinavian Journal of Medicine and Science in Sports*, **5**,713-720.

Bjorneboe, J., Bahr, R. and Andersen, T. (2010). Risk of injury on thirdgeneration artificial turf in Norwegian professional football. *British Journal of Sports Medicine*, **44** (11), 794-8.

Boden, B., Kirkendall, D., and Garrett, W. (1998). Concussion incidence in elite college soccer players. *American Journal of Sports Medicine*, **26**, 238-241.

Brooks, J. and Fuller, C. (2006). The influence of methodological issues on the results and conclusions from epidemiological studies of sports injuries: illustrative examples. *Sports Medicine*, **36**(6), 459-72.

Caraffa, A., Cerulli, G., Projetti, M., Aisa, G. and Rizzo, A.(1996). Prevention of anterior cruciate ligament injuries in soccer. A prospective controlled study of proprioceptive training. *Knee Surg. Sports Traumatol, Arthrosc*, **4**(1),19-21.

Chin, M., Lo, Y., Li, C. and So, C. (1992). Physiological profiles of Hong Kong elite football players. *British Journal of Sports Medicine*, **26**, 262–266.

Chomiak, J., Junge, A., Peterson, L. and Dvorak, J. (2000). Severe injuries in football players: Influencing factors. *American Journal of Sports Medicine*, **28**, 58-68.

Chong, R., Ambrose, A., Carzoli, J., Hardison, I. and Jacobson, B. (2001). Source of improvement in balance control after a training program for ankle proprioception. *Perceptual & Motor Skills*, **92**(1),265-72.

Chougle, A., Batty, P. and Hodgkinson, J. (2005). Audit of injuries in a premiership football squad over a 5-year period. *Journal of Sports Science and Medicine*, **4**, 211-213.

Cumps, E., Verhagen, E. and Meeuesen, R. (2007). Prospective epidemiological study of basketball injuries during one competitive season: Ankle sprains and overuse knee injuries. *Journal of Sports Science and Medicine*, **6**, 204-211.

Cumps, E., Verhagen, E., Annemans, L. and, Meeusen, R. (2008). Injury rate and socioeconomic costs resulting from sports injuries in Flanders: data derived from sports insurance statistics 2003. *British Journal of Sports Medicine,* **42**, 767- 772.

Dabebo, B., White, J. and George, K. (2004). A survey of flexibility training protocols and hamstring strains in professional football clubs in England. *British Journal of Sports Medicine*, **38**, 388-394.

De Loës, M. (1997). Exposure data. Why are they needed? *Sports Medicine,* **24**(3), 172-175.

Drawer, S. and Fuller, C.W. (2002). Evaluating the level of injury in English professional football using a risk based assessment process. *British Journal of Sports Medicine*, **36**, 446-451.

Dvorak J, Junge A, Grimm K. and Kirkendall D. (2007). Medical report from the 2006 FIFA World Cup Germany. *British Journal of Sports Medicine* ,**41**(9), 578–581.

Dvorak, J. and Junge, A. (2000). Football injuries and physical symptoms. A review of the literature. *American Journal of Sports Medicine* (Supp), **28**, S3-9.

Dvorak, J., Junge, A., Derman, W. and Schwellnus, M. (2011). Injuries and illnesses of football players during the 2010 FIFA World Cup. *British Journal of Sports Medicine,* **45**, 626-630.

Eirale, C., Hamilton, B., Bisciotti, G. Grantham, J.and Chalabi. H. (2010). Injury epidemiology in a national football team of the Middle East. *Scandinavian Journal of Science and Medicine in Sports*, **22**,3,323-329.

Ekstrand, J., Hägglund, M., Waldén, M.(2011). Epidemiology of muscle injuries in professional football (soccer). American Journal of Sports Medicine, 39,6,1226-32

Ekstrand J, Walde´n M, & Hagglund, M. (2004a) Risk for injury when playing in a national football team. Scandinavian Journal of Medicine and Science in Sports, **14**(1), 34-38.

Ekstrand J, Walde´n M, and Hagglund, M. (2004). A congested football calendar and the well-being of players. *British Journal of Sports Medicine* ,**38**,493–97.

Ekstrand, J. (1994b). Injury prevention. In *Football (Soccer).* B. Ekblom (ed.). London: *Blackwell Scientific Publications*, pp. 209-214.

Ekstrand, J. and Gillquist, J. (1982). The frequency of muscle tightness and injuries in soccer players. *American Journal of Sports Medicine*, **10**, 75-78.

Ekstrand, J. and Gillquist, J. (1983). The avoidability of soccer injuries. *International Journal of Sports Medicine,* **4**, 124-128.

Ekstrand, J. and Karlsson, J. (2003). The risk of injury in football. There is a need for a consensus about definition of injury and the design of studies. *Scandinavian Journal of Medicine and Science in Sports*, **13**, 147-149.

Ekstrand, J. and Nigg, B.M. (1989). Surface related injuries in soccer. *Sports Medicine,* **8**, 56-62.

Ekstrand, J. and Tropp, H. (1990). The incidence of ankle sprains in soccer. *Foot and Ankle,* **11**, 41-44.

