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Since 20 years the FIFA Medical Assessment and Research Centre (F-MARC) has focussed on the most important thing in sport and indeed in society – health.

The presented publication recognise the achievements of the F-MARC since its establishment in 1994. Under the leadership of chairman Professor Jiří Dvořák and head of research Professor Astrid Junge, F-MARC has conducted rigorous research studies that have benefited the development of our beautiful game. The results of scientific studies documented in 369 original publications by F-MARC offer many constructive answers to my original questions 20 years ago: what can medicine and science offer to improve the game of football and how can the frequency of football-related injuries be reduced at all levels of the game? It has been proven that injuries in football can be reduced by up to 50% if the complete warm-up programme “FIFA 11+” is practised on a regular basis. Research has also shown that playing football twice a week for 45 minutes is the best prevention tool for diseases such as high blood pressure, diabetes, obesity and others.

The power and popularity of football worldwide can be used to contribute to the improvement of public health, which has once again been well documented in studies connected to the “FIFA 11 for Health” programme, which has already been implemented in 20 countries and becoming a global health initiative of FIFA.

Now is the time for this research to be integrated into the daily lives of those in the football community and for us to fully benefit from the achievements of F-MARC within the 209 Member Associations of FIFA.

There can be no compromise in our focus on player’s health. I have no doubt that by combining our efforts, we can make an important contribution towards better health in football and society in general.

In my capacity as chairman of the FIFA Medical Committee, and together with members of our Medical Committee, I wholeheartedly congratulate to F-MARC, Prof Jiří Dvořák (Chairman) and Prof Astrid Junge (Head of Research) for presenting the update of all 369 scientific publications related to football. This publication gives an unique opportunity to further develop the spectacular evolution in the world of our sport for the good of more than 300 million football players.

This evolution started with our ambition to bring medicine into football, putting the various medical disciplines at the service of the health and the physical condition of our athletes. This led to the introduction of the Pre-Competition Medical Assessment as well as to various changes and amendments to the Law of the Game and the regulations of our competitions. We also introduced the “FIFA 11+” warm-up programme with the successful intention of drastically reducing the number of non-contact injuries.

Furthermore, we tackled the problem of sudden cardiac arrest on the pitch, introduced new regulations for cases of concussion, and proposed drinking and cooling breaks at matches played in high temperatures. We have already done so much, but we can still do even more. Indeed, we have seen that football itself can be a fantastic tool for improving health, and that is why, in our mind, “medicine for football” progressively became “Football for Health”.

Football, at all ages, can play a major role in the prevention and treatment of many illnesses, such as diabetes, hypertension, hypercholesterolemia, and others. With our “FIFA 11 for Health” programme, we have even gone a step further, giving advice to millions of children and youngsters, in more and more countries, to prevent illnesses and improve people’s general wellbeing.
1 Executive Summary

Football is the most popular sport worldwide with currently approximately 300 million players in 209 Member Associations. The Fédération Internationale de Football Association (FIFA) has, as the world football governing body, the responsibility to ensure the smooth running of its various competitions, and the development of the game for all age groups, at all levels of play, both sexes and all in the spirit of fair play.

Mindful that it also has the responsibility towards the players’ health, FIFA decided to play an active role in developing and supporting research on football medicine. In 1994 and upon the initiative of the current FIFA President, Joseph S. Blatter, the FIFA Medical Assessment and Research Centre (F-MARC) was established to reduce football injuries, and to promote football as a health enhancing leisure activity.

In 1994, epidemiological data related to football injury were sparse. Thus, F-MARC established an injury surveillance system at the 1998 FIFA World Cup France, which is now routinely implemented at all subsequent FIFA and Confederations competitions. At the same time epidemiological data for recreational football players was obtained in studies performed in the Czech Republic and Germany. The data revealed that each football player sustained on average 2.1 injuries per year, unrelated to the level of skills. Taking into account 300 million footballers worldwide, it was obvious to F-MARC that prevention is the way to go, however not only limited to the prevention of injuries but to all negative aspects occurring in relation to the game of football. “11” was used as synonym for prevention in football.

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11 steps to prevent sudden cardiac death

Following the tragic death of Marc Vivien Foé during the FIFA Confederations Cup 2003 France, FIFA has been fully committed to a programme of research, education and practical implementation to prevent and manage emergency cardiac arrest on the football field. The pre-competition medical assessment has been routinely implemented for all FIFA competitions. It has also been adapted for the routine examination within the Member Associations in accordance with the international accepted guidelines and recommendations. A clear protocol has been developed and applied for field of play for the recognition, response, resuscitation and the removal of the player under sudden cardiac arrest. FIFA has introduced and distributed the FIFA Medical Emergency Bag, including an automated electric defibrillator, to all 209 Member Associations. It has been reported that lives have been saved by using this equipment or as a result of educational courses provided by FIFA and/or the Member Associations.

FIFA 11+ to prevent injuries

The first injury prevention programme we developed consisted of ten evidence based and/or best practice exercises enhanced by the promotion of fair play. Thus, we called the programme the “FIFA 11”. The programme was subsequently further developed to be a complete warm-up programme focusing on the prevention of injuries: “FIFA 11+”. The programme has been tested in prospective controlled studies on female players in Norway, and on male players in California and Nigeria. All came to the same conclusion: if the programme is performed on a regular basis, injuries can be reduced by 30% while severe injuries can be reduced by 50%. Higher compliance with the programme results in less injuries. The simple conclusion is that injury prevention works but only if performed regularly. FIFA’s Member Associations have understood the power of the injury prevention programme, and many have implemented the programme to all clubs within their countries - to name but a few – Germany, Japan, Iran, Spain, Italy and others. The programme has since been introduced to more than 90 Member Associations, and the FIFA 11+ programme become an integrated part of all FIFA development courses. The programme has been also adapted for children and referees.
11 rules to prevent doping

Since the last prominent doping case, involving the most celebrated player Diego Maradona who tested positive for a prohibited substance during the 1994 FIFA World Cup, a stringent strategy has been developed and implemented by FIFA to prevent doping in football. This includes in and out-of-competition doping controls at the level of FIFA, Confederations and National Leagues as well as educational programmes for players, coaches, doctors and para-medical staff. FIFA supports and is compliant with the World Anti-Doping code improving the protocol of controls by developing the biological profile for individual football players. On average, approximately 30’000 doping controls are performed annually in football, revealing 0.4% positive findings (majority are so-called recreational drugs such as marijuana and cocaine) including 0.03% for performance enhancing substances such anabolic steroids. Although positive findings are rare, FIFA continues the fight against doping in football and sports in general, while being the first International Federation to implement the biological profile, by collecting blood and urine samples at the same time prior to and during the 2014 FIFA World Cup Brazil.

FIFA 11 for Health

Under the umbrella “Football for Health” the effects of recreational football for the prevention and the treatment of non-communicable diseases has been extensively studied involving children, mature women and ageing men. It revealed that playing football on a regular basis twice a week for 45 minutes has a positive impact on the health status, and could even be prescribed as a therapeutic procedure for a number of diseases such as high blood pressure, diabetes, child obesity and others. The results are based upon more than ten years of research work, including a collective effort of more than 150 researchers.

The “FIFA 11 for Health” programme is a football-based health-educational programme for school children. The programme is being promoted by prominent football players and has been successfully implemented in 20 countries. The programme is continuously being developed and is adapted towards the needs of the countries taking into consideration the social economic environment and the risk factors for diseases. It is intended that FIFA will introduce the programme to 100 Member Associations by 2019.

FIFA Medical Centres of Excellence

As part of the sustainable development of football medicine, 42 FIFA Medical Centres of Excellence for football players have been accredited around the world since 2005. The FIFA Medical Centres of Excellence, serving the needs of footballers at all levels of play, offering independent assessments including state-of-the-art treatment. Moreover, the centres have become an important part of the worldwide network for medical football doctors, physiotherapists and paramedical staff who deal with problems on a day-to-day basis with clubs and individual players.

Translation of Research into Education

While F-MARC has so far issued 369 original scientific publications in peer-reviewed journals, an additional future activities will be the education of medical personnel who cater for football players all around the world. A free E-learning platform will be launched on the 1 January 2016 offering information on all aspects of football medicine. The E-learning programme can be completed by passing the examination process or assessment tool, finally leading to a “FIFA Diploma in Football Medicine”. This way F-MARC’s concept of prevention will be disseminated around the world and support FIFA’s mission: ‘Develop the game, touch the world, built a better future.’

We sincerely thank FIFA and President J.S. Blatter for the unconditional support of our work, and the many engaged people who contributed to make F-MARC’s projects successful.

Prof Jiří Dvořák  
FIFA Chief Medical Officer  
Chairman F-MARC

Prof Astrid Junge  
Head of Research  
F-MARC
2 Epidemiology of Football Injury

2.1 Review of Literature

2.1.1 Football Injuries before 2000

What was known on football injuries

The ever-increasing number of active players, leading in turn to an increasing frequency of injury with the resulting cost for treatment and loss of playing time, made the need for an injury prevention programme evident. The Fédération Internationale de Football Association (FIFA), as the governing body of football, realised this need and decided to play an active role in developing and supporting research on football injuries. When F-MARC decided to address this problem, it soon became obvious that the epidemiologic information regarding football injuries was inconsistent and far from complete because of the employment of heterogeneous methods, various definitions of injury, and different characteristics of the teams assessed by investigators. Therefore, it was crucial for F-MARC to first establish what exactly was known and then define our future strategy based on that.

Aims of the review

• Analyse the literature on the incidence of injuries and symptoms in football players
• Identify risk factors for injury and demonstrate possibilities for injury prevention
• Assess the knowledge on the relationship between psychological factors and sports injuries

What did the medical literature tell us about injuries?

The first place to search for and to better understand the nature of injury in a sport is the available medical literature. The problem is that research studies differ on their basic definition of injury. Defining an injury can be quite difficult. Does it mean a player down on the field? Any medical treatment on or off the field? Being removed from play? For how long – minutes, hours, days, weeks, months? Meeting an arbitrary minimum diagnosis? Only injuries that were submitted for insurance reimbursement? Those that required a visit to an emergency department? Any physical complaint by a player? Unfortunately, there was no universally accepted definition of a sports injury in the literature. As such, reports of injury could be underestimates (e.g. insurance or emergency department records) or overestimates (e.g. a player complaint) of the actual rate of injury meaning injury incidence statistics can be quite variable and difficult to compare between sports, between projects, even within a particular sport as different authors use different definitions of an injury.

Defining an injury

Most definitions of injury have three criteria in common: missed training sessions or matches; an anatomic location of tissue damage and the need for medical treatment. Thus, a thigh contusion (location and diagnosis of tissue damage) that receives an ice application (treatment), but does not lead to any training or match missed would not be classified as “an injury” because the player missed no time. Despite this sounding fairly objective, there is much subjectivity for each of the criteria, especially time missed. Apart from different definitions, the epidemiologic information showed inconsistencies in methods, definitions, player/team characteristics and environmental factors. To make it even more complicated, there are also many pitfalls and biases in the rational estimation of the degree of severity of an injury.

Incidence of football injuries

Injury incidence is mostly defined as the number of injuries occurring during a time period when there was a risk of injury. Consequently, the incidence of football injuries has most frequently been calculated based on hours played during games and training. However, because of the above-mentioned problems, the injury rates reported in the literature result in an incidence ranging from 0.5 to 45 injuries per 1,000 hours of practice and games. Furthermore, incidence also varies between match play and training, gender, age and indoor and outdoor play. Obviously, the majority of injuries occur to the lower extremities, mainly in the knees and ankles.

Psychology and football injury

As opposed to external influences, the primary player-related risk factors in risk assessment are psychological components. It had been shown that they not only affected the overall performance of a player, but also their injury risk. Most investigations in this regard were based on either a stress theory or a personality-profile...
FOOTBALL MEDICINE PROJECTS | EPIDEMIOLOGY OF FOOTBALL INJURY

## Duration
1996 - 1998

## Countries
International

## References

### TAB. 2.1.1.1 Incidence of football injuries in different studies

<table>
<thead>
<tr>
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<th>Level of play</th>
<th>Injuries per 1000 game hours</th>
<th>Injuries per 1000 training hours</th>
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<td><strong>MALES</strong></td>
<td></td>
<td></td>
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<tr>
<td>Iceland</td>
<td>National elite, first league</td>
<td>24.6</td>
<td>2.1</td>
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<tr>
<td>Sweden</td>
<td>Sr. National team</td>
<td>30.3</td>
<td>6.5</td>
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<tr>
<td>Sweden</td>
<td>National top division</td>
<td>25.9</td>
<td>5.2</td>
</tr>
<tr>
<td>US</td>
<td>MLS professionals</td>
<td>35.5</td>
<td>2.9</td>
</tr>
<tr>
<td>UK</td>
<td>Premier League, 1st and 2nd division</td>
<td>25.9</td>
<td>3.4</td>
</tr>
<tr>
<td>Finland</td>
<td>Highest national league</td>
<td>25.9</td>
<td>3.4</td>
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<tr>
<td>Sweden</td>
<td>1st division</td>
<td>21.8</td>
<td>4.6</td>
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<tr>
<td></td>
<td>2nd division</td>
<td>18.7</td>
<td>5.1</td>
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<td></td>
<td>3rd division</td>
<td>16.9</td>
<td>7.6</td>
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<td>6th division</td>
<td>14.6</td>
<td>7.5</td>
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<td>Series (low)</td>
<td>11.9</td>
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<td>21.7</td>
<td>8.2</td>
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<td>Male youth</td>
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### What we learned from the reviews

The frequency of football injuries reported in the scientific literature is estimated to be approximately ten to 35 per 1,000 playing hours (Tab. 2.1.1.1). Reviewing the literature is an important first phase of any research programme. This review showed us some of the challenges of research into the frequency and characteristics of injury. The information regarding the sports medicine aspects of football injuries presented itself as inconsistent. More research was needed to identify high-risk groups and variables that may predict injuries within these subgroups. A uniform definition of injury based on sound epidemiologic and methodological principles was urgently needed.

With regard to psychological factors, situation-related emotional states and coping resources may represent important avenues for intervention. Therefore, we decided to further investigate these factors be investigated with respect to injury prevention and improvements in performance.

### Are some players just injury-prone?

Some coaches and players might say that a particular player is “injury-prone” because of their personality. Personality traits are situation-independent and characterise a person. However, according to the scientific literature, personality traits seemed to have no influence on the risk of injury and there was no typical personality profile for an injury-prone player. Nevertheless, several studies have shown that a certain readiness to take risks manifested by personality traits such as lack of caution, tough-mindedness or an enterprising or adventurous spirit might be a factor related to injury. We might think that anxiety might be a factor in injury. In this regard it is important to distinguish between general anxiety as a personality trait and situational anxiety in relation to competition. There was no data showing that general anxiety had any role in injury. However, competitive anxiety has been shown to be of utmost importance in injury occurrence.
2.1.2 Football Injuries in Children and Adolescent Players

What was already known about football injuries among children and adolescent players?

Football is the world’s most popular sport with both active players and spectators, and people all over the world are enthralled by the power of the beautiful game. However, it is still the smallest fraction of the playing population, made up of adult male professionals, which attracts most of our attention while by far the highest proportion of participants (22 million of the 38 million officially registered players) are actually under the age of 18 years. Previous research has shown that football may have beneficial health effects on players of all ages but that there is also a high risk of injury. Epidemiological data were collected on the incidence and characteristics of football injuries, and a consensus regarding the methodological standards for epidemiological studies was published. With regard to children and young players, however, comprehensive and comparable data on the frequency and characteristics of football injuries have largely been missing.

Aims of the review

To analyse and summarise previously published epidemiological data on football injuries in children and adolescent players in order to arrive at comprehensive conclusions and valid considerations for the development of future studies and injury-prevention programmes in children’s and youth football.

How we conducted the survey

A literature search was conducted using the Medline database PubMed up to November 2012. Studies were included in the analysis if they were published in an international peer-reviewed journal and if injury incidence was reported relative to the hours of football exposure. Studies using retrospective questionnaire analysis were excluded in the analysis in order to avoid retrospective bias. Ultimately, 32 titles fulfilled the given research criteria, thus establishing the base for this review. Additional information from the remaining 21 retrospective studies was considered where appropriate to obtain a broader perspective on the injury problem in children and youth football.

What did the literature tell us about injuries among children and adolescent players?

- **Incidence of injury**
  The overall injury incidence varied mostly between two and seven injuries per 1,000 hours of football for players aged 13-19. The review showed that the incidence of injury in children’s and youth football increases with age. Thus, incidence values observed in players of both sexes aged 17-19 approached the values observed in adult players. It was furthermore revealed that growth-related conditions may have an impact on the vulnerability of adolescent players, and that the potentially fluctuating maturation status among peers should be considered when comparing players of the same age group. Match injury was found to increase with age, whereas training injury remained rather stable. No relevant difference in injury incidence of boys and girls was apparent, and a comparison between the injury incidence in elite youth players and sub-elite players suggested that the two groups have a similar injury risk.

- **Mechanisms of injury**
  About 40 to 60% of all injuries were due to contact with another player or an object. Contact injuries were dominant during match play while noncontact injuries more frequently occurred during practice sessions.

- **Location and type of injury**
  Most injuries (60 to 90%) were located at the lower extremities with the ankle, knee, and thigh being mostly affected. This said, it should be noted that the proportion of injuries in these locations varied considerably between studies, possibly due to inconsistencies in definition and documentation as well as low sample size. The most common injury types were strains, sprains, and contusions.