Ekstrand, J., Gillquist, J. and Liliedahl, S. (1983a). Prevention of soccer injuries. Supervision by doctor and physiotherapist. *American Journal of Sports Medicine*, **11**, 116-120.

Ekstrand, J., Gillquist, J., Möller, M., Oberg, B. and Liljedahl, S. (1983b). Incidence of soccer injuries and their relation to training and team success. *American Journal of Sports Medicine*, **11**, 63-67.

Ekstrand, J., Hagglund, M. and Fuller, C. (2010). Comparison of injuries sustained on artificial turf and grass by male and female elite football players. *Scandinavian Journal of Medicine and Science in Sports*, **21**(6), 824-32.

Ekstrand, J., Timpka, T. and Hagglund, M. (2006). Risk of injury in elite football played on artificial turf versus natural grass: a prospective two-cohort study. *British Journal of Sports Medicine*, **40**(12), 975-80.

Engebretsen, A., Myklebust, G., Holme I., Engebretsen, L., and Bahr, R. (2008). Prevention of injuries among male soccer players: a prospective, randomized intervention study targeting players with previous injuries or reduced function. *American Journal of Sports Medicine* ,**36**(6), 1052–1060.

Engström, B. and Renström, P. (1998). How can injuries be prevented in the World Cup soccer athlete? *Clinics in Sports Medicine*, **17**, 755-768.

Engström, B., Forssblad, M., Johansson, C. and Tornkvist, H. (1990). Does a major knee injury definitely sideline an elite soccer player? *American Journal of Sports Medicine*, **18**, 101-105.

Engström, B., Johansson, C. and Törnvist, H. (1991). Soccer injuries among elite female players. *American Journal of Sports Medicine*, **19**, 372-375.

Federation de Internationale de Football Association (2010) September 19, 2010, http://www.fifa.com/

Ford, K.R., Manson, N.A., Evans, B.J., Myer, G.D, Gwin, R.C, Heidt, R.S Jr, Hewett, T.E.(2006). Comparison of in-shoe foot loading patterns on natural grass and synthetic turf. *Journal of Science and Medicine in Sport*.,9(**6**),433-40.

Fuller, C. (1995). Implications of health and safety legislation for the professional sportsperson. *British Journal of Sports Medicine*, **29**, 5-9.

Fuller, C. and Drawer, S. (2004). The application of risk management in sport. *Sports Medicine*, **34**, 349-356.

Fuller, C., Clarke, L. and Molloy, M. (2010). Risk of injury associated with rugby union played on artificial turf. *Journal of Sports Sciences*, **28**, 563-70.

Fuller, C., Dick, R., Corlette, J. and Schmalz, R. (2007a). Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players. Part 1: match injuries. *British Journal of Sports Medicine*, **41**, i20-26.

Fuller, C., Dick, R., Corlette, J. and Schmalz. R. (2007b). Comparison of the incidence, nature and cause of injuries sustained on grass and new generation artificial turf by male and female football players. Part 2: training injuries. *British Journal of Sports Medicine*, **41** (1 Suppl.), 27-32.

Fuller, C., Ekstrand, J., Junge, A. Andersen, T., Bahr, R., Dvorak, J., Hägglund, M., McCrory, P. and Meeuwisse, M. (2006). Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *British Journal of Sports Medicine*, **40**, 193-201.

Fuller, C., Junge, A. and Dvorak, J. (2004a). An assessment of football referees' decisions in incidents leading to player injuries. *American Journal of Sports Medicine*, **32**, 17-22.

Gioftsidou, A., Malliou, P., Pafis, G., Beneka, A., Godolias, G., Maganaris, C. (2006). The effects of soccer training and timing of balance training on balance ability. *The European Physical Journal - Applied Physics*, **96**,659-664.

Gioftsidou1,A., Malliou, P., Pafis, G., Beneka, A., Sapralis, K., Sofokleous, P., Kouli, O., Roka, S. and Godolias. G. . (2012). Balance training programs for soccer injuries prevention. *Journal of Human Sport & Exercise*, **7**, 3,639-647.

Giza, E., Mithöfer, K., Farrell, L., Zarins, B. and Gill, T. (2005). Injuries in women's professional soccer. *British Journal of Sports Medicine*, **39**, 212-216.

Goga, I. and Gongal, P. (2003). Severe soccer injuries in amateurs. *British Journal of Sports Medicine*, **37**, 498-501.

Goldman, E., Jones, D. (2010). Interventions for preventing hamstring injuries. Cochrane Database System Rev **20**, (1),CD006782.

Grantham, N. (2004). Sports Injury Bulletin – Soccer Injury Causes – Which Footballers Get Hurt Most Often, and What Can They Do To Prevent It? http://www.sportsinjurybulletin.com/archive/soccer-injuries.html. September 19, 2011,

Guttmann, A. (1994). Games and empires: Modern sports and cultural imperialism. New York: Columbia University Press.