- **Severity of injury and return to play**
  Using the established consensus, injury severity was measured using the categories mild, moderate, and severe injury, where mild is defined as an absence due to injury of between one and seven or eight days; moderate as an absence of between seven or eight and 28-30 days, and severe as an absence of more than 28 days.
or 30 days. It was shown that about half of all time-loss injuries led to an absence of less than one week whereas one third resulted in an absence of between one and four weeks and 10-15% of all injuries were severe. The average duration of absence from training or match play due to an injury was 15 days.

**What we learned from the review**

A coherent application of terms and definitions as defined in relevant consensus statements is crucial when it comes to warranting the validity and comparability of research findings. There is a remarkable lack of information on football injuries and their prevention for players younger than 13 years. This review suggests three key issues that should be addressed in future injury-prevention research among young football players: the number of severe contact injuries occurring during match play; a strict application of the laws of fair play – both in training and matches; and a continuing development of specific injury prevention tools for young players of football so that the children and youth players of today can become the responsible, successful and healthy adult footballers of tomorrow.

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**Duration:** 2012 - 2013  
**Country:** Switzerland  
**Cooperation:** Department of Sport, Exercise and Health, University of Basel  
**References:**  
2.2 Definitions of Injuries and Assessment Methods

2.2.1 Influence of Definition and Data Collection on Injury Incidence

Why we conducted this study

In our review of the medical literature, we found a considerable variation in the incidence of football injuries that were reported by different investigators. We realised that these differences may be caused, in part, by methodological differences such as, for example, different injury definitions. In the same way, methods of data collection, observation periods, study designs, and sample characteristics play a role. Whilst it was clear that the lack of standardisation disallowed the comparison of injury studies in football, it was however difficult for us to estimate the magnitude of the influence of these different methodologies on the reported incidences of football injuries. Therefore, we began to think about developing a system to allow multiple sports to be compared with each other.

Aims of the study

- Review the different methodologies applied in the evaluation of football injuries
- Analyse the influence of different definitions and data collection methods on the incidence of football injuries

Factors influencing the results of injury study

How to define an injury: When investigating the incidence of injuries, one must first define “injury.” “Football injury” is a general term; but there was no consensus among sports physicians about its exact definition, except that the injury was a result of participation in football. The many questions arising in this regard have been elaborated in the previous chapter.

Method of data collection: There were also many questions with regard to the best way to collect data. Firstly, who reports an injury? Athletes may under-report injuries and their severity. Why would they do this? Simply because they want to play! The trainer or physiotherapist may or may not report the injury to the doctor because many minor injuries do not need a physician’s supervision and the doctor’s position may be influenced by confidentiality issues. Video analysis is an option, but not all injuries are easily seen on videotape. For example, it is very difficult to tell exactly when a player suffered a groin strain. Finally, self-administered surveys vs. one-to-one personal, telephone or mail interviews do not give the same results. Further questions were: Should a single team or a single league be studied for one season or more than one season? Can we compare men with women, or youth with adult players?

Research design: In many injury studies, players were asked to remember injuries in their past. This method is called retrospective and leads to the problem of bias recall: the longer the recall period, the more details are forgotten. This means that only the most severe injuries and the injuries with the most medical intervention are remembered. Therefore, prospective studies became the norm where only newly occurring injuries are recorded.

Observation period: The observation period that is studied is another crucial point. There are published studies on periods of all lengths, from one competition to half a season, from a full season to a full calendar year and even more than one year. Further decisions to be taken are: Do we include the pre-season training? Do we assess only games or games and training?

How we collected the data

F-MARC decided to record injuries on a weekly basis for at least one year. For one year, all teams included in this prospective study were visited weekly by a physician who examined each player. This lead to 264 football players from the Czech Republic being systematically followed. In addition, the players were asked to complete a questionnaire at the end of the year. Their answers were then compared with the weekly injury reports of the physicians.

The F-MARC definition of a football injury is “any physical complaint caused by football” F-MARC recommends the additional documentation of the consequences of the injury with respect to the duration of restrictions in the participation in, or the absence from (time loss) regular training sessions and/or matches.

Results

In the retrospective questionnaire of the players, their personal incidence of injuries as well as their history of football-related complaints was significantly lower than
Weekly physician reports | Player recall
---|---
Players reporting 1 injury | 29.5 | 30.6
Players reporting 2 injuries | 20.5 | 8.9
Players reporting 3 injuries | 11.0 | 4.8
Players reporting > 3 injuries | 20.8 | 0.8

| Injuries per player | | |
|---|---|
| Mild injuries | 1.1 | 0.1 |
| Moderate injuries | .68 | .21 |
| Severe injuries | .32 | .35 |
| Any injury | 2.1 | .66 |

| Injuries per 1000 hrs of exposure | | |
|---|---|
| | 7.3 | 2.03 |

| % with any complaint | 91.3 | 61.7 |

Tab. 2.2.1.1 Summary of injury (% of total) reporting by physician weekly reports vs. player recall at the end of the year.

What we learned from this study

These findings were very important for our future approach to the study of injury incidence. Our data showed just how poor the use of retrospective recall could be for studying injury history in sports. Our conclusion was that most retrospective reports of injuries should be considered as an under-reporting of the actual frequency of injury. As such, based on our previous literature review and these results, F-MARC recommended prospectively studying injuries over a full year for games and training including preseason, using continuous data recording rather than any form of recall. To evaluate the causes of football injuries, we also suggested that each injury should be further classified by the timing (preseason or competition period, warm-up, match or training) and the situation (for example, indoor or outdoor, foul play, type of equipment used, Fig. 2.2.1.1).

Fig. 2.2.1.1 F-MARC injury report form
2.2.2 Consensus on the Injury Definition and Data Collection Procedures

The need for a common approach to football injury research

As outlined in the previous chapters, it had become very clear to F-MARC that variations in definitions and methods in sports injury research led to problems in interpreting research study results. Despite repeated calls for common strategies to be adopted, basic differences in definitions and implementation were continued to be found in studies of sports and football injuries. Therefore, FIFA and F-MARC decided to host an Injury Consensus Group. Using what is called a “nominal group consensus model”, the invited experts with a long history in the study of football injuries were asked to develop a consensus statement on definitions and methodological issues when investigating football injuries. They had to address and define key issues for data collection as well as guidelines for reporting surveillance, risk factor and intervention studies.

Defining an injury

The starting point for the consensus group was what we might think would be a simple definition:

What is a football injury?
Any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities. An injury that results in a player receiving medical attention is referred to as a “medical attention” injury and an injury that results in a player being unable to take a full part in future football training or match play as a “time loss” injury.

The next task was to define a “recurrent injury” because players get hurt multiple times and it is important to define what is a new injury and what is a re-injury for the most accurate reporting of various aspects of injury incidence.

What is a recurrent injury?
An injury of the same type and at the same site as an index injury and which occurs after a player’s return to full participation from the index injury. A recurrent injury occurring within two months of a player’s return to full participation is referred to as an “early recurrence”, one occurring two to 12 months after a player’s return to full participation as a “late recurrence” and one occurring more than 12 months after a player’s return to full participation as a “delayed recurrence”.

Simply sustaining an injury is only one part of the problem. The group also had to define the severity of injury:

What is a severe injury?
The number of days that have elapsed from the date of injury to the date of the player’s return to full participation in team training and availability for match selection determines the injury severity.

- slight 0 days lost
- minimal 1-3 days lost
- mild 4-7 days lost
- moderate 8-28 days lost
- severe >28 days lost

Finally, the group had to define exposure according to match and training. Exposure is the denominator in reporting injury rates. Rates of occurrence are generally reported as injuries per 1,000 player hours. In football, rates are reported per 1,000 match or training hours.

What is match exposure?
Play between teams from different clubs.

What is training exposure?
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.

Reporting an injury

Finally, the group suggested the following methodological concepts to improve reporting, interpreting and comparing football research studies:

- Studies should be of a prospective, cohort design to minimise the occurrence of errors associated with recall, which is a problem with retrospective study designs.
- Studies should record medical attention and/or time loss injuries.
- Injuries should be classified by location, type, body site and mechanism of injury (traumatic or overuse) and whether the injury was a recurrence. A traumatic injury refers to an injury resulting from a specific,
identifiable event and an overuse injury to one caused by repeated micro-trauma without a single, identifiable event responsible for the injury.

- The location and type of injuries should be recorded using the individual categories. When the number of injuries are few, categories may need to be combined.
- Other important categories that should be a part of all injury studies include whether the injury occurred during a match or during training, whether contact was involved, whether the contact was a violation of the rules.
- The study population should normally consist of more than one team of players and the study should last for a minimum period of one season (including pre-season), twelve months, or the duration of a tournament. Special attention is needed for players who enter or leave the study after the study begins as well as players entering the study with existing injuries. Intervention and risk factor studies require power calculations prior to beginning the project.
- A common set of forms should be used for all record keeping. The forms used by F-MARC for their injury studies are a good place to start when developing materials for keeping records.
- Injuries should be recorded according to time in the match using 15-minute intervals.

What we learned from this meeting

This consensus group was able to come to an agreement on definitions of injury, recurrent injury, severity and training and match exposures in football. The group accepted criteria for classifying injuries in terms of location, type, diagnosis and causation combined with the best methods for recording players’ baseline information, injuries and training and match exposure. For researchers performing injury surveillance, they gave recommendations on how the incidence of match and training injuries should be reported and proposed a checklist of issues and information that should be included in published reports of studies of football.

References:
2.2.3 Injury Surveillance in Multi-Sport Events

Why we conducted this study

The protection of athletes’ health by preventing injuries is an important task for international sports federations. Systematic injury surveillance is able to provide directions for injury prevention in different sports. But comparison of injury incidence between sports is difficult indeed, not only due to lack of standardisation of methods, but also due to the different nature of sports. On the one hand, conducting a comparative study during a major tournament, such as FIFA World Cups™ or the Olympic Games, offers the great advantage that multiple sports with athletes of a comparable skill level participate and that the observation period is defined by the event. Furthermore, a high standard of environmental factors, such as the quality of the playing fields and equipment, is guaranteed. On the other hand, the large number of teams from different backgrounds and with diverse medical support makes it more difficult to obtain reliable information about the incidence, occurrence and characteristics of injury. Therefore, a standardised and feasible injury-reporting system for multi-sport events would immensely assist in optimising the protection of the health of athletes.

Aims of the study

• Develop an injury surveillance system for multi-sports tournaments involving team and individual sports, using the 2008 Olympic Games in Beijing as an example
• Create a simple, flexible, acceptable, sensitive, representative and immediate/timely system as a role model for future studies

How we collected the data

Based on the system well-established for international football tournaments and used for all team sports during the 2004 Olympic Games, a group of experienced researchers set out to develop a scientifically sound and concise system to be implemented for both team and individual sports at the 2008 Olympic Games. To be applicable for both individual and team sports, the original injury-reporting system had to be modified to meet the different needs. However, the most important principles and advantages of the system were preserved, such as the definition of injury, injury report by the doctor responsible for the athlete, daily reports independent of whether or not an injury occurred, and one report form per team and not per injury or athlete. Based on this procedure, a simple and concise injury report form including the most important variables was developed and tested during the 2007 World Championships of the International Association of Athletics Federations (IAAF) in Osaka.

Results

The following key points of the system were identified:

Definition of injury:
• "Any musculoskeletal complaint newly incurred due to competition and/or training during the tournament that received medical attention regardless of the consequences with respect to absence from competition or training."
• Injuries should be diagnosed and reported by qualified medical personnel (team doctor, physiotherapist) to ensure valid information on the characteristics of the injury and a comparable standard of data. In general, the chief doctor of the national team should be responsible for reporting the injuries of their athletes. The team doctors should report all newly incurred injuries (or the non-occurrence of injuries) daily on the provided injury report form and should return it daily.
• The single page form for all sports injuries that receive medical attention from the team doctor during the day or, if no athlete is injured, the non-occurrence of injury, require documentation of: accreditation number of the athlete, sport and event, round/heat/training, date and time of injury, injured body part, type of injury, cause of injury and an estimate of the expected duration of subsequent absence from competition and/or training.

Cause of injury:
1. An overuse injury refers to an injury resulting from repeated micro-trauma without a single, identifiable event responsible for the injury and a traumatic injury refers to one caused by a specific, identifiable event. Overuse injuries should be divided into two groups based on the onset of symptoms. A non-contact
trauma is defined as a traumatic event without contact with another athlete or object, such as a fall.
2. A recurrent injury is defined as an “injury of the same location and type, which occurs after an athlete’s return to full participation from the previous injury”.
3. Contact events are categorised as contact with another player, a moving object (e.g. ball, puck, racket) or a static object (e.g. hurdles, net, goalpost). If applicable, it should be indicated whether or not the injury is caused by a violation of the rules of the respective sport.
4. Playing field conditions (e.g. uneven ground) include alterations of the playing field by the weather (e.g. slippery ground).

Absence in days:
• The team doctor is asked to provide an estimate of the number of days that the athlete will not be able to undertake their normal training programme or will not be able to compete. Duration of absence from sport is regarded as an indicator of injury severity.
• Analysis of data should include response rate, frequency and characteristics of injury, athletes included, exposure and injury incidence for competition and training separately.

What we learned from the study
A concise injury surveillance system for multi-sports events has been developed for both team and individual sports and tested during the 2007 World Championships of the International Association of Athletics Federations (IAAF) in Osaka. The system has been accepted by experienced team doctors and shown to be feasible for single-sport and multi-sport events. It can be modified depending on the specific objectives of a certain sport or research question; however, a standardised use of injury definition, report forms and methodology will ensure the comparability of results. It will be used during the 2008 Olympic Games in Beijing and should serve as a role model for future studies in single and multi-sport events.

Duration: 2007 - 2008
Countries: International
Cooperation: IOC, FINA, IIHF, OSTRC, IAAF
Reference:
2.3 Injuries during the Football Season

2.3.1 Injuries of Male Players of Different Age and Skill Level

Why we conducted these studies

Most coaches and parents who watch numerous games had developed some observation regarding injuries in older vs. younger age groups, or between high vs. low level players. Some believed that older players suffer more injuries than younger players, others that highly skilled players are injured more and again others that highly skilled players had fewer injuries than players of poorer skill. Another question was whether there were regional differences. We therefore decided to look further into the injury incidence question by collecting information on injuries in different age groups, skill levels and regions.

Aims of the studies

- Investigate in a prospective manner the incidence of football-related injuries and complaints among football players of different ages and skill levels
- Compare the incidence and circumstances of football injuries in youth players of two European regions

How we collected the data

A total of 264 players of different age groups and skill levels were observed for one year; players in the higher levels of play trained and competed more. All injuries and complaints as well as the game and training exposure were recorded. The injured players were examined weekly by physicians and all injuries were assessed according to the International Classification of Diseases (ICD10 - an international standard for classifying medical conditions) with regard to the injury type and location, the treatment required, and the duration of subsequent performance limitations.

Results

Five hundred and fifty-eight injuries were documented. Two hundred and sixteen players (82%) suffered one or more injuries and only 48 players (18%) had no injury. As expected, the ankle and knee were the two most common injury locations with ligament sprains and muscle strains the most common diagnoses. The average number of injuries per player per year was 2.1, ranging from 1.8 to 3.8 (Tab. 2.3.1.1). Injuries were classified as mild (52%), moderate (33%), or severe (15%). Almost half of all injuries were contact injuries and half of all the contact injuries were associated with foul play. Nine out of ten players had some football-related complaint. Only 23 players reported no injuries and no complaints related to football.

The younger players (14-16 years old) had slightly fewer injuries per player and a lower injury rate than the 16-18 years old players yet the data for the 16-18 years old was nearly comparable with the adults. The injury rate during training for the low level players was more than twice as high as that of similar aged players of high level. Game injury rates for the low level players were almost twice as high as those of the high level players. For the adult players, if one assumes that local teams are of lower skill than competitive amateur teams and both are of lower ability than the third league and top level players, a similar pattern of injury rate is seen with the lower level adults having a much higher rate of injury than the more skilled adults.

Football-related complaints

We were also interested in football-related complaints that were unrelated to injury. The most frequent complaint was in regard to the lumbar spine (26% of players) followed by the ankle (22%), thigh (19%), head (18%) and knee (17%). It is interesting that an area not generally listed as a frequent site of injury (the spine) is cited by over one-quarter of the players with the high level 14-16 years old registering the fewest complaints (14%) and the top level adults having the most players with complaints (52%).

Comparison of two European regions

The regional comparison involved weekly follow-ups for 311 youth players over one year with complete reports on 180 players from the Czech Republic and 131 from the Alsace region (Germany/France) using the same methodology. The comparison of injury data revealed no substantial differences between players from the Alsace region and the Czech Republic in injury incidence per 1,000 hours of exposure, degree of injury severity, or the circumstances in which the injuries occurred. Players from the Czech Republic spent more time in training and playing football than players from the Alsace region did, but the ratio of training...
FOOTBALL MEDICINE PROJECTS

EPIDEMIOLOGY OF FOOTBALL INJURY

Duration: 1996 - 1998
Countries: Czech Republic, Germany, France
Cooperation: Czech Football Association
References:

Tab. 2.3.1.1 Exposure time and average number of injuries per player in different age and skill-level groups

<table>
<thead>
<tr>
<th></th>
<th>Adult players</th>
<th>Youth 16-18y</th>
<th>Youth 14-16y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top</td>
<td>3rd league</td>
<td>Amateur</td>
</tr>
<tr>
<td>Training hours</td>
<td>307.4</td>
<td>337.1</td>
<td>184.3</td>
</tr>
<tr>
<td>Game hours</td>
<td>51.3</td>
<td>60.2</td>
<td>46.3</td>
</tr>
<tr>
<td>Training/game ratio</td>
<td>6.0</td>
<td>5.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Injury per player

<table>
<thead>
<tr>
<th></th>
<th>TOTAL</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult players</td>
<td>2.0</td>
<td>.86</td>
<td>.95</td>
<td>.19</td>
</tr>
<tr>
<td>Youth 16-18y</td>
<td>1.8</td>
<td>.71</td>
<td>.68</td>
<td>.45</td>
</tr>
<tr>
<td>Youth 14-16y</td>
<td>2.1</td>
<td>.94</td>
<td>.59</td>
<td>.53</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>HIGH LEVEL</th>
<th>LOW LEVEL</th>
<th>HIGH LEVEL</th>
<th>LOW LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2.2</td>
<td>2.6</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Mild</td>
<td>1.23</td>
<td>1.59</td>
<td>1.03</td>
<td>.87</td>
</tr>
<tr>
<td>Moderate</td>
<td>.78</td>
<td>.55</td>
<td>.53</td>
<td>.59</td>
</tr>
<tr>
<td>Severe</td>
<td>.22</td>
<td>.45</td>
<td>.24</td>
<td>.48</td>
</tr>
</tbody>
</table>

What we learned from the studies

The incidence of injuries varied between players of different age and skill level. Part of the explanation for the patterns observed could be related to the amount of training and subsequent level of fitness. Low level players trained at half the exposure of the high level players, yet had somewhat similar numbers of injuries meaning their rates would be around twice as high. The number of matches was similar, but with less preparation they suffered more injuries leading to the higher injury rate. This indicates that training, coaching and fitness are effective injury prevention measures. This also showed that increasing the ratio of training hours to match hours, meaning either train more or compete less, is a factor in injury reduction. This F-MARC study suggested that prevention programmes promoting fair play and improvement in techniques and skills may reduce the incidence of injuries.

Set up for the epidemiological study in Prague

hours to match hours was similar. Again, when the players were grouped according to playing ability, the incidence of injury per 1,000 hours of exposure was generally higher in the low-skill groups than in the high-skill groups.

We found a higher proportion of injuries were caused by foul play in the Czech Republic. We also found that significantly more Czech players agreed that it was acceptable for a player to commit a “professional foul” if required to do so in view of the score and the importance of the match.
2.3.2 Severe Injuries of Male Players

Why we conducted this study

The injury literature categorizes severity of injury according to time lost from work. A person with a mild injury would miss less than one week of work, a moderate injury keeps a person out of work for one to four weeks and a severe injury would keep a person out of work for four weeks or more. According to our own results, about 80-90% of football injuries from the hip and below are mild or moderate. When considering the potential population of football players, however, the public health impact of the 10-20% of injuries that are severe would be substantial. As a next step in our research programme, we therefore wanted to analyse factors related to severe football injuries in players by age (14 to 42 years) and skill level (local teams to first league teams).

Aims of the study

- Analyse severe traumatic and overuse injuries incurred by football players of different ages and skill levels
- Describe the intrinsic and extrinsic factors influencing the occurrence of these injuries

How we collected the data

We followed up on 398 players for one year in the Czech Republic. After a baseline examination, all teams were visited weekly by a physician, who documented all injuries and complaints. All players who sustained a severe injury were asked to see the orthopaedic surgeon, who then conducted a standard clinical examination and an analysis of the medical history. All players answered a questionnaire concerning the circumstances of their injury (for example, training, game, contact) and their judgment of the situation (for example, foul play).

Results

During the one year observation period the 398 players sustained 686 injuries. Of these injuries, 113 (16.5%) were classified as severe injuries and we were able to obtain details on 97 (86%) of the severe injuries. The most important findings were: Trauma was the cause of 81.5% of the severe injuries and overuse was the cause of 18.5%. With regard to diagnoses joint sprains clearly dominated (30%), followed by fractures (16%), muscle strains (15%), ligament ruptures (12%), meniscal tears and contusions (8%), and other injuries. The most frequent location for severe injuries was the knee (29%), before ankle (19%) and spine (9%).

Of the knee injuries, just under one quarter were injuries to the anterior cruciate ligament and another quarter were meniscal injuries. About two thirds of the knee injuries did not involve contact with another player. Five knee injuries happened during match play and four of these players had a history of prior knee injury, one during the same game. The two oldest players who sustained a serious knee injury consequently retired from play.

Nearly 60% of severe injuries occurred during games. Two thirds of all severe injuries happened at away matches. There was no real pattern to the location on the field where the injury occurred. Injuries were evenly distributed across playing positions.

Forty-six percent of injuries were caused by contact and 54% involved no body contact. Nearly one third of severe injuries were a result of foul play. Just over half of all injuries received no treatment on the field or in the dressing room after training/competition.

All but one of the groin injuries were non-contact and half were felt to be from overuse. The average age of these players was 19 years. Twenty-four percent of the injured players had suffered an injury to the same, previously injured, body part.

The average time lost due to injury was 9.2 weeks. Three-quarters of the injured players fully returned to play in less than eight weeks, but about 10% were out of football for more than six months. The incidence of severe injuries per 1,000 hours in the low level players was twice that of the high level players.

Severe injuries were evenly spread across the age groups. The most frequent injuries in the 14-16 year olds were to the spine, joint sprains and contusions (Fig. 2.3.2.1). In the 16-18 year olds, the most common injuries were joint sprains (Fig. 2.3.2.1) and fractures. In the 18-25 year olds, muscle strains and joint sprains were the most common. Finally, in players 25 years and older, ligament ruptures, meniscal tears and muscle strains predominated. Increasing age was associated with increases in
muscle strains, ligament ruptures and meniscal tears and a decrease in joint sprains, contusions as well as spinal injuries (Fig. 2.3.2.1).

What we learned from the study

From these results, the following factors were determined to influence the occurrence of severe injuries: first, personal or so-called intrinsic factors: age, previous injuries, joint instability, abnormality of the spine, poor physical condition, poor football skills, or inadequate treatment and rehabilitation of injuries; second, environmental or so-called extrinsic factors: subjective exercise overload during practices and games, amount and quality of training, playing field conditions, equipment such as wearing of shin guards and taping and violations of existing rules (foul play). These findings lend further support that critical factors in preventing injuries is complete rehabilitation from a prior injury along with improved skill and fitness.

**Duration:** 1996 - 1998  
**Country:** Czech Republic  
**Cooperation:** Czech Football Association  
**Reference:**  
2.3.3 Injuries of Female Players of the German National League

Why we conducted this study

FIFA President Joseph S. Blatter once said “We have seen the future of football and that future is feminine.” In 2004, it was estimated that there were over 20 million female players in over 100 nations with over six million female players in the US alone. The FIFA Women’s World Cup 1999 final in the US drew over 90,000 spectators – history’s largest audience for a women’s event. But despite the growth in participation in women’s football, the study of women’s football had lagged behind. Research on other sports had shown that it is a mistake to train women using the same guidelines as normally used for men. When this happened, the rate of injury to women rose dramatically over that of men. The unique physiology of women and the differences in capacity versus men required that women in sports train differently than men. While there had been some work published on training women, especially in track-and-field and swimming, there was little reported on women in football. There were only a few studies on any aspect of women’s football, be it fitness, technique or tactics. Numerous injury epidemiology studies investigated on men’s football, but the data on female football was scarce. It has been known for some time that there is a clear difference between men and women in the rate of injuries to the anterior cruciate ligament (ACL) of the knee. Female football players sustain three to six times more knee ligament injuries than men. As the F-MARC mission was to explore the nature of football injuries, it seemed appropriate to focus our attention on women football players. Thus, we undertook a large scale project on injuries to females playing in the German professional league.

Aim of the study

• Analyse the incidence and risk factors of football injuries in elite female football players

How we collected the data

In an attempt to determine injury incidence in high level women’s football, we studied the German national league. Data was obtained on 165 female football players from nine teams (aged 22.4 ± 5.0 years) for one complete outdoor season. Injury epidemiology data is usually reported as the rate of injury per 1,000 hours, so each team trainer documented exposure to football for each player on a weekly basis. Each team physiotherapist reported all injuries with regard to their location, type and circumstances of occurrence. An injury was defined as any physical complaint associated with football that limited sports participation for at least one day.

Results

Of the 165 players followed, 115 players (corresponding to 70%) reported 241 injuries, meaning that each injured player sustained about two injuries. In this study, 16% of injuries were due to overuse and 84% were traumatic. Forty-two percent of the traumatic injuries happened during training (2.8 per 1,000 hours training), and 58% during match play (23.3 per 1,000 match hours). The ratio of training to match hours as a factor in injuries and performance in this study was 5.9, meaning that each female player trained about six hours for each match hour. Considering this ratio, the match injury rate was over eight times greater than the training rate. Just over half of the traumatic injuries were due to contact and the remaining traumatic injuries occurred without any contact (Fig. 2.3.3.1). The most frequent site of injury was to the thigh, knee and ankle, as all sustained about the same number of injuries (Fig. 2.3.3.2). Regarding the type of injury, the most frequent diagnosis was an ankle sprain. Injury severity was determined according to time lost from play. According to this, 51% of injuries were classified as minor, 36% as moderate, and 13% as severe. Half the severe injuries were
The injury rates reported were similar to those reported for some male players, but lower than what F-MARC had seen at major women’s international competitions. As with males, there was a high match injury rate and a comparably low training injury rate. An important finding of this investigation was the frequent occurrence of ACL ruptures. Consequently, we recommended that there should be a special focus on prevention of ACL ruptures in female football players, mostly occurring in non-contact situations.

**What we learned from the study**

The injury rates reported were similar to those reported for some male players, but lower than what F-MARC had seen at major women’s international competitions. As with males, there was a high match injury rate and a comparably low training injury rate. An important finding of this investigation was the frequent occurrence of ACL ruptures. Consequently, we recommended that there should be a special focus on prevention of ACL ruptures in female football players, mostly occurring in non-contact situations.

**Injuries with absence of more than one month**

- 14 ruptures of knee ligaments incl eleven ACL ruptures
- Six ligament ruptures of ankle
- Two fractures (lower leg, foot)
- Two strains of thigh
- One knee sprain
- Six others

**Tab. 2.3.3.1 Injuries resulting in absence of more than one month**

**Fig. 2.3.3.1 Mechanisms of injury**

<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Contact</th>
<th>Non-contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tackle</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>Fouling</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Collision</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Running</td>
<td>29</td>
<td>15</td>
</tr>
<tr>
<td>Change in direction</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>Stopping</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Jumping</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Hit by ball</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
<td>9</td>
</tr>
</tbody>
</table>

**Fig. 2.3.3.2 Location of injury**

**Germany wins the FIFA Women’s World Cup China 2007™**

**Duration:** 2003 - 2004

**Country:** Germany

**Cooperation:** German Football Association, University of Saarland, Germany

**Reference:**

2.3.4 Injuries in the Tunisian Professional Leagues

Why we conducted this study

A popular phrase is “football is football”. This means that the game is the same no matter where it is played: scoring, tactics, skills, patterns of play, fitness and more are similar regardless of where the game is being played. Of course there are some cultural differences: the European and South American games do display some differences, but that does not mean that someone from Norway could not play with a group of Peruvians. If this phrase on the commonality of football were correct, would it also be true for injuries? We knew there were some differences between men and women regarding selected injuries, most notably the rate of anterior cruciate ligament injuries. But when it came to men’s injuries, the vast majority of injury studies reported in the literature have been conducted on European players. As most observers of the game will comment on the aforementioned cultural differences in tactics, we wondered if there might be cultural differences in the injury profile too. Therefore we intended to analyse the injuries suffered by players in predominately Arabic countries.

Aim of the study

- Analyse the frequency, characteristics and circumstances of injuries suffered by players of the Tunisian professional football league

How we collected the data

This study was conducted over an entire professional league season. All teams in the first and second Tunisian professional football leagues were asked to participate. During the spring season of 2002, any football injuries that resulted in absence from at least one scheduled training session or match were reported by the team doctors on a weekly basis. Incidence and rate of injury were described according to their diagnosis and circumstances of occurrence. For each player, the coaches recorded the amount of time in training and matches, as well as the reason for any absences.

Results

A total of 479 players from 18 professional Tunisian football teams were followed for 13 weeks. There was substantial variability in injury rate between the teams which could be real or might represent differences in record keeping. Overall, the incidence of injuries was 4.7 per 1,000 hours of exposure to football, but the rates for individual teams ranged from 1.3 to over 17 in the first league and 1.5 to 9.2 in the second league per 1,000 hours of exposure. As with other studies, we separated training and overuse injuries from match injuries and saw that the incidence of overuse and training injuries was similar in both leagues (Fig. 2.3.4.1). For both leagues, approximately 70% of all injuries occurred without contact with another player.

Compared to that, the average incidence of match injuries was significantly higher in the first league (22.5 injuries per 1,000 match hours) than in the second league (7.2 injuries per 1,000 match hours, Fig. 2.3.4.2) but each value could have been influenced by extremely high (first league) or low (second league) rates at some matches.

These injury rates, while substantial and worthy of reduction, were much lower than those seen in international tournaments reported by F-MARC. A quarter of all injuries were re-injuries, i.e. were of the same type and in the same location as a previous injury. Whenever we see such a high incidence of re-injury, the first question is in relation to the decision to return to play: either a player was allowed to return to play before rehabilitation was complete or was allowed to return to play without appropriate preventive measures like a brace to support a prior ankle sprain.

In approximately one third of injuries, a strain of the thigh muscle was diagnosed. Additionally, ten muscle ruptures of the thigh were reported whereas two muscle ruptures occurred in the lower leg. Forty-one injuries (23%) were sprains of the ankle (n=35) or knee (n=5). Injuries that constituted severe tissue damage included three fractures (nose, rib, metatarsal), two dislocations (foot, elbow), three ruptures of the knee ligaments and one meniscus lesion.

Sixty-one percent of the injuries resulted in absence from training or matches for up to one week, one third of the injuries resulted in absence for eight to 28 days, and 11 injuries in absence for more than 28 days. The over-
all incidence of injuries resulting in absence for at least one month was 0.3 per 1,000 hours exposure, although four of the 11 severe injuries occurred in one team. The majority of these injuries (73%) were sustained during matches, but only two of them were the result of contact with another player. Injuries resulting in a subsequent absence of more than one month affected mainly the knee (two ligament ruptures, two sprains) and the thigh (three muscle ruptures, one contusion with haematoma); the other three severe injuries included a fracture of the metatarsal bone, inflammation of the Achilles tendon and pubalgia. Of the four long lasting knee injuries, three occurred in the same team, which was also the team with the highest overall incidence of injury.

What we learned from the study

So, could we say that “football is football” when it comes to injuries? The overall incidence of injury in the first Tunisian professional league was similar to that reported for high-level European teams, but was lower than what had been reported for major international tournaments. The major difference, however, was in the fraction of total injuries that were non-contact in nature and this percentage was substantially higher in these Arabic players. Some consider that non-contact injuries are among the most preventable of injuries, so it seemed advisable that these teams improved their efforts in the prevention of injuries. Preventive interventions aiming at improvement in the quality of training and adequate rehabilitation after injury were recommended to reduce the rate of injury.

<table>
<thead>
<tr>
<th>Injuries with absence of more than 28 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Two ligament ruptures in the knee</td>
</tr>
<tr>
<td>• Two sprains of the knee</td>
</tr>
<tr>
<td>• Three muscle fibre ruptures in the thigh</td>
</tr>
<tr>
<td>• One contusion with haematoma in the thigh</td>
</tr>
<tr>
<td>• One tendonitis of the Achilles tendon</td>
</tr>
<tr>
<td>• One fracture of the metatarsal bone</td>
</tr>
<tr>
<td>• One pubalgia</td>
</tr>
</tbody>
</table>

Fig. 2.3.4.1 Incidence of overuse injuries and injuries during training

Fig. 2.3.4.2 Incidence of match injuries

Duration: 2001 - 2002  
Country: Tunisia  
Cooperation: Tunisian Football Association  
2.3.5 Injuries in the Congo National Football League

Why we conducted this study

Information on the incidence, characteristics and causes of injuries in African players is scarce. As F-MARC had shown earlier, data reported in studies from Europe and the United States was not necessarily transferable to Africa. Injury frequency and characteristics vary with different styles and levels of play, but also between countries and geographical regions. With regard to African league players, one survey in seven clubs of the premier league in Nigeria reported an injury prevalence of 81.6% during the 2006 football season. However, due to the study methods, the data was not comparable with studies using the definitions of the injury consensus. In fact, none of the few studies performed in African players was of sufficient quality with regard to design and methodology to allow for comparison of data or conclusions on injury frequency. Still, the existing data hinted at possibly high frequency and in some cases considerable severity of injuries, raising major concerns, particularly when considering the limited access to qualified sports injury care in these players.

Aim of the study

- Determine the incidence and characteristics of football injuries among African league-level players

How we collected the data

Three stadiums in Kinshasa were selected for their pitch quality meeting FIFA standards. Only match and not training injury frequency and characteristics were recorded to facilitate data collection. During the first round of the 2006-2007 football season, 180 matches were played in these stadiums, plus a further 28 during the second round. Three independent physicians familiar with the F-MARC injury recording procedure were designated to record all injuries for both teams of a match. Injury definition referred to any injury resulting from play regardless of time loss. For the expected absence from play in more severe injuries, they had to confirm their estimate with the team’s medical staff.