Hagel, B., Fick, G., and Meeuwisse, W. (2003). Injury Risk in Men's Canada West University football. *American Journal of Epidemiology*, **1**,157(9),825-33

Hägglund M., Waldén M. and Ekstrand, J. (2003). Exposure and injury risk in Swedish elite football: a comparison between seasons 1982 and 2001. *Scandinavian Journal of Medicine and Science in Sports*, **13**, 364-370.

Hägglund, M., Waldén, M. and Ekstrand, J. (2005a). Injury incidence and distribution in elite football-a prospective study of the Danish and the Swedish top divisions. *Scandinavian Journal of Medicine and Science in Sports*, **15**, 21-28.

Hägglund, M., Waldén, M. and Ekstrand, J. (2006). Previous injury as a risk factor for injury in elite football: a prospective study over two consecutive seasons. *British Journal of Sports Medicine*, **40**, 767-772.

Hägglund, M., Waldén, M. and Ekstrand, J. (2007). Lower reinjury rate with a coach-controlled Rehabilitation program in amateur male soccer: A randomized controlled trial. *American Journal of Sports Medicine*, **35**, 1433-1442.

Hägglund, M., Waldén, M. and Ekstrand, J. (2009). UEFA injury study--an injury audit of European Championships 2006 to 2008. *British Journal of Sports Medicine*, **43**, 483-489.

Hagglund, M., Walden., M. Bahr, R. and Ekstrand, J. (2005). Methods for epidemiological study of injuries to professional football players: developing the UEFA model. *British Journal of Sports Medicine*, **39**, 340–346.

Hale S., Hertel, J., Olmsted-Kramer, L. (2007). The effect of a 4-week comprehensive rehabilitation program on postural control and lower extremity function in individuals with chronic ankle instability. *The Journal of orthopaedic and sports physical therapy*,**37**(6),303–311.

Hawkins, R. and Fuller, C. (1996). Risk assessment in professional football: an examination of accidents and incidents in the 1994 World Cup finals. *British Journal of Sports Medicine*, **30**, 165-170.

Hawkins, R. and Fuller, C. (1996). Risk assessment in professional football: an examination of accidents and incidents in the 1994 World Cup finals. *British Journal of Sports Medicine*, **30**, 165-170.

Hawkins, R. and Fuller, C. (1998a). An examination of the frequency and severity of injuries and incidents at three levels of professional football. *British Journal of Sports Medicine,* **32**, 326-332.

Hawkins, R. and Fuller, C. (1998b). A preliminary assessment of professional footballers' awareness of injury prevention strategies. *British Journal of Sports Medicine*, **32**, 140-142.

Hawkins, R. and Fuller, C. (1999). A prospective epidemiological study of injuries in four English professional football clubs. *British Journal of Sports Medicine,* **33**, 196-203.

Hawkins, R., Hulse, M., Wilkinson, C., Hodson, A. and Gibson M. (2001). The association football medical research programme: an audit of injuries in professional football. *British Journal of Sports Medicine,* **33**, 43-47.

Herrington, L., Hatcher, J., Hatcher, A.and McNicholas, M.(2009). A comparison of Star Excursion Balance Test reach distances between ACL deficient patients and asymptomatic controls. *Knee*,**16**(2),149–152.

Hertel, J., Miller, S. J., & Denegar, C. R. (2000). Intratester and intertester reliability during the Star Excursion Balance Tests.*Journal of Sport Rehabilitation*, **9**, 104–116.

Hoff, G. and Martin, T. (1986). Outdoor and indoor soccer: injuries among youth players. American *Journal of Sports Medicine*, **14**, 231-233.

Hoffman, M. and Payne, G. (1995). The effects of proprioceptive ankle disk training on healthy subjects. *The Journal of orthopaedic and sports physical therapy*, **21**(2),90-93.

Høy, K., Lindbiad, B., Terkelsen, C., Helleland, H. and Terkelsen, C. (1992). European soccer injuries. A prospective epidemiologic and socioeconomic study. *American Journal of Sports Medicine*, **20**, 318-322.

Hrysomallis, C. (2007). Relationship between balance ability, training and sports injury risk. *Sports Medicine*,**37**(6),547-556.

Inklaar, H. (1994a). Soccer injuries I: Incidence and severity. *Sports Medicine*, **18**, 55-73.

Inklaar, H. (1994b). Soccer injuries II: Aetiology and prevention. *Sports Medicine*, **18**, 81-91.

Inklaar, H. (1995). The epidemiology of soccer injuries in a new perspective. Thesis, University of Utrecht, Utrecht, The Netherlands.

Inklaar, H., Bol. E., Schmiki, S. and Mosterd, W. (1996). Injuries in male soccer players: team risk analysis. *International Journal of Sports Medicine*, **17**, 229-234.

Jacobson, I. and Tegner, Y. (2007). Injuries among Swedish female elite football players: a prospective population study. *Scandinavian Journal of Medicine and Science in Sports*, **17**, 184-191.

Junge, A. and Dvorak, J. (2000). Influence of definition and data collection on the incidence of injuries in football. *American Journal of Sports Medicine*, **28**, S40-46.

Junge, A. Langevoort, G., Pipe, A., Peytavin, A., Wong, F., Mountjoy, M., Beltrami, G., Terrell, R., Holzgraefe, M., Charles, R. and Dvorak, J. (2006). Injuries in team sport tournaments during the 2004 Olympic games. *American Journal of Sports Medicine*, **34**, 565-576.

Junge, A., Dvorak, J., Graf-Baumann, T. and Peterson, L. (2004b). Football injuries during FIFA tournaments and the Olympic Games, 1998-2001: development and implementation of an injury-reporting system. *American Journal of Sports Medicine*, **32**, 80-89.

Keller, C., Noyes, F. and Buncher, C. (1988). The medical aspects of soccer injury epidemiology. *American Journal of Sports Medicine* **16** ,105-12.

Le Gall F., Carling, C., Reilly, T., Vandewalle, H., Church, J. and Rochcongar, P. (2006). Incidence of injuries in elite French youth soccer players: a 10-season study. *American Journal of Sports Medicine*,**34**(6), 928–938.

Lee, A., & Galvez, J.C., (2012). Jet lag in athletes. Sports health, **4**(3):211-6

Levy, I. (1988). Formulation and sense of the NAIRS athletic injury surveillance system. *American Journal of Sports Medicine,* **16**, S132-133.

Lewin, G. (1989). The incidence of injury in an English professional soccer club during one competitive season. *Physiotherapy,* **10**, 601-605.

Lilley, K., Gass, E. and Locke, S. (2002), A retrospective injury analysis of state representative female soccer players. *Physical Therapy in Sport,* **3**, 2-9.

Lindenfeld, T., Noyes, F. and Marshall, M. (1988). Sports injury research: Components of injury reporting systems. *American Journal of Sports Medicine,* **16**, S69-80.

Lindenfeld, T., Schmitt, D ., Hendy, M., Mangine, R. and Noyes, F. (1994). Incidence of injury in indoor soccer. *American Journal of Sports Medicine,* **22**(3), 364-71.

Lüthje, P., Nurmi, I., Kataja, M., Belt, E., Helenius, P., Kaikonen, J.P., Kiviluoto, H., Kokko, E. and Lehtipuu, T. (1996). Epidemiology and traumatology of injuries in elite soccer: a prospective study in Finland. *Scandinavian Journal of Medicine and Science in Sports,* **6**, 180-185.

Malliou, P., Gioftsidou, A., Pafis, G., Beneka, A. and Godolias, G. (2004). Proprioceptive training (balance exercises) reduces lower extremity injuries in young soccer players. *Journal of Back and Musculoskeletal,* **17**, 101-104.

Marples M. (1954). A History of Football (Review), by Asa Briggs, pp. 69-70.

McGregor, J., Rae, A. and Melvin, W. (2000). A three year review of injuries to professional footballers (1995-98) and comparison with previous observations (1990-93). *Scottish Medical Journal*, **45**, 17- 19.

McHugh, M., Tyler, T., Mirabella, M., Mullaney, M. and Nicholas, S. (2007). The Effectiveness of a balance training intervention in reducing the incidence of noncontact ankle sprains in high school football players. *American Journal of Sports Medicine*. **35**(8), 1289-1294.

McMaster, W. and Walter, M. (1978). Injuries in soccer. American Journal of Sports Medicine, **6**, 354-357.

McSharry, P.E. (2007). Effect of altitude on physiological performance: a statistical analysis using results of international football games. British Medical Journal, 335, 7633, 1278-81.

Meeuwisse, W. (1994). Athletic injury etiology: Distinguishing between interaction and confounding. *Clinical Journal of Sport Medicine*; **4**, 171–5.

Meyers, M.C. and Barnhill, B.S.(2004). Incidence, causes, and severity of high school football injuries on FieldTurf versus natural grass: a 5-year prospective study. *American Journal of Sports Medicine*, **32**, 1626-1638.

Mohr, M,. Nybo, L. , Grantham, J. and Racinais, S. (2012). Physiological Responses and Physical Performance during Football in the Heat. *PLoS One*, **7**(6), e39202.

Morgan, B. and Oberlander, M. (2001). An Examination of Injuries in Major League Soccer. *American Journal of Sports Medicine*, **29** (4), 426-430.

Naunheim, R., Standeven. J., Richter, C. and Lewis L. (2000). Comparison of impact data in hockey, football, and soccer. *Journal of Trauma*, **48**, 938-941.

Nielsen, A. and Yde, J. (1989). Epidemiology and traumatology of injuries in soccer. *American Journal of Sports Medicine*, **17**, 803-807.

Nigg, B., and Segesser, B. (1988). The influence of playing surfaces on the load on the locomotor system and on football and tennis injuries. *Sports Medicine* ,**5** (6):375-85.

Norton, K., Schwerdt, S. and Lange, K. (2001). Evidence for the aetiology of injuries in Australian football. *British Journal of Sports Medicine,* **35**(6), 418-23.

Noyes, F., Lindenfeld, T. and Marshall, M. (1988). What determines an athletic injury (definition)? Who determines an injury (occurrence)? *American Journal of Sports Medicine,* **16**, 65-68.