Results

A total of 310 forms from 155 matches could be analysed. There were 932 injuries recorded, corresponding to six injuries per match and 182 injuries per 1,000 playing hours. Of these, 883 (94.6%) were mild, meaning they did not cause any absence from play. Time-loss injuries occurred with a frequency of 9.8 per 1,000 playing hours. No injury caused an absence from play of more than a month, and five injuries (10%) an absence from one to four weeks. The most frequent injury type was a contusion (65% of all injuries). An ankle sprain was the most frequent diagnosis, accounting for 27% of all injuries and 40% of time-loss injuries.

With regard to circumstances of injuries, more injuries occurred during the second (57.6%) than during the first half of matches (42.4%). Almost all injuries were caused by contact with another player (98%), and of these 85% (777 injuries) resulted from foul play according to the assessment of the recording physicians. Two thirds of these were consequently sanctioned by the referee.
What we learned from the study

This was the first study of African players which, by virtue of the methodology used, allows for the comparison of the findings with previous studies based on the F-MARC recording principles. One distinction however, which might have influenced results, was the use of dedicated physicians as recorders as league teams in the Congo do generally not possess of medical staff. The injury frequency found in these African league players (182 injuries per 1,000 hours of match play) was six to 12 times higher than what has been reported in studies from other regions (12-35 injuries per 1,000 hours of match play). While the pitch conditions and equipment might partly explain this difference, the recording by a physician exclusively attending to this task could also result in higher numbers of recorded injuries. The negligible occurrence of injuries without contact with another player (2%) and which are supposed to be due to fatigue or lack of concentration was another major difference to previous studies where these injuries occurred about 12 to 30 times more often. Apart from the recording method, a different style of play has to be considered as the vast majority of injuries were caused by foul play.

No major difference was found in the location and characteristics of injury which mirrored the findings of previous studies. As common in football, the ankle was the most frequently injured joint, distortions of the same the most frequent diagnosis and contusions the most frequent type of injury.

In conclusion, despite minor methodological differences, the study confirmed the trend towards higher injury frequency in African players indicated by studies applying different methods. More studies in African elite and amateur players are needed to balance the interpretation of these data and to better weigh them against the lack of access to qualified care for risk assessment. Future studies need to take the findings of this study in consideration in their design in order to establish the much needed evidence for future prevention approaches in African players.
2.4 Injuries during Football Competitions

2.4.1 Injuries during FIFA Competitions 1998 - 2001

Why we conducted this study

Major international sport competitions like the various FIFA competitions and the Olympic Games attract a large number of spectators and are highly entertaining for the viewing audience. The competitive pressures are so intense that it should not be surprising that the incidence of injury during international championships is quite high. From the very beginning, a better understanding of the nature of injury at major competitions seemed highly desirable for F-MARC. While comparative information on the risk and incidence of injuries in different sports could provide most important insights, we have already elaborated in the previous chapters on the problems of the many different methods and specific definitions of injury, severity, diagnosis, level of competition, and more. Consequently, F-MARC wanted to assess exposure-related incidence of injuries in different types of sports using the same methodology.

Aims of the study

- Develop an injury reporting system for use during major sporting competitions
- Implement this system during FIFA competitions and Olympic Games
- Describe the incidence, circumstance, and characteristics of injuries in international football competitions

How we collected the data

The only way to obtain valid comparative information within football is for one group to use a constant set of definitions and a common methodology that has been demonstrated to be effective, reliable and valid. F-MARC developed an easy to use injury-reporting system to analyse the incidence, circumstances and characteristics of injury during major international football competitions. This modified comprehensive injury report form was implemented during twelve international football competitions during 1998-2001; male and female, futsal and outdoor, Olympic Games, and FIFA World Cups from U-17 through to the FIFA World Cup™. The physicians of all participating teams were specially trained and asked to report all injuries after each match. The response rate was 84% on average, but as teams and physicians became more familiar with the forms and responsibilities, the response rate in the most recent competitions was 100%.

Results

A total of 901 injuries were reported from 334 matches which gives a gross incidence of 2.7 injuries per match (Tab. 2.4.1.1) or 88.7 injuries per 1,000 match hours. The competition with the highest injury rate was the FIFA U-20 World Cup 2001 (4.7 injuries per match) and the lowest rate (1.3 injuries per match) was reported in the FIFA Women’s World Cup 1999 and the FIFA Futsal World Cup 2000. In Futsal however this was misleading due to the shorter match duration, the injury rate per 1,000 hours of futsal was in fact over double of that of outdoor football. The average rate of injury in men’s football was just under twice of that of women (2.4 vs. 1.3 respectively for FIFA competitions and 3.7 vs. 2.1 for Olympic competitions, Fig. 2.4.1.1).

The rate of injury that resulted in missing training or competition was 35 per 1,000 match hours or approximately one injury per match. Player-to-player contact was a factor in 86% of the injuries and approximately half of all injuries were caused by foul play. The ankle and thigh were the most common locations for injury. Nearly 60% of all injuries were contusions. On average, there was one concussion and 1.3 fractures per competition. The most severe injuries (> 30 days out of play) were to the knee with most of them being ligament tears and foot/ankle fractures. While just over half of the injuries occurred during the second half, there was no relationship between the time and severity of injury.

Fig. 2.4.1.1 Injuries per match in male and female players
**What we learned from the study**

We showed that the F-MARC injury reporting system could be used as a routine matter in FIFA competitions. The number of injuries per match differed substantially between the competitions for players of different age, sex and skill level. The consistent findings in many of the details of injury such as location, diagnosis, etc demonstrated the high quality of the data obtained.

At the same time, the problems, challenges and demands inherent in studying a single competition and trying to make overall statements about injury rates became obvious. In football as in any sport, a single match is simply a snapshot of “the game”. Any competition is like a short movie, but analysis of multiple competition settings and the data from hundreds of matches gives probably a more accurate picture of match-related injuries. For example, if only the FIFA Women’s World Cup 1999 was studied, the injury rate would appear to be fairly small, while the rate for women in the 2000 Olympic Games was nearly twice as high. If our decision had been to focus on men at the FIFA U-20 World Cup 1999 or the 2000 Olympic Games, the injury rate would be thought to be alarming – nearly four injuries per match. Acknowledging that any one competition may be an extreme for all kinds of reasons, when all were considered collectively, we were likely to get a more consistent view on injury incidence at world championship football events.

<table>
<thead>
<tr>
<th>Tournament</th>
<th>No of matches</th>
<th>Player hours</th>
<th>No of injuries (total)</th>
<th>Injuries per match</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIFA World Cup France 1998</td>
<td>64</td>
<td>2046</td>
<td>149</td>
<td>2.4</td>
</tr>
<tr>
<td>FIFA Women’s World Cup USA 1999</td>
<td>32</td>
<td>776</td>
<td>30</td>
<td>1.3</td>
</tr>
<tr>
<td>FIFA Confederations Cup Mexico 1999</td>
<td>16</td>
<td>248</td>
<td>13</td>
<td>1.7</td>
</tr>
<tr>
<td>FIFA U-17 World Championship New Zealand 1999</td>
<td>32</td>
<td>1039.5</td>
<td>53</td>
<td>1.7</td>
</tr>
<tr>
<td>FIFA World Youth Championship Nigeria 1999</td>
<td>52</td>
<td>957</td>
<td>104</td>
<td>3.6</td>
</tr>
<tr>
<td>FIFA Club World Championship Brazil 2000</td>
<td>14</td>
<td>313.5</td>
<td>30</td>
<td>3.2</td>
</tr>
<tr>
<td>Men’s Olympic Football Tournament Sydney 2000</td>
<td>32</td>
<td>1023</td>
<td>116</td>
<td>3.7</td>
</tr>
<tr>
<td>Women’s Olympic Football Tournament Sydney 2000</td>
<td>16</td>
<td>495</td>
<td>32</td>
<td>2.1</td>
</tr>
<tr>
<td>FIFA Futsal World Championship Guatemala 2000</td>
<td>40</td>
<td>220</td>
<td>42</td>
<td>1.3</td>
</tr>
<tr>
<td>FIFA Confederations Cup Korea/Japan 2001</td>
<td>16</td>
<td>528</td>
<td>33</td>
<td>2.1</td>
</tr>
<tr>
<td>FIFA U-17 World Championship Trinidad &amp; Tobago 2001</td>
<td>32</td>
<td>1056</td>
<td>93</td>
<td>2.8</td>
</tr>
<tr>
<td>FIFA World Youth Championship Argentina 2001</td>
<td>52</td>
<td>1435.5</td>
<td>206</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>OVERALL</strong></td>
<td><strong>398</strong></td>
<td><strong>10137.5</strong></td>
<td><strong>901</strong></td>
<td><strong>2.7</strong></td>
</tr>
</tbody>
</table>

Tab. 2.4.1.1 Incidence of injury in FIFA competitions and the Olympic Games

---

**Duration:** 1998 - 2001  
**Countries:** International  
**Cooperation:** All team physicians of the competitions  
2.4.2 Injuries during the 2002 FIFA World Cup Korea/Japan™

Why we conducted this study

All athletes accept a certain risk of injury when they step on their chosen field of play. Within any sport there are specific and predictable patterns of injury that vary according to age, gender and level of play. While studying the recreational football player will give information about the masses of players in a sport, studying the elite demonstrates the extremes of injury likely in a sport.

The FIFA World Cup™ is the largest, most popular single sport event in the world, viewed by staggering numbers of spectators. This quadrennial competition is the pinnacle of achievement for a player, their team and their country and an enormous source of pride for their fans. The pressure on those players then can be substantial, meaning that their risk of injury might be higher in the FIFA World Cup™ than in domestic competitions.

Using F-MARC’s proven reliable data collection procedure for FIFA competitions, we wanted to focus on the incidence, circumstances and characteristics of injury during the 2002 FIFA World Cup Korea/Japan™, the first ever FIFA World Cup™ in Asia.

Aims of the study

- Analyse the incidence, circumstances and characteristics of injury during the 2002 FIFA World Cup™
- Compare the findings with data reported for previous international men’s football tournaments

How we collected the data

The physicians of 32 participating teams (Fig 2.4.2.1) were required to report on all injuries after each match on the standardised F-MARC injury report form. Because F-MARC had been doing this for all FIFA competitions since 1998, the team doctors were well aware of their role in this data collection process. All team doctors attended a pre-tournament meeting to confirm the procedures and their responsibilities. As such, our response rate was 100% for FIFA World Cup™ injuries.

Results

A total of 171 injuries were reported from the 64 matches, which is equivalent to an incidence of 2.7 injuries per match or 81.0 injuries per 1,000 match hours. Between one and two injuries per match resulted in absence from subsequent training or match (Tab. 2.4.2.1 and 2.4.2.2).

Compared with the table in the chapter on “Review of the literature” (2.1) on epidemiological data, this injury rate of 81 per 1,000 game hours is over double of that of the highest rate reported in the literature. This rate is also the highest amongst all other FIFA competitions as detailed in the previous chapter “Injuries during FIFA competitions”. Slightly more than a quarter of all injuries were non-contact and 73% were contact injuries. Half of the contact injuries (37% of all injuries) were caused by foul play as rated by the team doctor and the injured player, yet only 21% of the situations that led to an injury were identified by the referee as a foul. The top five locations for injury were the thigh, lower leg, ankle, head and knee (in descending order). Injuries tended to increase with time in each half (Fig. 2.4.2.2). The patterns of injury were similar in the group matches and the knock-out rounds.

<table>
<thead>
<tr>
<th></th>
<th>Numbers of injuries</th>
<th>Number of injuries with time lost</th>
<th>No contact</th>
<th>Contact no foul</th>
<th>Contact foul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concussion</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Upper extremity</td>
<td>8</td>
<td>3</td>
<td>0</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Trunk</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hip</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Groin</td>
<td>9</td>
<td>8</td>
<td>8</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Thigh</td>
<td>30</td>
<td>26</td>
<td>17</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Knee</td>
<td>22</td>
<td>15</td>
<td>4</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Lower leg</td>
<td>29</td>
<td>15</td>
<td>5</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Ankle</td>
<td>25</td>
<td>19</td>
<td>3</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Foot</td>
<td>14</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

Tab. 2.4.2.1 Number and circumstances of injury
What we learned from the study

While the incidence of injuries during the 2002 FIFA World Cup™ was similar to those reported for the 1994 and 1998 FIFA World Cups™, there were more severe injuries that led to absence from subsequent training or competition. That fact and the increased number of injuries toward the end of each half might indicate fatigue issues in the preparation for the FIFA World Cup™. It had been suggested that under-performance and injuries might be due to match density in the weeks and months leading up to the FIFA World Cup™. While all players signed a fair play pledge prior to the competition, awareness of the importance of fair play had still to be increased and the role of fair play in the prevention of injury needed to be stressed.
2.4.3 Injuries during the 2006 FIFA World Cup Germany™

Why we conducted this study

To further follow-up on our findings at the 2002 FIFA World Cup™, F-MARC conducted another study on injury incidence at the largest and most widely watched single sport competition in the world four years later. While F-MARC principally applied the same method as in the previously described studies of injuries at every FIFA competition since 1998, at the 2006 FIFA World Cup™ in Germany we followed the consensus statement on injury surveillance with respect to definition, methodology and implementation published in 2006. This consensus defines an injury as “any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities”. An injury that results in a player receiving medical attention is referred to as a “medical attention” injury and an injury that results in a player being unable to fully participate in future football training or competition as a “time loss” injury.

Aim of the study

• Continue the injury surveillance of FIFA’s flagship event at the 2006 FIFA World Cup™

How we collected the data

F-MARC used the same injury surveillance methods as described in the previous chapters. Again, all definitions and duties of the team doctor were explained and discussed at the official FIFA Team Workshop held prior to the competition in March in Düsseldorf in Germany. Each team doctor was required to submit the standard F-MARC injury report form after each match defining the time of injury, location and type of injury, severity (a physician-based estimate of absence), whether the physician felt a foul occurred, whether the referee sanctioned the foul and whether there was treatment (on the field or after the match). These forms were collected by the FIFA Medical Officer at the respective venue and were then faxed to the FIFA medical office.

In addition to this injury assessment by the team doctors, all on-pitch treatments during matches were categorised and digitally recorded. These on-pitch treatments during play were compared against the written injury reports from the team doctors.

Results

A total of 145 injuries were reported (68.7 injuries per 1,000 match hours or 2.3 injuries per match). For comparison, in 2002, there were 171 injuries (80.96 injuries per 1,000 match hours or 2.7 per match; Tab 2.4.3.1). Accordingly, there were marginally fewer injuries in the 2006 FIFA World Cup™ than in 2002.

The number of injuries to the thigh from 2002 to 2006 was reduced (Tab. 2.4.3.2) and there were fewer head injuries reported in the 2006 FIFA World Cup™ than in the 2002 competition. Thirteen head injuries were registered at the 2006 FIFA World Cup™ (6.15 per 1,000 player hours) compared with 25 in 2002 (11.83 per 1,000 player hours). Only one concussion occurred in 2006, whereas four were recorded in 2002. In this competition, injuries increased in the first half, but varied within the second half, not approaching the level seen in that final 15 minutes of the first half.

When the videos of on-pitch treatments were compared with the written reports, only about half of the injuries treated on the pitch were listed on the physician’s report as an injury.

What we learned from the study

There are several possible reasons for the slightly lower injury rate in 2006. First of all, in the 2006 FIFA World Cup™ the national teams had a longer period for preparation, whereas in 2002 the national teams left almost immediately after the end of the domestic season within their own countries. In the case of head injuries, another possible explanation is the stringent application of the laws of the game by the referees. Based on F-MARC research results, The International Football Association Board gave referees the authority to severely sanction what were felt to be injurious fouls such as intentional elbows to the head. In our view, the consequent decrease in head injuries supported the importance of scientific evidence as a convincing factor for the guardians of the laws of the game and the interpretation by referees.
FOOTBALL MEDICINE PROJECTS | EPIDEMIOLOGY OF FOOTBALL INJURY

Duration: 2006
Countries: International
Cooperation: All team physicians of the 2006 FIFA World Cup™
2.4.4 Injuries of Female Players in Top-Level International Competitions

Why we conducted this study

From the very beginning, F-MARC has realised the discrepancy between the ever growing popularity of women’s football and the limited research directed to the female player. Accordingly, we had undertaken a study on 165 female football players from nine teams in the German national league for one complete outdoor season in 2003/2004 as described in a previous chapter. The team physiotherapists had reported all physical complaints associated with football that limited sports participation for at least one day as well as their location, type and circumstances of occurrence. The injury rates reported in that study were similar to those reported for male players. There had been a high match injury rate and a comparably low training injury rate while ACL ruptures occurred rather frequently.

In general, the published work on injuries in women’s football focused mostly on injuries to elite players during their competitive season, yet injuries during major international competitions assuming a high public profile and placing considerable pressure on players, were investigated infrequently. In the previously described study on twelve major international football competitions, F-MARC had reported that the incidences of injury in female players in the 1999 FIFA Women’s World Cup and the football competition of the 2000 Olympic Games were considerably lower than the rates in the corresponding competitions for male players. Therefore, F-MARC decided to give these competitions particular attention.