Orava, S. (1980). Stress fractures. *British Journal of Sports Medicine*, **14**, 40-44.

Orchard J, Seward H, McGivern J, and Hood S. (1999). Rainfall, evaporation and the risk of non-contact anterior cruciate ligament injury in the Australian Football League. *Medical Journal Aust ralia*, **170**, 304-306.

Orchard, J. and Seward, H. (2001). Epidemiology of injuries in the Australian Football League, seasons 1997–2000. *British Journal of Sports Medicine,* **36**, 39-45.

Orchard, J.(2002). Is there a relationship between ground and climatic conditions and injuries in football? *Sport Medicine*, **32** (7), 419-32

Ostenberg, A. and Roos, H. (2000). Injury risk factors in female European football. A prospective study of 123 players during one season. *Scandinavian Journal of Medicine & Science in Sports,* **10**(5), 279-285.

Pafis, G., Gioftsidou, A., Malliou, P., Beneka, A., Ispirlidis, I. and Godolias, G. (2005). (Balance exercises) reduce lower extremity injuries in young soccer players. In: *Science and Football V*. T. Reilly, J. Cabri, D.Araújo (eds.). London: E. & F.N. Spon, pp. 310-315.

Parry, L. and Drust, B. **(**2006). Is injury the major cause of elite soccer players being unavailable to train and play during the competitive season? *Physical Therapy in Sport*, **7** , 58–64.

Peterson, L. Junge, A. and Chomiak, J. (2000). Incidents of Football Injuries and Complaints in Different Age Groups and Skill Level Groups. *American Journal of Sports Medicine,* **28** (5) 551-557.

Peterson, L., Junge, A., Chomiak, J., Graf-Baumann, T. and Dvorak, J. (2000). Incidence of football injuries and complaints in different age groups and skill-level groups. *American Journal of Sports Medicine,* **28**, S51-57.

Poulsen, T., Freund, K., Madsen, F. and Sandvej, K. (1991). Injuries in high-skilled and low-skilled soccer: A prospective study. *British Journal of Sports Medicine,* **25**, 151-153.

Putukian, M., Knowles, W., Swere, S. and Castle, N. (1996). Injuries in indoor soccer: the Lake Placid Dawn to Dark Soccer Tournament. *Is Journal of Sports Medicine,* **24**,317-322.

Rahnama, N., Reilly, T. and Lees, A. (2002). Injury risk associated with playing actions during competitive soccer. *British Journal of Sports Medicine,* **36**, 354-359.

Rasool, J. and George, K. (2007). The impact of single-leg dynamic balance training on dynamic stability, *Physical Therapy in Sport*, **8**, 177-184.

Reilly, T. and Gilbourne, D. (2003). Science and football: a review of applied research in the football codes. *Journal of Sports Science*.**21**(9),693-705.

Renstrom, P., Peterson, L. and Edberg, B. (1977). Valhalla artificial pitch at Gothenburg 1975–1977, a two-year evaluation. Sweden: Naturvardsverket.

Rozzi, S., Lephart, S., Sterner, R. and Kuligowski, L. (1999). Balance training for persons with functionally unstable ankles. *The Journal of orthopaedic and sports physical therapy* ,**29**(8),478-486.

Soderman, K., Werner, S., Pietila, T. and Engstrom, B., (2000). Alfredson H. Balance board training: prevention of traumatic injuries of the lower extremities in female soccer

players? A prospective randomized intervention study. *Knee surgery, sports traumatology, arthroscopy*,**8**,356-363.

Soligard, T., Bahr, R. and Andersen, T. (2010). Injury risk on artificial turf and grass in youth tournament football. *Scandinavian Journal of Medicine and Science in Sports*, **22**(3),356-61

Steffen, K., Andersen, T. and Bahr, R. (2007). Risk of injury on artificial turf and natural grass in young female football players. *British Journal of Sports Medicine*,**41** (1 Suppl.), 33-37.

Steffen, K., Emery, C.., Romiti, M., Kang, J., Bizzini, M., Dvorak, J., Finch, C.F. and Meeuwisse, W. (2013). High adherence to a neuromuscular injury prevention programme (FIFA 11+) improves functional balance and reduces injury risk in Canadian youth female football players:a cluster randomised trial. *British Journal of Sports Medicine*, **1**–10.

Taimla, S., Kujala, U. and Osterman, K. (1990). Intrinsic risk factors and athletic injuries. *Sports Medicine*, **9**, 205-215.

Tropp, H., Ekstrand, J. and Gillquist, J. (1984). Stabilometry in functional instability of the ankle and its value in predicting injury. *Medicine and Science in Sports and Exercise*, **16**, 64-66.

Tropp, H., Askling, C. and Gillquis,t. J. (1985). Prevention of ankle sprains. *American Journal of Sports Medicine* **13**, 259–262.

Tucker, A. (1997). Common soccer injuries. Diagnosis, treatment and rehabilitation. *Sports Medicine*, **23**, 21-32.

Twellaar, V., Verstappen, F. and Huson, A. (1996). Is prevention of sports injuries a realistic goal? A four-year prospective investigation of sports injuries among physical education students. *American Journal of Sports Medicine*, **24,** 528-534.

Van Mechelen, W. Hlobil, H. and Kemper, H. (1992). Incidence, severity, aetiology and prevention of sports injuries: a review of concepts. *Sports Medicine,* **14**, 92-99.

Volpi, P., Melegati, G., Tornese, D. and Bandi, M. (2004). Muscle strains in soccer: a five-year survey of an Italian major league team. *Knee Surgery, Sports Traumatology and Arthroscopy*, **12**, 482-485.

Waldén, M., Hagglund, M. and Ekstrand, J. (2004). UEFA Champions League study: a prospective study of injuries in professional football during the 2001–2002 seasons. *British Journal of Sports Medicine,* **39**,542–546.

Waldén, M., Hagglund, M. and Ekstrand, J. (2005a). Injuries in Swedish elite football – aprospective study on injury definitions ,risk for injury and injury pattern during 2001. *Scandinavian Journal of Medicine and Science in Sports,* **15**, 118–125.

Waldén, M., Hagglund, M. and Ekstrand, J. (2005b). UEFA Champions League study: a prospective study of injuries in professional football during the 2001–2002 season. *British Journal of Sports Medicine* ,**39**(8), 542–546.

Waldén, M., Hagglund, M. and Ekstrand, J. (2007). Football injuries during European Championship 2004–2005. *Knee Surgery, Sports Traumatology and rthroscopy* ,**15**(9),1155–1162.

Waldén, M., Hägglund, M., Orchard, J., Kristenson, K., Ekstrand, J. (2013). Regional differences in injury incidence in European professional football. *Scandinavian Journal of Medicine and Science in Sports,* **4**,:424-430.

Wedderkopp, N., Kaltoft, M., Lundgaard, B., Rosendah,l M. and Froberg, K. (1999). Prevention of injuries in young female players in European team handball. A prospective intervention study. *Scandinavian Journal of Medicine and Science in Sports* ,**9**,41-47.

Wekesa, M. (1995). A one-year prospective study of soccer injuries in the 1992-1993 Kenyon national team. *African Journal of Health and Science*, **2**, 392-394.

Williams, S., Hume, P. and Kara, S. (2011). A Review of Football Injuries on Third and Fourth Generation Artificial Turfs Compared with Natural Turf. *Sports Medicine*, **41**, 903-923.

Witvrouw, E., Danneels, L., Asselman, P., D'Have, T. and Cambier, D. (2003). Muscle flexibility as a risk factor for developing muscle injuries in male professional soccer players. A prospective study. *American Journal of Sports Medicine*, **31**, 41-46.

Woods, C., Hawkins, R., Hulse, M. and Hodson, A. (2002). The Football Association Medical Research Programme: an audit of injuries in professional football -analysis of preseason injuries. *British Journal of Sports Medicine*, **36**, 436-441.

Woods, C., Hawkins, R., Hulse, M. and Hodson, A. (2003). The Football Association Medical Research Programme: an audit of injuries in professional football -analysis of ankle sprains. *British Journal of Sports Medicine*, **37**, 233-238.

Woods, C., Hawkins, R., Maltby, S., Hulse, M., Thomas, A. and Hodson, A. (2004). The Football Association Medical Research Programme: an audit of injuries in professional football -analysis of hamstring injuries. *British Journal of Sports Medicine*, **38**, 36-41.

Yoon, Y., Chai, M. and Shin, D. (2004). Football injuries at Asian tournaments. *American Journal of Sports Medicine*, **32**, S36-42.

Appendices

i **Saudi Arabian Football Federation support letter.**

ii **Saudi National Team support letter.**

iii **Consent form studies 1,2 3 and 4 in Arabic.**

iv **Consent form studies 1,2 3 and 4 in English.**

V **Player's Baseline Information Form. Appendix 1.**

vi **Exposure Report Form. Appendix 2.**

vii **INJURY REPORT FOR Saudi Footballers, (Match). Appendix 3.**

viii **INJURY REPORT FOR Saudi Footballers, (training). Appendix 3.**

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x **Consent form study 6**

xi **Participation information sheet study 6**

KINGDOM OF SAUDI ARABIA
SAUDI ARABIAN FOOTBALL FEDERATION

المملكة العربية السعودية
الاتحاد العربي السعودي لكرة القدم

Ref. No. : .....
Date : 5 APRIL 2010
Enclosed : .....

الرقم : .....
التاريخ : .....
المرفقات : .....

To: Liverpool John Moores University.

Subject: Letter of Support for PhD student:

Almutawa, Mubarak Mohammad M

Dear Sir,

The Saudi Arabian Football Federation (SAFF) received a proposal submitted by Mr. Almutawa expressing his desire to conduct a project to collect data on sports injuries for the Saudi Footballers. The SAFF and its authorities are encouraging young Saudis to conduct such projects which will -at the end- assist the development process of the football industry in our country.

Therefore, the SAFF is pleased to support Mr. AlMutawa to facilitate his access to the national football teams as well as all the premier league clubs. Wishing the best of luck in his researches.