Aim of the study

- Analyse the incidence, characteristics and circumstances of injuries occurring in top-level international women’s football competitions

How we collected the data

Data collection was undertaken following the established F-MARC method immediately post match at seven international women’s football competitions: the FIFA Women’s World Cups 1999 and 2003, the FIFA U-19 Women’s World Cups 2002 and 2004, the FIFA U-20 Women’s World Cup 2006 and Women’s Olympic Football Tournaments in the 2000 and 2004 Olympic Games. As usual, the physicians of all attending teams were instructed in the use of the single-page form, on which all injuries during a given match or, when applicable, the non-occurrence of injury were recorded, at a pre-competition instructional meeting. For each match, both team doctors were asked to return the completed form for their team to the FIFA Medical Officer. Confidentiality of all information was ensured. An injury was defined as any physical complaint during a match which received medical attention from the team doctor, regardless of the consequences with respect to absence from the rest of the match or training. In the first competition (FIFA Women’s World Cup 1999), an earlier version of the form was used, which did not include the physician’s judgment about foul play and the consequences of the injury.

Results

A total of 387 injuries were reported in the seven competitions. This is equivalent to 2.2 injuries per match or 67.4 injuries per 1,000 player hours. The injury rates ranged from 1.3 injuries per match in the FIFA Women’s World Cup 1999 to 2.9 injuries per match in the FIFA U-20 Women’s World Cup 2006 (Tab. 2.4.4.1).

The overall injury rate was similar for each half, but the lowest rate occurred during the first 15 minutes of each half. Most injuries occurred during player-to-player contact.

The lower extremity was most commonly affected, followed by the head and neck, trunk and upper extremity (Tab. 2.4.4.2). The exact body parts injured most often were the ankle (24%) and head, followed by thigh, knee and lower leg. Most injuries were diagnosed as contusions (45%), sprains or ligament ruptures (26%) and less often strains or muscle fibre ruptures. Twelve injuries were diagnosed as a concussion, 13 ligament ruptures, nine fractures, eight dislocations and two lesions of the meniscus. The most common diagnosis was an ankle sprain (16%), followed by contusions of the head, thigh and lower leg and injuries to the knee ligaments. There were seven ligament ruptures and 15 sprains of the knee.

Only 16% of all injuries were non-contact. In the opinion of the team doctor, 35% of all contact injuries were due
to foul play. However, the referee sanctioned only half of those injuries.

<table>
<thead>
<tr>
<th>Tournament</th>
<th>Injuries per match</th>
<th>Injuries per 1000 match hrs</th>
<th>Time loss injuries per match</th>
<th>Time loss injuries per 1000 match hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIFA Women’s World Cup 1999</td>
<td>1.3</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women’s Olympic Football Tournament 2000</td>
<td>2.1</td>
<td>65</td>
<td>0.8</td>
<td>24</td>
</tr>
<tr>
<td>FIFA U-19 Women’s World Cup 2002</td>
<td>2.8</td>
<td>85</td>
<td>1.6</td>
<td>49</td>
</tr>
<tr>
<td>FIFA Women’s World Cup 2003</td>
<td>1.7</td>
<td>52</td>
<td>0.9</td>
<td>27</td>
</tr>
<tr>
<td>Women’s Olympic Football Tournament 2004</td>
<td>2.3</td>
<td>70</td>
<td>1.0</td>
<td>30</td>
</tr>
<tr>
<td>FIFA U-19 Women’s World Cup 2004</td>
<td>2.2</td>
<td>68</td>
<td>0.7</td>
<td>20</td>
</tr>
<tr>
<td>FIFA U-20 Women’s World Cup 2006</td>
<td>2.9</td>
<td>89</td>
<td>1.0</td>
<td>29</td>
</tr>
<tr>
<td>Overall</td>
<td>2.2</td>
<td>67.4</td>
<td>1.0</td>
<td>29.8</td>
</tr>
</tbody>
</table>

Tab. 2.4.4.1 Incidence of injury in women’s world competitions

What we learned from the study

The incidence of injury in international top-level women’s football competitions was within the range of values previously reported for elite male and female club players, but still lower than the rates from equivalent international men’s competitions. However, the diagnoses and mechanisms of injury among the female players differed substantially from those previously reported in male football players.

Most of the injuries affected the lower extremity, especially the ankle, knee and thigh, a finding also reported previously for elite male and other female football players, with an ankle sprain being the most frequently diagnosed injury. The frequency of head injuries diagnosed as concussions was substantially greater than the numbers reported in men’s competitions. Possible explanations for more concussions being diagnosed in females might be because there is more caution evident in the women’s game or that some concussions in the men’s matches were missed or some concussions were recorded as contusions.

A primary distinction with the circumstances of injuries in males was that about half of all injuries in men are due to foul play while in women, only about one third of injuries were a result of foul play.

<table>
<thead>
<tr>
<th>Location</th>
<th>Total</th>
<th>Without time loss</th>
<th>With time loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/neck</td>
<td>67</td>
<td>32</td>
<td>17</td>
</tr>
<tr>
<td>Trunk</td>
<td>33</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Upper Extremity</td>
<td>32</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Hip/groin</td>
<td>12</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Thigh</td>
<td>47</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>Knee</td>
<td>43</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>Lower leg</td>
<td>41</td>
<td>27</td>
<td>8</td>
</tr>
<tr>
<td>Ankle</td>
<td>93</td>
<td>33</td>
<td>44</td>
</tr>
<tr>
<td>Foot/toes</td>
<td>12</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Tab. 2.4.4.2 Number of injuries by location for women’s world championships

Duration: 1999 - 2006
Countries: International
Cooperation: All team physicians of the competitions
2.4.5 Injuries during the FIFA Futsal World Cups 2004 and 2008

Why we conducted this study

Futsal is a variant of association football played on a smaller pitch with a smaller ball, both indoors and outdoors. It is the official FIFA-recognised version of five-a-side football and as such has similarly strictly defined Laws of the Game. It is played on a hard surface without using boards or walls, allowing it to be staged on handball or basketball courts. Having its roots in some European countries and South America, futsal is continuously gaining more and more supporters worldwide. The first FIFA Futsal World Cup was played in 1989. The game is considered a “school of football” with high demands on technique and skills, speed and agility. It is therefore used for youth development in many countries. Considering this broad use in youth players, it is a concern that it is far less extensively studied from a sports medical and scientific perspective than football. A few studies on its physical demands showed that futsal includes more high intensity activities than football. With regard to injuries, some studies on indoor football had shown inconsistent results when compared with 11-a-side outdoor football, and nothing was known on futsal injuries. We therefore decided to gain a better understanding of injuries in futsal in order to be able to design targeted prevention measures.

Aim of the study

- Analyse the incidence and characteristics of injury during FIFA Futsal World Cups and compare the results with FIFA World Cups™

How we collected the data

We investigated three Futsal World Cups in 2000, 2004 and 2008. As our objective was to compare the frequency and characteristics of injuries in futsal with injuries in football, we applied exactly the same injury recording definitions and system as had been used at all other FIFA World Cups™. An injury was defined as any physical complaint resulting from match play and attended to by the team doctor. The team doctor would record the details of injuries that occurred in their team on the standardised form after each match. Due to the different duration of futsal matches and a smaller number of players, number of injuries per match would not allow for comparison with football, so we also calculated injuries per 1,000 player hours and per 1,000 player matches as had been recommended for team sports.

Results

The average response rate throughout all three events was 93%. In total, 253 match reports were analysed, corresponding to 843 player hours. This resulted in 165 injuries overall which translated into 1.3 injuries per match, 195.6 injuries per 1,000 player hours and 130.4 injuries per 1,000 player matches.

With regard to circumstances, more injuries (64%) occurred during contact with another player and less than half of these injuries were due to foul play. Overall, one quarter of all injuries was due to foul play. Based on the judgement of the team doctors, two thirds of these foul plays were consequently sanctioned by the referees. There was no difference in injury occurrence between the first and second half of matches.

About 70% of all injuries concerned the lower extremity, with the second most frequent location being the head and neck with 13%. The knee was the most often affected body part prior to the thigh and ankle. Most injuries were classified as contusions, followed by joint sprains and ligament ruptures. Information on the expected loss of playing time due to the injury was available in 84% of all injuries, and showed that almost half of the injuries resulted in some absence from play, most of them of a duration of one to three days.

What we learned from the study

This study was the first to provide a more detailed picture of the frequency and characteristics of injuries in futsal based on a scientifically validated recording method. In absence of comparable data from futsal, the most important and relevant comparison to make was the one with football. Importantly, this would need to consider the different duration of matches, rules and player numbers. Therefore, injury frequency had to be based on the time effectively played and not on match incidence.
A major finding was the 2.6 times higher injury rate in futsal as compared to football when relating the incidence to the time spent playing. However, when comparing the frequency of injuries related to player hours, the incidence was in fact similar for both games. Differently from what might be expected given the smaller pitch dimensions, fewer injuries in futsal were caused by contact with another player, and fewer injuries were due to foul play than in football.

With regard to severity, fewer injuries in futsal (about a half) resulted in absence from play as compared to football where these accounted for more than two thirds of all injuries. As in elite football players, most of the injuries occurred at the lower extremity with contusions and ankle sprains being the most frequent diagnoses. There was a higher incidence of groin strains in futsal, possibly related to the higher agility and speed of play. Concussions also occurred markedly more often in futsal than in football (3.6 times) where rule changes in force since 2006 had led to a reduction of concussions.

The insights gained in this study need to be substantiated in further investigations, in particular with regard to injury causes in order to be able to develop effective prevention methods for futsal players. This would apply especially to concussions and groin injuries as the more frequent injury types compared to football.
2.4.6 Injuries and Illnesses at the 2010 FIFA World Cup South Africa™

**Why we conducted this study**

During three consecutive FIFA World Cups™, and multiple youth and women’s events, F-MARC had recorded all injuries occurring during matches, resulting in a comprehensive database allowing for comparison between different player groups and observing trends over time. However, much less was known about injuries occurring during training and illnesses of players during these events. The European Football Confederation UEFA had documented training injuries during its championships in 2004 and 2008 showing that they resulted in absence from play during elite events in football. F-MARC had considerably contributed to the expansion of the injury recording system to include illnesses at the 2008 Olympic Games. In a pilot study during the FIFA Confederations Cup 2009, F-MARC had found an incidence of illnesses of 16.5 per 1,000 player days with the majority being respiratory tract infections. It was therefore decided to extend the established surveillance of injuries during matches to training injuries and illnesses occurring at any time during the 2010 FIFA World Cup™ in order to give more meaning to the Confederations Cup data by comparison.

**Aims of the study**

- Analyse the incidence and characteristics of injuries in both match play and training during the 2010 FIFA World Cup™
- Analyse the incidence and characteristics of illnesses in players during the 2010 FIFA World Cup™

**How we collected the data**

All team doctors were informed in detail of the planned extended investigations at the team workshop four months prior to the event. The existing and well-established injury recording system during matches at FIFA competitions was amended to include training injuries and illnesses. The definitions of injury and recording parameters remained the same, but in addition team doctors were asked to provide the duration of training sessions and document injuries occurring during the same. In compliance with the definition of the term “incidence”, illnesses were defined as any physical complaint (unrelated to injury) newly incurred during the event. Pre-existing chronic disease was not to be reported unless an exacerbation necessitated medical attention by the team doctor. Both training injuries and illnesses had to be reported daily.

**Results**

Overall, the 2010 FIFA World Cup™ comprised 64 matches and 736 players. As half of the teams were expelled after the group matches and the remaining teams stayed for a variable further period of time, all calculations for illnesses and training injuries were made based on player days which amounted to a total of 13,179. Overall response rate by team doctors was 97.4% with four match reports missing, and in about 13% of the daily non-match day reports the training times were either missing or illegible.

A total of 125 injuries were reported, resulting in an incidence of two injuries per match. Almost two thirds of the injuries resulted from contact with another player, less than a quarter of these due to foul play. Injury frequency showed a continuous increase with the duration of play and was highest during the last 15 minutes of matches. As previously seen, almost three quarters of the injuries were to the lower extremities, with contusion of the thigh and lower leg as well as a thigh strain being the most frequent diagnoses. About a third of the injuries did not prevent the player from continuing to play, and half of them resulted in an absence from play of one to three days. Only two injuries resulted in absences of more than a month. The overall incidence of time-loss injuries was 1.3 per match.

During training sessions, 104 injuries occurred, corresponding to 7.9 injuries per 1,000 training hours. About 40% of injuries occurred in contact with another player, a quarter was classified as overuse injuries and about 13% as a recurrence of a previous injury. The most frequent diagnoses where ankle sprains and thigh strains. About 57% of training injuries resulted in an absence from play, in half of them this absence was estimated to be one to seven days.

During the event, 99 illnesses occurred in 89 players (12.1% of all players), corresponding to 7.7 per 1,000 player days. Most illnesses concerned either the respiratory or the digestive system, with the most frequent diagnosis...
being an upper respiratory tract infection (almost a third of cases) followed by gastroenteritis (21%) and sleep disorders (10%). The most frequent symptoms were pain, fever, diarrhoea/vomiting and dyspnoea/cough. Causes identified were in the vast majority infections and less often environmental. Medication was the most often used therapy, with antibiotics and oral analgesics, either alone or in combination, being the most frequently used type of medication. Most of the illnesses did not cause any absence from play (59%) or only a short absence of one to three days with an average time loss per illness of 1.8 days.

What we learned from this study

There was a continuation of the downward trend in match injuries observed over the previous three FIFA World Cups™ both for total injuries and time-loss injuries per match. The location and type of injuries did not differ much as compared to previous competitions, but the cause of injury showed a much higher proportion of injuries occurring without contact with another player (36% in 2010 as compared to 27% in 2002 and 2006). This could cautiously be explained as a consequence of too high match loads on players resulting in fatigue, an explanation which would be supported by the increase of injury frequency with time during matches. Less than a quarter of injuries were due to foul play, which deviates markedly from previous observations and needs to be assessed further.

Training injuries did not differ substantially with regard to severity, but there were differences in the cause and type of injury. The frequency of time-loss training injuries was similar as in the UEFA studies at the EURO. Illnesses occurred in 12% of players, which would be a proportion almost twice as high as was found at the swimming and athletics championships and the 2010 Winter Olympic Games also investigated by F-MARC. As the duration of these events varies considerably, however, the way to compare them is illness related to player days. Doing so, the results were indeed similar as compared to, for example, the athletics championships.

Overall, the trend towards fewer injuries at FIFA World Cups™ was considered as being extremely positive and a result of the many preventive efforts by FIFA and F-MARC over the years. Illnesses occurring during the event did not present a major problem for participating teams, either with regard to frequency or severity and consecutive absence from play. Their characteristics of illnesses complied with what would be usually expected in a travelling party.
2.4.7 Injury Surveillance in World Football Tournaments 1998-2012

Why we conducted this study

Protecting the health of their athletes should be a key concern for all international sports bodies, and injury surveillance is an important prerequisite for injury prevention. FIFA started to systematically document all injuries incurred by players during its tournaments as early as 1998. Until the end of 2012, football injuries have been surveyed in all 51 FIFA tournaments as well as in the four Olympic Games (2000-2012), and valuable insights on the incidence and characteristics of football injuries could be gained. This study is unique in that no other report on such comprehensive number of tournaments or over a period of 14 years has yet been published.

Results

From 1998-2012, 1,681 matches were played in the 53 top-level tournaments, and the team doctors returned 3,091 completed injury report forms to the FIFA Medical Officers. This corresponds to an average response rate of 92%.

A total of 3,944 injuries were reported from 1,546 match- es, which is equivalent to 2.6 injuries per match. The incidence of injury varied between 1.9 (FIFA Women’s World Cups) and three (FIFA U-20 World Cups) injuries per match in the different types of tournaments. In general, the injury incidence was lower in tournaments for female players compared with the respective tournaments for male players (except for the Olympic Games). The incidence of injuries in male players decreased in the FIFA World Cups™ and in the football tournaments of the Olympic Games from 1998 to 2012. The opposite trend was observed for female players in the FIFA Women’s World Cups 1999 to 2007, the football tournaments of the Olympic Games from 2000 to 2008, and the FIFA U-17 Women’s World Cups 2008 to 2012 (see Figures 1 and 2). For the World Cups, it could be shown that the contrary trends for men and women were due to the changes in the number of contact injuries.

Most injuries affected the lower extremity (70%), followed by injuries to the head and neck (15%), trunk (8%) and upper extremities (7%). The majority of injuries were sustained during contact with another player while 20% of all injuries were due to non-contact activities. Based on the judgment of the team doctors, almost half (47%) of the contact injuries were caused by foul play. In tournaments of female players, significantly fewer contact injuries were caused by foul play than in the respective tournaments of male players (except for the FIFA U-19/U-20 World Cups). Since only half of the injuries incurred during matches (47%) actually prevented players from participating in a match or training, the overall incidence of time-loss injuries was 1.1 per match. The incidence of time-loss injuries was similar in male and female players when the same types of tournaments were compared, except for the FIFA World Cup™ where the injury rate was significantly lower in female players.
What we learned from the study

During the past 14 years, injury incidence in top-level football tournaments changed: while the injuries rate in male players decreased, the opposite trend was observed in female players. These changes seem to be influenced by playing style and refereeing. A strict application of the Laws of the Game is thus an important means of injury prevention. Beyond that, more detailed studies on injury mechanism and refereeing in injury situations are needed to make specific recommendations for future injury prevention in top-level tournaments.