SAFF General Secretary

Faisal O. Al Abdulhadi

KINGDOM OF SAUDI ARABIA - Riyadh 11432 P.O.Box 5844
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المملكة العربية السعودية - الرياض ١١٤٣٢ - ص.ب : ٥٨٤٤
تلفون : ٤٨٢ ٢٢٤٠ سنترال - ٤٨٢ ١٣١٤ مباشر - فاكس : ٤٨٢ ١٢١٥ (٠١)
تلكس دولي : ٤٠٤٣٠٠ سافوتب إس جي - برقياً : كوره
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KINGDOM OF SAUDI ARABIA

SAUDI ARABIAN FOOTBALL FEDERATION

المملكة العربية السعودية

الاتحاد العربي السعودي لكرة القدم

Ref. No. : 3194/N/A

Date : 5-12-2010

Enclosed : —

الرقم :

التاريخ :

المرفقات :

To: Liverpool John Moores University

Subject: Letter of Support for PhD Student:

Al Mutawa, Mubarak Mohammad M.

Dear Sir,

The Saudi Arabian Football Federation (SAFF) would like to express our sincere gratitude for your cooperation with Mr. Al Mutawa who is pursuing his Higher Education at your University. He is contracted with our National Team. Also, he is currently collecting data on sports injuries on Saudi Footballers. SAFF and all the related bodies are encouraging young Saudi national to conduct such projects which will result in enhancing and developing the football industry in our country.

Therefore, SAFF is pleased to support Mr. Al Mutawa and to confirm that he is contracted with our national team; also, he has been given the authority to collect data on our national football teams. We wish all the best of luck in his researches.

With my best regards,

SAFF National Team Manager

Fahad Al Msaibeeh

KINGDOM OF SAUDI ARABIA - Riyadh 11432 P.O. Box 5844
Tel: 482 2240 Central - 482 1314 Direct - Fax: (01) 482 1215

المملكة العربية السعودية - الرياض ١١٤٣٢ - ص.ب: ٥٨٤٤
تلفون: ٤٨٢٢٢٤٠ سنترال - ٤٨٢ ١٣١٤ مباشر - فاكس : ٤٨٢ ١٢١٥ (٠١)

LIVERPOOL JOHN MOORES UNIVERSITY

CONSENT FORM

جامعة ليفربول جون موريس

استمارة قبول

التحليل المتوقع للإصابات الرياضية للاعبي كرة القدم المحترفين في المملكة العربية السعودية

مبارك المطوع، مدرسة العلوم الرياضية

1- أؤكد أنني قرأت وفهمت المعلومات المقدمة للدراسة أعلاه. وكانت لدي الفرصة لدراسة المعلومات وطرح الأسئلة والحصول على إجابة كافية عليها. [ ]

2- إنني أفهم أن مشاركتي طوعية وأنني حر في الانسحاب في أي وقت دون إبداء أي سبب وأن هذا لن يؤثر على حقوقي القانونية. [ ]

3- [ ] إنني أفهم أن أي معلومات شخصية يتم جمعها خلال الدراسة سيتم إغفالها وتظل سرية.

4- إنني أوافق على المشاركة في الدراسة أعلاه (يرجى تحديد نوع الدراسة أو التدخل المعين الذي تسعى للحصول عليه مثل مجموعة التركيز والمعاينة وبرنامج التدريب إذا كان ملائما)

للدراسات التي تشمل استخدام تسجيل المقابلات الشخصية المسموعة/ المرئية أو مجموعات التركيز ..إلخ أو إمكانية استخدام اقتباسات حرفية من المشاركين في النشرات أو العروض المستقبلية نرجو تضمين ما يلي:

5- إنني أفهم أن المقابلة الشخصية/ مجموعة التركيز سيتم تسجيلها بالصوت/ الصورة وأنا سعيد بالتقدم لها. [ ]

6- إنني أفهم أنه يمكن استخدام أجزاء من حوارنا شفهيا في النشرات أو العروض المستقبلية ولكن تلك الاقتباسات سيتم إغفالها. [ ]

التوقيع: التاريخ: اسم المشارك

التوقيع: التاريخ: اسم الباحث

التوقيع: التاريخ: اسم الشخص الحاصل على الموافقة (إذا كان غير الباحث)

ملحوظة:- عند إكمالها تكون نسخة واحدة للمشارك ونسخة واحدة للباحث.

LIVERPOOL JOHN MOORES UNIVERSITY

CONSENT FORM

Prospective Analysis of Sports Injuries in Professional Footballers in Saudi Arabia

Almutawa, Mubarak. School of sports sciences.

1. I confirm that I have read and understand the information provided for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and that this will not affect my legal rights. ☐
3. I understand that any personal information collected during the study will be anonymised and remain confidential ☐
4. I agree to take part in the above study ☐

Name of Participant	Date	Signature
Name of Researcher	Date	Signature
Name of Person taking consent	Date	Signature

(if different from researcher)

Note: When completed 1 copy for participant and 1 copy for researcher

Appendix 1

Player's Baseline Information Form

Team Name: B……. Team code No: 2525……..

Player's No.	Player's Name.	Playing position	Date of birth	Weight kg	Stature CM	Body Mass BMI kg	Dominant Leg (L/R/B)	previous injury

Goalkeeper **G.K** Defender, **DEF**., Midfielder **,M.F**, Forward, **F.W**, age as the start of season/year/tournament.
Left, Right, Bilateral

Appendix 2

Exposure Report Form No.. : Team Code

(for the documentation of individual players' exposures)

Date										
Training/match										
Player code no. Report the duration of training and match for each player (minutes)										

Appendix 3

INJURY REPORT FOR Saudi National Football Team

———/———/———Date———————/——————————Match———————————Team
———————e – mail———————Tel/Fax———————— physician, physiotherapist Name of the responsible

Please report;

All injuries (traumatic and overuse) caused by football **regardless** the consequences with respect to participation during training or match.

The information provided is for medical and research purposes and will be treated confidentially.

Player	Time	Location		Diagnosis		Severity	Circumstances		Consequences	
No.	minute of match	injured body part	code	type of injury	code	absence in days	contact	foul	referee's sanction	treatment
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯
							Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯	Yes ◯ No ◯

DEFINTIONS AND CODES

LOCATION OF INJRY

TRUNK

1. HEAD / Face
2. Neck / Cervical spine
3. Thoracic spine
4. Lumbar spine
5. Stemma / Ribs
6. Abdominal
7. Pelvis / Sacrum

UPPEREXTREMTY

11. Shoulder
12. Upper Arm
13. Elbow
14. Forearm
15. Wrist
16. Hand
17. Finger
18. Thumb

LOWER EXTREMITY

21. Hip
22. Groin
23. Thigh
24. Knee
25. lower leg
26. Achilles tendon
27. Ankle
28. Foot

CONSEQUENCES

29. Toe

DIAGNOSIS

1. Concussion with loss of consciousness
2. concussion without loss of consciousness
3. Fracture
4. Dislocation
5. Muscled fiber rupture
6. Tendon rupture
7. Ligamentus rupture with instability
8. Ligamentus rupture without instability
9 Lesion of meniscus without instability
10. Sprain
11. Strain
12. Contusion
13. Bursitis
14. Tendonitis
15. Laceration / Abrasion
16. Others

SEVERITY OF INJURY IN DAYS

Estimated duration of absence from training or play for example

0 = 0 bays

1 = 1 day

2 = 2 days

7 = 1 week

14 = 2 weeks

> 30 = more than 4 weeks

CORCUMSTANCES AND CONSEQUENCES

Contact with another or an object (expect ground)

Foul judgment of the player. Overt and hidden fouls

Referee's sanction of the foul that caused the injury

Treatment by a physician, physiotherapist or dentist (immediately or later)

INJURY REPORT FOR Saudi National Football Team

———/———/——— - -Date——————————/——————————————Training ——————————————Team
——————————e – mail——————————Tel/Fax—————————— physician, physiotherapist Name of the responsible

Please report;

All injuries (traumatic and overuse) caused by football **regardless** the consequences with respect to participation during training or match.

The information provided is for medical and research purposes and will be treated confidentially.

Player	**Time**	**Location**		**Diagnosis**		**Severity**	**Circumstances**		**Consequences**	
No.	**minute of match**	**injured body part**	**code**	**type of injury**	**code**	**absence in days**	**contact**	**foul**	**referee's sanction**	**treatment**
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○
							Yes ○ **No** ○	**Yes** ○ **No** ○	**Y**○ **N**○	**Yes** ○ **No** ○

DEFINTIONS AND CODES

LOCATION OF INJRY

TRUNK

1. HEAD / Face
2. Neck / Cervical spine
3. Thoracic spine
4. Lumbar spine
5. Stemma / Ribs
6. Abdominal
7. Pelvis / Sacrum

UPPEREXTREMTY

11. Shoulder
12. Upper Arm
13. Elbow
14. Forearm
15. Wrist
16. Hand
17. Finger
18. Thumb

LOWER EXTREMITY

21. Hip
22. Groin
23. Thigh
24. Knee
25. lower leg
26. Achilles tendon
27. Ankle
28. Foot

CONSEQUENCES

29. Toe

or an object (expect ground)

player. Overt and hidden fouls

Referee's sanction of the foul that caused the injury

Treatment by a physician, physiotherap

DIAGNOSIS

1. Concussion with loss of consciousness
2. concussion without loss of consciousness
3. Fracture
4. Dislocation
5. Muscled fiber rupture
6. Tendon rupture
7. Ligamentus rupture with instability
8. Ligamentus rupture without instability

9 Lesion of meniscus without

10. Sprain
11. Strain
12. Contusion
13. Bursitis
14. Tendonitis
15. Laceration / Abrasion
16. Others

SEVERITY OF INJURY

IN DAYS

Estimated duration of absence from training or play for example

0 = 0 bays

1 = 1 day

2 = 2 days

7 = 1 week

14 = 2 weeks

> 30 = more than 4 weeks

CORCUMSTANCES AND

Contact with another

Foul judgment of the