Duration: 1998 - 2012
Countries: International
Cooperation: All team physicians of the world football tournaments
2.5 Risk Factors and Injury Causation

2.5.1 Risk Factors of Injuries in Different Ages and Skill Level

Why we conducted this study

The F-MARC approach to prevention is based on a risk management model. In order to prevent injury, the factors that contribute to injury must be identified. Once the various risk factors have been identified, studies need to test just which factors are significant predictors of injury. After the particular factors have been identified, prevention programmes can be designed. Once designed, these programmes need to be tested continually to see if they do indeed reduce injuries before being communicated to the players on a broad base. When F-MARC was established, the medical literature contained only incomplete and contradictory information on risk factors for football injuries. So, after having established the frequency and characteristics of football injuries, we turned to the risk factors as the next step in our approach to prevention.

Aims of the study

• Analyse the influence of intrinsic and extrinsic risk factors on the occurrence of football injury
• Create a multidimensional predictor score for football injuries

How we collected the data

Following our scientific principles, F-MARC undertook a prospective project: after performing a baseline examination of possible predictive variables, almost 400 Czech players were followed up weekly for one year to register subsequent injuries and complaints. The baseline investigation included a medical examination, a football-specific test, and a questionnaire to obtain information on potential injury predictors and then all players were followed up weekly for one year to register subsequent injuries and complaints.

Results

398 players from the Czech Republic had weekly follow-ups over one year, and complete information was obtained from 264 players (67%). The players averaged 19 years of age. A majority of the players (82%) were injured during the observation period.

The baseline assessment as well as the questionnaire showed several differences between the injured and the uninjured players. This allowed us to identify 17 risk factors for injuries covering a wide spectrum of issues such as previous injuries, acute complaints, inadequate rehabilitation, poor health awareness, life-event stress, playing characteristics, slow reaction time, low endurance, insufficient preparation for games and more. In a next step, the individual risk factors were added and a predictive sum was calculated for each player. We hypothesised that the more baseline risk factors present, the higher the probability of that player incurring an injury in the ensuing year.

Risk factors for football injuries

- Number of previous injuries
- Wearing bandages to treat acute injury
- Pain in the joints
- Age of beginning football (older than six)
- Did not begin football in a club
- Recently changed to another club
- Body fat proportion
- Smoking
- Drinking alcohol (more than two days a week)
- Reaction time
- Life-event stress
- Muscular warm-up (fairly poor or poor)
- Endurance (pulse rate >135 beats/min five minutes after 12-minute run)
- Self rating: dribbling/long passing (average to poor)
- More a “fighter” than technician when getting past an opponent
- Exhausted or aching/stiff muscles before a game (often or always)
- Regeneration during preparation period (one day a week or less)

Figure 2.5.1.1 shows the relationship between the sum of risk factors and the proportion of those players with that sum of risk factors. For example, about 65% of the uninjured players had no risk factors while only about 35% of the injured players had no risk factors. For the injured players, the more baseline risk factors, the more these players were injured. With but a few exceptions, if a player had five or more risk factors, they suffered an injury.
FOOTBALL MEDICINE PROJECTS | EPIDEMIOLOGY OF FOOTBALL INJURY

**Duration:** 1996 - 1998  
**Countries:** Czech Republic, Germany, France  
**Cooperation:** Czech Football Association  

During that season, if we used two risk factors as the cutoff score, more than 80% of the players were correctly classified as to whether they went on to incur an injury (Tab. 2.5.1.1). Another important finding was that the more baseline risk factors, the more severe the injury (Fig. 2.5.1.2). The multidimensional sum of risk factors was a reasonable way to identify who might be injured, but failed to correctly identify the nature of injury, e.g. contact vs. non-contact.

Fig. 2.5.1.1 Proportion of uninjured and injured players in relationship to the sum of risk factors

![Proportion of uninjured and injured players](image)

Fig. 2.5.1.2 Sum of risk factors and injury severity

![Sum of risk factors and injury severity](image)

<table>
<thead>
<tr>
<th>Number of previous injuries (more than 6)</th>
<th>Uninjured</th>
<th>Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain in the joints (more than ‘a little’)</td>
<td>4.3</td>
<td>15.9</td>
</tr>
<tr>
<td>Muscular warm-up (fairly poor or poor)</td>
<td>6.5</td>
<td>19.4</td>
</tr>
<tr>
<td>Self rating of dribbling or passing (average to poor)</td>
<td>26.2</td>
<td>45.8</td>
</tr>
<tr>
<td>Recent change of club (yes)</td>
<td>12.8</td>
<td>31.4</td>
</tr>
</tbody>
</table>

**Tab. 2.5.1.1 Frequency of selected risk factors (% of total)**

<table>
<thead>
<tr>
<th>Sum of risk factors</th>
<th>Uninjured</th>
<th>Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤2</td>
<td>66.7</td>
<td>14.7</td>
</tr>
<tr>
<td>&gt;2</td>
<td>33.3</td>
<td>85.3</td>
</tr>
</tbody>
</table>

The research group during the risk factor study in Prague 1996

**What we learned from the study**

Having determined that multiple risk factors are indicative of potential injury, it made sense to try and determine how to reduce those risk factors. If a player could reduce their number of risk factors, they should be reducing their risk of injury. But how to achieve that? Players themselves need to work on their own to improve their fitness, skill, lifestyle habits and maintain a commitment to fair play. Further, coaches need to ensure they properly apply training principles for warm-up, progression of work load in a session and throughout the season, a reasonable training/match relationship and more. Medical professionals need to ensure adequate rehabilitation and recovery, pay attention to player’s complaints and suggest preventive measures. Finally, officials and administrators need to continually look at the rules with an eye towards safety.
2.5.2 Risk Factors for Injuries in Elite Female Football Players

Why we conducted this study

Epidemiological data on injuries in elite female football players had been rare for a long time. Consequently, F-MARC had aimed to contribute to the body of knowledge and conducted prospective epidemiological studies in professionals and world championship events, which found that in high level female football, injury incidence is as high as in professional male football.

Risk factors in elite football had also been only incompletely evaluated. In Iceland, increasing age and previous injury were the main risk factors for injury. In contrast, age was not a factor in lower division Swedish female players. Although many possible variables had been evaluated in studies on risk factors, only a few consistent results had been reported. This could have partly been due to differences in, for instance, the gender or skill level of the populations investigated. However, no study had so far analysed risk factors for injuries in elite female football players, and we therefore decided to finally address this issue.

Aims of the study

- Identify risk factors for injuries in female football players in the German national league on the basis of player characteristics
- In a prospective manner, document the injury incidence over an entire outdoor season

How we collected the data

All twelve teams of the German women’s professional league were invited and eight teams submitted complete data. Each team was contacted weekly to ensure compliance and update data records. A total of 143 players were followed over an entire season.

The coach reported exposure and the physiotherapist for each team recorded baseline information. This included anthropometric data, position, preferred leg, prior season matches and a detailed medical history with emphasis on past ligament injuries.

The physiotherapist also recorded injuries and reasons why a player was unable to participate. An injury was defined as “any physical complaint associated with football (received during training or match play), which limits athletic participation for at least the day after the day of onset”. A player was injured until she was able to participate fully in games and/or training. An overuse injury was the consequence of repetitive micro-trauma. An injury was traumatic if it was caused by a single traumatic incident. Traumatic injuries were classified further as contact or non-contact.

Results

In these elite female football players, we found the following (see also Tab. 2.5.2.1):

- The tallest players (>175cm) had the highest rates of injury.
- The heaviest players as well as the players who had played the most matches in the previous season showed the highest non-contact injury rate.
- Injured players, especially those with non-contact injuries, were found to have the least training and total exposure time.
- The players with the highest match exposure (>45 hours per season) had the lowest injury rate.
- Players with a previous ACL rupture had a high risk of another rupture. However, a history of an ankle or knee sprain was not predictive of another sprain.
- The injury rate for defenders and strikers was greater than for midfielders or goalkeepers. Injuries to field players were mostly contact injuries while injuries for the goalkeeper were mostly non-contact.
- A total of 62% of players were either uninjured or sustained only one injury during the season; 15% had two injuries, 13% had three injuries and 10% had four or more injuries. Thus, the players who sustained four or more injuries accounted for 30% of all reported injuries.
- More injuries occurred to the dominant limb especially more ankle injuries, ligament ruptures and contusions.
<table>
<thead>
<tr>
<th>Mechanism</th>
<th>Total</th>
<th>Dominant</th>
<th>Non-dominant</th>
<th>X²</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overuse</td>
<td>22</td>
<td>16</td>
<td>6</td>
<td>4.545</td>
<td>0.03</td>
</tr>
<tr>
<td>Contact</td>
<td>81</td>
<td>52</td>
<td>29</td>
<td>6.747</td>
<td>0.01</td>
</tr>
<tr>
<td>Non-contact</td>
<td>73</td>
<td>37</td>
<td>36</td>
<td>0.014</td>
<td>0.91</td>
</tr>
<tr>
<td>Body part</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thigh, groin, hip</td>
<td>56</td>
<td>33</td>
<td>23</td>
<td>1.786</td>
<td>0.18</td>
</tr>
<tr>
<td>Knee</td>
<td>42</td>
<td>25</td>
<td>17</td>
<td>1.524</td>
<td>0.22</td>
</tr>
<tr>
<td>Lower leg</td>
<td>19</td>
<td>7</td>
<td>12</td>
<td>1.316</td>
<td>0.25</td>
</tr>
<tr>
<td>Ankle</td>
<td>41</td>
<td>27</td>
<td>14</td>
<td>4.122</td>
<td>0.04</td>
</tr>
<tr>
<td>Foot, toe</td>
<td>18</td>
<td>13</td>
<td>5</td>
<td>3.556</td>
<td>0.06</td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sprain</td>
<td>66</td>
<td>33</td>
<td>33</td>
<td>0.000</td>
<td>1.00</td>
</tr>
<tr>
<td>Including rupture of ligament *</td>
<td>26</td>
<td>18</td>
<td>8</td>
<td>3.846</td>
<td>0.049</td>
</tr>
<tr>
<td>Contusion</td>
<td>36</td>
<td>24</td>
<td>12</td>
<td>4.000</td>
<td>0.046</td>
</tr>
<tr>
<td>Strain</td>
<td>33</td>
<td>19</td>
<td>14</td>
<td>0.758</td>
<td>0.38</td>
</tr>
<tr>
<td>Fracture</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0.000</td>
<td>1.00</td>
</tr>
<tr>
<td>Others</td>
<td>39</td>
<td>28</td>
<td>11</td>
<td>7.410</td>
<td>0.01</td>
</tr>
<tr>
<td>Total</td>
<td>176</td>
<td>105</td>
<td>71</td>
<td>6.568</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Significant p values are in bold.
* This row shows only the number of complete ligament ruptures (grade III sprains), which are also included in the row above (all sprains grade I–III). Data in this row are not included in the totals at the bottom.

Tab. 2.5.2.1 Mechanism, affected body part as well as diagnosis of injuries as related to the injured leg

What we learned from this study

This study pointed out the importance of identifying players with risk factors with regard to e.g. anthropometric characteristics, playing position and injury history. Once identified, it appeared appropriate to individualise training programmes for injury prevention as was already recommended for other training contents for example, improving conditioning training to reduce the risk of late match injuries. In addition, the rules and application of the rules, especially in contact situations, should be considered by the responsible football associations. We concluded that appropriate education of referees in the awarding of more stringent penalties for foul play could also help to decrease injury risk.

Duration: 2003 - 2004
Country: Germany
Cooperation: Schulthess Klinik, Zurich; University of Saarland, Germany
2.5.3 Tackling Situations of Male Players during FIFA Competitions

Why we conducted these studies

Risk is the chance of something adverse happening. Although adverse events typically result in harm such as substantive loss or personal injury, they provide important learning experiences. If a work-related event happens, most organisations take the opportunity to identify, analyse, and get some understanding of the underlying causes of the event in order to develop procedures that would prevent such an occurrence from happening again. Specifically in football, an adverse event like a tackle is scrutinised by the referee at the time. Sometimes, the sport’s governing bodies use video coverage after the match has concluded. However, such retrospective assessments have more often been used to ensure that players and teams are held accountable and punished for foul actions rather than to use the information to act in a proactive manner to determine risk that would allow injuries to be reduced or prevented.

Most observers of the game would agree readily that tackling is the most dangerous action in football. F-MARC had learned from previous work that player-to-player contact is responsible for nearly 50% of post-match injury reports and foul tackles for nearly 30% of on-pitch and 20% of post-match medical reports. Being tackled, as opposed to tackling, was shown to be responsible for more than 60% of injuries. In another study, F-MARC also investigated how well (or how poorly) referees detect injury-provoking activities during the stresses of competition. The referees, however, must not bear all the weight of judgment on injuries – the players also make decisions that can lead to injuries. Referee and player decisions plus rules interpretation affect the outcome of these player-to-player confrontations.

We felt that with some understanding of tackle parameters it could be possible to identify changes to the laws of football relating to tackling to reduce the level of injury in football. To improve safety of players during these risky situations, we needed to detail just what actions went into a tackle and the outcome of that tackle.

Aims of the studies

- Determine which tackles have the greatest injury potential
- Investigate players’ errors associated with tackling in the context of international football
- Identify and classify tackle parameters
- Quantify the frequency of tackles that might lead to injury and rank those tackles with the greatest propensity for injury
- Identify where changes to the laws of football about tackling might produce a reduction in the level of injury in football

How we collected the data

We used the video recordings from 123 matches in three FIFA competitions to identify tackling parameters (direction, action, mode, match time, contact location, diagnosis and severity). Consistent with the F-MARC projects at FIFA competitions, team doctors had to provide reports of post-match medical attention to players.

A total of 8,572 tackles were assessed of which 3,464 (40.4%) were fouls. A total of 299 incidents required on-pitch medical attention and 131 of these (44%) were from foul tackles, 76 (25%) of which lead to a post-match physician report. Of the over 8,000 tackles, 200 resulted in post-match injury reports and 96 of these (48%) were from foul tackles (Fig. 2.5.3.1). Of those players whose injury generated a post-match report, 74% were the tackled player. A little over half of those injured lost no time as a result of their injury and 30% of the injuries were minor. There were no differences in severity or playing position whether the player was tackled or was the tackler.

Fig. 2.5.3.1 Consequences of tackling
The critical findings about tackling

Of special interest in this project were the tackling action, mode and direction that led to injury. Conversely to what was believed prior to the study, tackles from the side were twice as likely to require post-match medical attention as tackles from behind. Injuries to the head or neck (for both players) and the torso (for tackling players) were most likely to receive on-pitch medical attention while injuries to the foot (for both players) and the lower leg and thigh (for tackling players) were less likely to receive on-pitch medical attention. Tackles with the greatest tendency for injury involved clash of heads and two-footed tackles (for tackled players) and clash of heads, two-footed tackles, jumping vertically and tackles from the side (for tackling players). From information like this, a framework of injury mechanisms and risk of injury was developed (Tab. 2.5.3.1).

<table>
<thead>
<tr>
<th>Framework sector</th>
<th>Tackle category/injured player’s status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tackled</td>
</tr>
<tr>
<td>Very high</td>
<td>Clash of heads</td>
</tr>
<tr>
<td>High</td>
<td>Two footed</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>- Front</td>
</tr>
<tr>
<td></td>
<td>- Side</td>
</tr>
<tr>
<td></td>
<td>- Sliding in</td>
</tr>
<tr>
<td></td>
<td>- Staying-on-feet</td>
</tr>
<tr>
<td></td>
<td>- Jumping vertically</td>
</tr>
<tr>
<td></td>
<td>- Upper-body contact</td>
</tr>
<tr>
<td>Low</td>
<td>Behind</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Very low</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 2.5.3.1 Framework sector corresponding to the propensity for each tackle category to cause injury for tackled and tackling players.

What we learned from the studies

These are probably the only investigations into tackling in such detail with comparison in relation to player error. Our analysis suggested that player error during tackling, inadequacies in the laws and/or their application by referees were equally responsible for the high levels of injury observed.

Although referees play a major role in managing on-pitch incidents, the greater responsibility for injuries rests with the football’s ruling bodies to ensure the Laws of the Game are adequate, implemented efficiently, and that players are held accountable for serious injuries resulting from their errors whether by poor tackling technique, lack of experience, or deliberate violation of the laws of football. This study showed that, different to previous belief, tackling from the side is far more dangerous than tackling from behind. The laws of football relating to tackling need to be continuously reviewed to ensure greater protection from injury by reducing the overall level of risk and by protecting players from tackles with the highest propensity for injury.

We estimated that 44% of the injuries that required on-pitch attention were due to player error and rules inadequacies were responsible for the remaining 56%. The relationships for injuries that required post-match medical attention was similar (48% and 52% respectively).
2.5.4 Video Analysis of Ankle Injuries

Why we conducted this study

In our precedent studies, we had established that the most common location of injury is to the ankle, knee and thigh with ankle injuries in particular ranging between three and nine per 1,000 player hours. It was also known that football players are more predisposed to arthritis of the ankle joint than is the general population. The high prevalence of arthritis in the ankle among retired football players also supported that there was an important need to identify the causes and mechanisms of foot and ankle injuries.

Player-to-player contact is a risk factor in the majority of football injuries, but it would make intuitive sense to have as complete an understanding as possible for the most frequent injuries. Consequently, F-MARC wanted to establish a full accounting of the mechanisms leading to the most frequent injuries to the foot and ankle so that if a prevention programme were developed, the programme would have substantive impact for those practising this programme.

Aims of the study

- Determine the specific mechanisms of ankle injury from match video recordings of injuries
- Assess the relationships between foot/ankle injuries and foul play and tackle type

How we collected the data

The study was designed to obtain information on ankle injuries across the age spectrum of international competitions. We studied four international competitions (1998 FIFA World Cup™, FIFA U-17 World Championship 1999, 2000 Olympic Games, and FIFA U-20 World Championship 2001) These four competitions were chosen so that a wide range of ages could be studied (U-17, U-20, U23 and full nationals). Video recordings from 180 matches were reviewed against the physician reports of ankle injuries. Recordings of 85 ankle and 29 foot injuries were examined for common factors of injury and 76 of these recordings were of sufficient quality for analysis.

Results

Of these 76 injuries, 52 (69%) were contusions, 20 (26%) were sprains, and four (5%) were fractures. The injuries were nearly equally split between the two halves. In 72 of the 76 cases, these injuries involved direct player-to-player contact which often happened during upright tackling from the side or behind. The forces and direction of impact lead to injury. Fouls were called in about half to two thirds of the times an injury occurred.

Significantly more injuries involved a tackle from the side with a lateral or a medial tackling force. The injured limb was usually weight-bearing at the time of injury. The injuries that resulted in the most time lost from football happened when the limb was weight-bearing. The most common foot and ankle positions at the time of injury were pronated/neutral in the sagittal plane (foot pointed straight ahead) for weight-bearing limbs, and plantar flexed/neutral in the coronal plane (foot pointed laterally) for non-weight-bearing limbs. The most common foot and ankle rotations at the time of injury were external (23 or 30%) and evasion (28 or 37%).

Despite the more severe incidents involving the weight-bearing limb, referees were no more likely to punish a player for a foul on a weight-bearing limb than they were to penalise for an incident to the non-weight-bearing limb. Most of the incidents leading to injury were punished with a sanction for a foul (Tab. 2.5.4.1).

<table>
<thead>
<tr>
<th>Tackle direction</th>
<th>Foul</th>
<th>Not foul</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Side</td>
<td>31</td>
<td>21</td>
</tr>
<tr>
<td>Behind</td>
<td>13</td>
<td>5</td>
</tr>
</tbody>
</table>

Tab. 2.5.4.1 Number of injuries deemed to be fouls as a function of tackle direction (n=76)

What we learned from the study

Ankle injuries differ from knee ligament injuries because the ankle is damaged during contact while the majority of knee injuries show no direct contact. The majority of ankle injuries were caused by tackles involving lateral or medial forces that created a corresponding eversion (the sole of the foot rolls out) or inversion (the sole of the foot rolls in) rotation of the foot. If the player stayed on this foot, the risk for severe injury was far higher. A primary football-specific mechanism was identified:
player-to-player contact with impact by an opponent on the medial aspect of the leg just before or at foot-strike resulting in a laterally directed force causing the player to land with the ankle in a vulnerable, inverted position. A laterally directed blow to the ankle (Figure 2.5.4.1) may not be the cause of the injury, but rather place the ankle into a particularly vulnerable position that cannot be corrected prior to the ligament tearing.

The proportions of injuries that were deemed to be the result of a foul were very similar whether or not the incidents were a time loss injury. Rules enforcement had drastically reduced the incidence of tackles from behind and we suggested that similar enforcement needed to be applied to tackles from the side. Whether the penalty should be a yellow card, red card, or a possible timed suspension is a matter for the rule makers to consider. Legal tackles can still lead to injury.

Fig. 2.5.4.1 Proposed mechanism of a lateral ankle sprain during tackling. Illustration reproduced with permission. ©Oslo Sports Trauma Research Center/T. Bolic

Duration: 2001 - 2003
Countries: International
Cooperation: Harvard Combined Orthopaedic Surgery Program, Boston, Massachusetts, USA; University of Leicester, UK
2.5.5 Causation of Injuries in Elite Female Players

Why we conducted this study

It had been reported that “the women’s game is rapidly changing not only in playing dynamics but also the distinct athletics of the players”. Accordingly, public interest in women’s football is constantly on the rise. This reflected a positive trend in the international standing of female football players and of the sport in general, and more and more international competitions have been integrated within the official calendar of FIFA.

However, enhanced physical condition, and especially higher match exposure, may lead to an increased risk of injuries in the female player. Some publications supported with findings of F-MARC had indicated a lower injury rate for women than for men yet older findings had shown the opposite. It had been stated that age and skill-level may have more of an influence than gender alone. We therefore intended to investigate further the mechanisms of injury in women’s football to gain a better understanding of the risk factors involved in order to develop effective prevention programmes.

Aims of the study

- Analyse the various tackling parameters that lead to injury in women’s football
- Investigate the mechanisms of injury in women’s football
- Compare these with results reported previously for men’s football

How we collected the data

We studied six FIFA women’s competitions from 1999 to 2004. Injuries were recorded using the established F-MARC injury reporting procedures. Videotapes of each match were provided by FIFA Information Systems and used to identify relevant parameters of injury. For each contact injury recorded on videotape, the following factors were determined:

- Tackling direction of the tackling player with respect to the tackled player (behind, side, front)
- Tackling mode of the tackling player (staying on feet, sliding in, jumping vertically)
- Tackling action adopted by the tackling player (one-footed, two-footed, use of arms, use of upper-body, use of head)
- Match referee’s decision (non-foul, foul, yellow card, red card)
- On-pitch treatment defined as any medical attendance seen on video
- Time in the match
- Striking player defined as the player putting in active force in the incidence leading to injury

Results

There were 293 injuries reported and 233 injuries could be categorised using the parameters in this project. Of the 233, a total of 200 were due to contact and 33 were non-contact injuries.

Sixty percent of all contact injuries were to the lower extremity. More specifically, contact injuries were centred on the head and neck (20%), ankle (19%) and thigh (13%). Of the non-contact injuries, over half were to the lower extremity. The non-contact injuries to the head and neck as well as trunk injuries were all due to accidental ball impact.

Tackling details

Most tackles that led to injury in females were from the side (52%), front (38%), and behind (11%). One-footed tackles or tackles with an upper body action accounted for 86% of all injuries. Injuries from a two-footed tackle were all to the tackled player (Tab. 2.5.5.1).

There was no difference in injuries according to playing position, time in match, type or stage of competition. Goalkeepers were injured from tackles from the front while forwards and defenders were hurt from tackles from the side. Defenders sustained more injuries as the tackling player than any other position. Non-contact injuries were most common in forwards and least in midfielders. This type of injury increased by 30% in the second half of play.
Injuries per 1000 tackles - women

<table>
<thead>
<tr>
<th>From behind</th>
<th>1-footed</th>
<th>Injuries per 1000 tackles - men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Side</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Jumping</td>
<td>6</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>From the side</th>
<th>1-footed</th>
<th>Injuries per 1000 tackles - men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing</td>
<td>54</td>
<td>36</td>
</tr>
<tr>
<td>Side</td>
<td>30</td>
<td>28</td>
</tr>
<tr>
<td>Jumping</td>
<td>19</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>From the front</th>
<th>1-footed</th>
<th>Injuries per 1000 tackles - men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>Side</td>
<td>28</td>
<td>21</td>
</tr>
<tr>
<td>Jumping</td>
<td>15</td>
<td>4</td>
</tr>
</tbody>
</table>

Tab. 2.5.1.1 Summary of women’s tackling injuries

Time loss injuries

Half of all injuries led to some time loss. This was a constant across all variables of injury (location, playing position, time of injury, various tackle parameters). Fourteen time-loss injuries leading to seven or more days away from play were identified on the videotapes. Four of the 14 were non-contact injuries and all required the players to be substituted. The ten contact injuries were equally split between tackles from the front or side. The referee sanctioned the offending player in three instances (one yellow card) and all but one was substituted within ten minutes of the tackle.

What we learned from the study

Player-to-player contact is a major cause of injury in international top-level football. It is often presumed that the player being tackled is the one who gets injured, but most we found in this study that injuries occur about equally to the player executing the tackle and the player being tackled.

This study identified several differences in the causation of injuries between women’s and men’s football. Tackles from behind were rarely seen in injury situations in female players, whereas sliding-in tackles were shown to have a much higher risk than in men’s football. Several investigations had identified elbowing as frequent high-risk tackling mechanisms and these have led to suggested changes in the laws of the game. Differently from men’s football, the use of elbow in aerial challenges was rarely seen as a cause of injury in women’s football.

Findings like these once more cautioned F-MARC against applying what we know about men’s football to the women’s game. These gender differences in tackle properties need to be taken into account by the match referees to ensure the safety of the players.
2.5.6 Tackling Situations of Female Players in Top-Level Competitions

Why we conducted this study

With the aim of prevention, it is not only important to know the number of injuries sustained in football training and matches, but also to understand the circumstances in which they occur. Tackling is the most dangerous aspect of football play, so a full understanding of tackling should help with developing suggestions for injury prevention.

Contact injuries during tackling and collisions had been reported to be responsible for between 44% and 87% of all traumatic injuries in men’s, women’s and adolescents’ football. In 1995, the English FA reported that 37% of all injuries or more than 90% of all contact injuries were due to tackling actions. In earlier reports, “tackle action” did not include unintentional collisions, use of elbows and heading, whereas in later publications, all mechanisms that lead to contact between two or more players were considered as a tackle.

However, the available, if limited, data on tackling and injury in football was focused exclusively on men’s football. While at first glance the games appear to be similar, F-MARC had already found subtle as well as obvious differences between the men’s and women’s game from tactics to skills to injuries. Consequently, it was only logical for us to specifically analyse tackle mechanisms in female players, too.

Aims of the study

- Analyse tackle-actions in women’s football during match situations
- Assess their risk-potential as functions of players’ age, playing position and stage in a competition
- Compare the results about tackle parameters observed in women’s football with the results reported previously for men’s football

How we collected the data

A total of 24 matches from four FIFA competitions and two Olympic Games were studied. A tackle referred to any incident during normal play where an obvious contact between at least two players occurred. At least one of the players had to be challenging for the ball. The tackled player was defined as the player being either in possession of the ball or the player from the team in control of the ball immediately prior to contact.

Every tackle had the following factors recorded

- Tackle direction – from behind, side or front
- Tackle mode – staying-on-feet, sliding-in or jumping vertically
- Tackle action – one-footed, two-footed, use of arm/ hand, upper body or head challenge
- Referee decision – non-foul, foul, yellow card, red card
- On-pitch treatment – any medical attendance seen on video
- Time in the match
- Any tackle where the match was interrupted by the referee, a player was on the ground for more than 15 seconds, a player appeared to be in pain or a player received medical treatment during the match

Corresponding to injuries reported as the number per 1,000 player hours, we expressed the tackles per 1,000 player hours and number of injuries per 1,000 tackles.

Tackle analysis

A total of 3,531 tackles were analysed. This worked out to 147 tackles per match (or 1.6 tackles per minute). Over 60% of the tackles were from the side and in 65% of all tackles, the tackling player stayed on her feet. Combining these two factors showed that 44% of all tackles were by a player on her feet tackling from the side. Sliding tackles accounted for only 12% of all tackles, but nearly two thirds of all sliding tackles came from the side. While tackles from the side while standing was the most common tackle for both women and men, the rate of this tackle was far greater for women than for men (Tab. 2.5.6.1).

A standing tackle from the side had the lowest injury rate (16 per 1,000 tackles). Sliding tackles from the front had the highest injury rate (126 per 1,000 tackles). However, the referees sanctioned tackles from behind and sliding tackles the most.

The different tackle codes were similar across time of the match, but 46.1% of all yellow cards were given in the last 15 minutes of each half with no differences between
the first and second half. The incidence of injurious situations per tackle and on-pitch treatments for the last 15 minutes of each half was more than that observed in the first 30 minutes of each half.

Over half of the tackles were to midfielders, yet when controlling for the number of players playing each position, forwards were the most tackled players at an average of 13 challenges per match. There were few differences in tackle parameters according to the type of competition or the stage (group vs. knock-out) of the competition.

<table>
<thead>
<tr>
<th>% all tackles</th>
<th>Tackles per match</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women</td>
</tr>
<tr>
<td>From behind</td>
<td></td>
</tr>
<tr>
<td>Standing</td>
<td>14.1</td>
</tr>
<tr>
<td>Side</td>
<td>2.3</td>
</tr>
<tr>
<td>Jumping</td>
<td>10.9</td>
</tr>
<tr>
<td>From the side</td>
<td></td>
</tr>
<tr>
<td>Standing</td>
<td>43.9</td>
</tr>
<tr>
<td>Side</td>
<td>7.3</td>
</tr>
<tr>
<td>Jumping</td>
<td>10.5</td>
</tr>
<tr>
<td>From the front</td>
<td></td>
</tr>
<tr>
<td>Standing</td>
<td>7.3</td>
</tr>
<tr>
<td>Side</td>
<td>2.0</td>
</tr>
<tr>
<td>Jumping</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Tab. 2.5.6.1 Comparison of tackles in women and men

Risk situations are difficult to define and to determine in football. This study highlighted the importance of determining general match characteristics and tackling information to improve our understanding of injury causation in women. Differences in the tackle mechanisms associated with injury and risky situations in female players were shown. An increase in the number of tackles, risk situations and yellow cards towards the end of each half together with the increasing fatigue may partially explain the increased late-match frequency of injury.

Tackles leading to injury were sanctioned more frequently by the match referees than non-injury tackles, except for sliding-in tackles. While sliding-in tackles had previously been shown to have the highest propensity for injury, they were not specially regarded by the referees in injury situations. Therefore, it was concluded that the context of sliding-in tackles and referees’ decision had to be elaborated further to ensure players’ health.

What we learned in this study

Risky situations are difficult to define and to determine in football. This study highlighted the importance of determining general match characteristics and tackling information to improve our understanding of injury causation in women. Differences in the tackle mechanisms associated with injury and risky situations in female players were shown. An increase in the number of tackles, risk situations and yellow cards towards the end of each half together with the increasing fatigue may partially explain the increased late-match frequency of injury.

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2.5.7 Refereeing in Injury Situations

Why we conducted this study

Because of their unique role, the referee can be considered an extrinsic factor in injuries. In their previous studies, F-MARC had shown that contact is a factor in half to three-quarters of all acute football injuries and that foul play is an important risk factor for injury. But not all contact leads to injury and not all injuries from contact are called a foul. Referees must decide quickly, in a very public setting, whether the contact was or was not within the laws of the game. In fact, our research had revealed that football players appear to suffer from high levels of injury from tackles that match referees deem to be fair.

As a next step in our approach to prevention of injuries in football, we therefore decided to investigate and identify whether these injuries occur because the current rules are inadequate to protect the players from injury or because referees cannot implement the existing rules effectively during competition.

Aims of the study

- Determine whether referees could reliably identify the legality of incidents leading to injury
- Determine whether the rules of football adequately protect players from injury
- Determine whether injuries occur as a result of players’ non-compliance with the rules with special focus on head/neck injuries

How we collected the data

Strictly following our principles, the study was again based on the standardised F-MARC reports of team doctors on the details of match injuries from twelve FIFA competitions (398 matches). In addition, we collected video recordings of tackles to identify the factors of the foul and injury. A tackle referred to any event that occurred during the normal course of a match and involved physical contact between two or more players while one or more of the players challenged for possession of the ball. Then, a panel of FIFA international referees with an average number of 8.8 years’ experience as an international referee assessed the legality of incidents that resulted in injuries. The results of the video analysis, referee’s decision, and panel conclusion were compared.

The incidents leading to 148 contact injuries were identified on videotape of which the referees reached a consensus decision on the foul/non-foul status of 139 incidents. Further, a total of 128 head/neck injuries was reported by the team doctors, of which the incidents leading to 84 injuries were identified on videotape. For the general injuries, the match referees identified 47% and the panel identified 69% to have resulted from foul play. The match referees and panel agreed on 70% of the decisions. The referee panel was in good agreement (91%) with the match official on the decision where a foul occurred, but agreed with the match official only 49% of the time when no foul was called. Most of the general injuries occurred in the attacking goal area and involved a vertical jump or aerial contact.

For head/neck injuries, the match referees identified 40% and the panel identified 49% as foul play. The match referees and the referees’ panel agreed on 85% of the decisions. There was no typical situation involving head/neck injuries meaning the referee did not have any specific cues prior to an injury. This resulted in further disagreement by the referee panel on the presence of a foul (94% agreement) or no foul (only 20% agreement) at the time of a head/neck injury (Tab. 2.5.7.1). The situation where the referee panel identified a foul that the match referee had not identified involved actions with a vertical jump. Notice that whereas for general injuries there was better agreement on head/neck injury fouls in the attacking goal area, in head/neck injuries the proportion of injuries that were awarded a foul decreased by both the referee and the panel as the attack moved toward goal (Tab. 2.5.7.2).

What we learned from the study

The referees taking part in the FIFA competitions were among the best referees from around the world; however, the match referees were required to make decisions in difficult circumstances and within very short time
It was, therefore, the effectiveness with which referees could identify foul situations during match and the willingness of players to comply with the rules of football that were the main issues to be addressed by FIFA as football’s governing body.

<table>
<thead>
<tr>
<th>Area of pitch</th>
<th>Ratio of fouls awarded to number of injuries (number of incidents)</th>
<th>Match referees</th>
<th>Panel A referees</th>
<th>Match referees</th>
<th>Panel B referees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defensive goal area</td>
<td>Match referees</td>
<td>0.70</td>
<td>0.85</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Defensive midfield</td>
<td>Panel A referees</td>
<td>0.49</td>
<td>0.77</td>
<td>0.50</td>
<td>0.72</td>
</tr>
<tr>
<td>Attacking midfield</td>
<td>Match referees</td>
<td>0.21</td>
<td>0.36</td>
<td>0.28</td>
<td>0.31</td>
</tr>
<tr>
<td>Attacking goal area</td>
<td>Panel B referees</td>
<td>0.21</td>
<td>0.36</td>
<td>0.28</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Tab. 2.5.7.2 Proportion of injury situations identified as fouls by the match and panel referees, as a function of the area of the pitch (n = 139)

*Ratio not provided as the total number of incidents was less than 6

Our results indicated that the current rules of football were adequate to protect players from injury for the majority of situations and that contact injuries were more likely to be caused by players’ failure to comply with these rules. Match referees, however, often failed to award fouls and punish players for incidents that led to injury. However, in the specific case of incidents leading to head/neck injuries, the decisions reached by match referees were generally more reliable. The increased awareness of head injury may have led to more strict enforcement of the rules by the match referee.

The more information that a referee can obtain regarding actions that lead to injury could well lead to referees and referees’ observers arriving at similar decisions.

Referee cautioning a player with the yellow card during a match at the 2006 FIFA World Cup Germany™

Referee taking a decision during a match at the 2006 FIFA World Cup Germany™
2.5.8 Risk of Injury on Artificial Turf

Why we conducted these studies

Football has traditionally been played on natural grass. However, artificial turf has become more popular with an increasing number of pitches being built in countries where the climatic conditions are unsuitable for grass pitches. In 2006, FIFA approved the use of artificial turf for all matches. In addition to match play issues, artificial turf provides a year-round, all-weather training surface. Still, acceptance of artificial turf by players has remained limited because of a continuing perception of a different pattern of injury and an increased injury risk. Before FIFA could widely promote artificial surface, the football community needed proof that these new products are no different from grass in terms of injury risk. Preliminary data from the FIFA U-17 World Cups in 2003 and 2005 had suggested no significant difference in the incidence, nature, cause and severity of injuries sustained on both surfaces, but the study had been too small for definite conclusions.

Aims of the studies

- Compare the incidence, nature, severity and cause of match and training injuries sustained on grass and artificial turf by American collegiate male and female football players
- Compare the incidences and injury patterns of female and male elite teams when training and playing matches on artificial turf and natural grass

How we collected the data

The two studies in the US on match and training injuries were conducted on American college and university football teams over two seasons – for 52 men’s and 64 women’s teams (in 2005) and 54 men’s and 72 women’s teams (in 2006). The studies included all organised matches from their pre-season, in-season and post-season football competitions. Detailed injury reports were recorded on the playing surface, location, diagnosis, severity and cause of all match injuries. The number of days lost from training and match play was used to define the severity of an injury. The incidence of injury was documented per 1,000 player match or training hours.

Results

The main findings of the two studies of the US college and university players showed no major differences in either the risk or the cause of training or match injuries on artificial turf and grass in both male and female football players. Neither did the severity nor the causes of injury differ significantly between the two surfaces in both genders. In both match and training the most common injury location on both surfaces was the lower limb in both genders. Three to four times more matches and training hours were analysed for grass than for artificial turf, which accounts for the difference in injury numbers recorded.

During matches, a total of 848 injuries for men (artificial turf: 183, grass: 665) and 946 for women (artificial turf: 134, grass: 812) were recorded. The injury rate on grass for male (23.92) and female (21.79) players per 1,000 match injuries was similar to previous findings and there were no differences in match injuries as compared to artificial turf for men (25.43 injuries/1,000 match hours) or for females (19.15 injuries per 1,000 match hours, Tab. 2.5.8.1). There were also no surface-related differences for non-season-ending time-loss injuries. The most common injuries during matches were for men a lateral ankle sprain, hamstring strain and concussion; for women a lateral ankle sprain, concussion, and ACL tear.

During training, three to four times more teams were analysed on grass. A total of 818 injuries to men (artificial turf: 189 grass: 629) and 774 to women (artificial turf: 122, grass: 652) were recorded. The injury rate on grass for male (23.92) and female (21.79) players per 1,000 match hours was similar to previous findings and there were no differences in match injuries as compared to artificial turf for men (25.43 injuries/1,000 match hours) or for females (19.15 injuries per 1,000 match hours, Tab. 2.5.8.1). There were also no surface-related differences for non-season-ending time-loss injuries. The most common injuries during matches were for men a lateral ankle sprain, hamstring strain and concussion; for women a lateral ankle sprain, concussion, and ACL tear.

The third study was performed on twenty European elite level teams (15 male, 5 female) playing home matches on artificial turf prospectively; their injury risk when playing on artificial turf was compared with the risk on grass. Individual exposure, injuries (time loss) and injury severity were recorded by the team medical staff.
The later study on elite level teams recorded 2,105 injuries during 246,000 hours of exposure to football. Seventy-one percent of the injuries were traumatic and 29% were overuse injuries. There were no significant differences in the nature of overuse injuries recorded on both surfaces for either gender. The incidence (injuries/1,000 player hours) of acute (traumatic) injuries did not differ significantly between both surfaces, for men (match 22.4 vs. 21.7; RR 1.0 (95% CI 0.9–1.2); training 3.5 v 3.5; RR 1.0 (0.8–1.2)) or women (match 14.9 v 12.5; RR 1.2 (0.8–1.8); training 2.9 v 2.8; RR 1.0 (0.6–1.7)). During matches, men were less likely to sustain a quadriceps strain (P = 0.031) and more likely to sustain an ankle sprain (P = 0.040) on artificial turf.

### What we learned from these studies

The large number of athletes (college/university teams and elite level teams) investigated in the studies provided an ideal setting to compare the risks of injury on artificial turf and grass. The adequate statistical power of the studies for the first time allowed analysing injury subcategories to a greater depth. The main results showed generally no differences in the risk of acute injuries between play on artificial turf and natural grass in male and female players, in training or matches, and at adult elite level or amateur youth level. However, there might be differences in the pattern of injury sustained on these two surface types. Indications of a lowered risk of muscle strains when playing on artificial turf compared to grass, were found in the elite level teams. These tendencies of a difference in injury pattern between the two types of surfaces need to be investigated further in studies with larger cohorts and a higher statistical power.

### References

### 2.5.9 Influence of Match Events on Injury Incidence during FIFA World Cups™

#### Why we conducted these studies

Football is a sport of a highly competitive nature, especially at the top level. Changes in the score, foul play, injuries or yellow/red cards may have a profound impact on the course of a match. They may influence players’ attitudes, emotion, concentration, behaviour and team strategies, and thereby affecting the risk of injury.

In FIFA World Cups™ (and other international tournaments), the importance of the result of a single match is crucial, which might emphasise the specific roles of the different playing positions (i.e. forwards having to score goals), and consequently affect their risks for suffering an injury. Furthermore, FIFA World Cups™ are tournaments with intense match schedules, which could hypothetically lead to incomplete recovery between matches, and therefore increase the risk of injuries. Few studies on the relationship between recovery time and injury incidence in top-level football have been published.

#### Aims of the studies

- Investigate the relationship between injury incidence and changes in the score of the match, teams’ current drawing/losing/winning status, red / yellow cards, injuries and foul play, as well as differences in the injury incidence between the playing positions
- Investigate the relationship between injury incidence and recovery time between matches
- Analyse differences between foul play injuries and non-foul injuries with regard to injury types and locations, as well as match circumstances in which they occur

#### How we collected the data

The studies were based on team doctors’ post-match injury reports from the FIFA World Cups™ in 2002, 2006 and 2010. The injury data were obtained through the injury surveillance system developed by F-MARC, and methods applied are in accordance with the consensus statement on injury definition and data collection procedures. Other match information were retrieved from FIFA’s official match statistics for all 192 matches of the same tournaments, accessed on FIFA’s official website. A yellow/red card, injury and goal were defined as potentially game-disrupting incidents (PGDI).

#### Results

From the three FIFA World Cups™, 441 injuries were reported, giving an overall injury incidence of 67.8 per 1,000 match hours. There were statistically significant differences in the injury incidence related to the changes in the score and to the teams’ drawing/losing/winning status. The injury incidence was lowest during the initial 0-0 score and highest when the score was even but goals had been scored. Teams currently winning had a higher injury incidence than drawing or losing teams. There were also statistically significant differences in the injury incidence between the playing positions, with forwards having the highest injury incidence, followed by defenders, midfielders and goalkeepers.

The injury incidence was significantly higher during match periods within the minute of or during a five-minute period following a PGDI than in other periods of the match. The frequency of PGDIs had a tendency to increase towards the end of each half (Fig. 2.5.9.1), and a yellow card was the most frequent PGDI.

The incidence of non-foul injuries was significantly higher than of foul play injuries. Lower leg and ankle injuries were significantly more often caused by foul than non-foul play, whereas the opposite was observed for thigh injuries. Contusions were a significantly more often caused by foul than non-foul play, while the opposite was found for muscle strains/ruptures/tears. Foul play injuries were significantly less severe (defined by resulting days of absence from playing/training football) than non-foul play injuries. No significant differences between the incidence of foul play and non-foul injury regarding match period, teams’ current drawing/losing/winning status or playing position were observed. We also found a linear relationship between number of fouls and of injuries in a match (Fig. 2.5.9.2).

#### What we learned from these studies

The high injury incidence following PGDIs could be a potential target for intervention. Opportunities for sanctions, including temporary expulsion from a match for players committing violent fouls, could be considered. A few minutes’ absence for the player violating the rules could
theoretically help to re-establish the players’ concentration on the game more rapidly.

Considering the positive association between number of fouls and of injuries in a match, efficient intervention in the beginning of the match may be important. A possible way could be the referees’ early interventions in matches that start with high foul frequencies, for example by severely sanctioning foul play or communicating with the team captains and/or management in order to caution the teams, or resolutely instruct them to play fairly.

The relationships between injury incidence and match events, playing positions and recovery time require future research, as they may provide clinically significant targets for interventions.

**Fig. 2.5.9.1:** Average incidence of injury and number of other potentially game-disruptive incidents during the course of the match.

**Fig. 2.5.9.2:** Average number of fouls per matches in matches with different number of injuries.

**Fig. 2.5.9.3:** Average number of fouls per 1000 match-hours.

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**References:**


2.6 Head Injuries

2.6.1 Head and Neck Injuries during FIFA Competitions

Why we conducted this study

As in other contact sports such as basketball, ice hockey and rugby the risk of concussion in football players had always been a major concern and the risks associated with head injuries had been recognised by FIFA for a long time. There was also a concern that repeated head injuries may lead to long-term brain damage. Despite these concerns and the potential of long-term disability, recognition of head injuries had not received the attention that other injuries had. The English Football Association stressed that “a head injury is a potentially serious injury which can lead, in a small number of cases, to significant complications. No head injury is trivial.” But while the football medicine community had gained a good understanding of ankle, knee, muscle and other injuries, head injuries had not been studied to the same degree as other injuries. Therefore, F-MARC decided to further investigate into the matter. A major first step in the prevention of any injury is recognising the factors that lead to injury.

Aims of the study

- To identify those risk factors that have the greatest impact on head and neck injuries in international football
- By using video analysis, further determine the incidence and causes associated with head/neck injuries
- Determine the relationship of player’s gender and age with injury diagnosis

What is concussion?

Concussion is the temporary loss of normal brain function as a result of an injury. A player does not need to have lost consciousness to suffer concussion. The player may be confused or unaware of the time, date or place for a while after the injury. The terms concussion and minor traumatic brain injury can be used interchangeably.

How we collected the data

We analysed incidents resulting in head/neck injuries in 20 FIFA competitions (men and women) from 1998 to 2004. Again, team doctors provided medical reports using the same methodology as the other F-MARC injury studies on frequency, characteristics, risk factors and causes. We defined injuries by the need for players to receive post-match medical attention from their team doctors. To assess the incidents leading to injury, we obtained video recordings of heading incidents and studied these videos to identify a range of parameters associated with the incidents.

Identifying head injuries

From the physician reports, we identified a total of 248 head/neck injuries of which 163 were identified and analysed on video sequences (Tab. 2.6.1.1). The most common injuries were contusions (53%), lacerations (20%) and concussions (11%). The incidence of all head/neck injuries was 12.5/1,000 player hours (men: 12.8; women: 11.5) and 3.7 for time-loss injuries (men: 3.5; women: 4.1).

There was some minor variation in injury rates between tournaments and gender, but overall, the rates seemed to be fairly consistent (Tab. 2.6.1.2). The most common causes of injury involved aerial challenges (55%) and the use of the upper extremity (33%) or head (30%). 49 injuries resulted from head to head contact (Fig. 2.6.1.1) of which 16% were concussions. The unfair use of the upper extremity was significantly more likely to cause an injury than any other player action. The male player used his upper extremity far more frequently than did the female player and for males, this type of challenge was unfair over half the time.

Only one injury (a neck muscle strain) occurred as a result of heading the ball throughout the 20 competitions, which was equivalent to 0.05 injuries/1000 player hours. Form the data obtained from our analysis, we were able to generate a series of risk factors by sex, age and diagnosis (Tab.2.6.1.3).
Injury diagnosis

<table>
<thead>
<tr>
<th></th>
<th>As identified by team physicians</th>
<th>As identified by videotape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Concussion</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>Fracture/dislocation</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Contusion</td>
<td>57</td>
<td>41</td>
</tr>
<tr>
<td>Laceration/abrasion</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Others</td>
<td>12</td>
<td>17</td>
</tr>
</tbody>
</table>

Tab. 2.6.1.1 Percentage of injury type in male and female players

Tournament Incidence of injuries per 1,000 player hours

<table>
<thead>
<tr>
<th>Tournament</th>
<th>Incidence of injuries per 1,000 player hours</th>
<th>Lost time injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All injuries</td>
<td>Men</td>
</tr>
<tr>
<td>FIFA U-17 World Cup</td>
<td>11.1</td>
<td>–</td>
</tr>
<tr>
<td>FIFA U-19 World Cup</td>
<td>–</td>
<td>11.1</td>
</tr>
<tr>
<td>FIFA U-20 World Cup</td>
<td>15.8</td>
<td>–</td>
</tr>
<tr>
<td>Olympic Games</td>
<td>16.8</td>
<td>13.2</td>
</tr>
<tr>
<td>FIFA Club World Cup</td>
<td>9.6</td>
<td>–</td>
</tr>
<tr>
<td>FIFA Confederations Cup</td>
<td>10.7</td>
<td>–</td>
</tr>
<tr>
<td>FIFA World Cup™</td>
<td>10.1</td>
<td>10.9</td>
</tr>
<tr>
<td>All tournaments</td>
<td>12.8</td>
<td>11.5</td>
</tr>
</tbody>
</table>

Tab. 2.6.1.2 Incidence of head and neck injuries per 1000 player hours in male and female players

What we learned from the study

Our analysis identified consistent factors in head/neck injuries. First, the majority of injuries occurred in what might be considered to be low-risk areas of the football pitch (e.g., defensive and attacking outfields) rather than in the highly critical penalty areas where matches can be decided through risks that players might be prepared to take. Next, most of the injuries were a consequence of aerial challenges, from the side or front, for a high, free ball. Finally, the actions most likely to cause injury involved the use of the upper extremity or the head, but in the majority of cases the referee deemed the challenges to be fair and within the current laws of the game.

<table>
<thead>
<tr>
<th>Group most common cause of injury risk factor</th>
<th>Location of incident on pitch possession status prior to challenge direction of challenge mode of challenge action during challenge intent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Men: Defensive outfield free ball from the side jumping use of upper extremity fair challenge</td>
</tr>
<tr>
<td></td>
<td>Women: Defensive outfield free ball from the front jumping use of head fair challenge</td>
</tr>
<tr>
<td>Tournaments for players aged</td>
<td>≤ 20 years: Attacking outfield free ball from the side jumping use of upper extremity fair challenge</td>
</tr>
<tr>
<td></td>
<td>&gt; 20 years: Defensive outfield free ball from the side jumping use of head fair challenge</td>
</tr>
<tr>
<td>Injury diagnosis</td>
<td>Concussion: Attacking outfield free ball from the front jumping use of head fair challenge</td>
</tr>
<tr>
<td></td>
<td>Contusion: Attacking outfield free ball from the side jumping use of upper extremity fair challenge</td>
</tr>
<tr>
<td></td>
<td>Laceration/abrasion: Defensive outfield free ball from the side jumping use of head or upper extremity fair challenge</td>
</tr>
</tbody>
</table>

Tab. 2.6.1.3 Most common causes of head/neck injuries as a function of players’ gender and age and diagnosis of injury

Fig. 2.6.1.1 Head-to-head contact

Duration: 2004
Countries: International
Cooperation: University of Leicester, UK
2.6.2 Biomechanical Aspects of Head Injuries

Why we conducted these studies

Heading as the intentional use of the unprotected head to control and advance the ball is a most unique aspect of football. Media reports and earlier scientific information on perception deficits in a fraction of footballers had fed the growing controversy regarding potential long-term consequences of repeated low-severity head impacts of heading. While there was substantial emotion about this sensitive topic, there had been little scientific data available on skill and forces that occur when heading a football.

F-MARC decided to use modelling impact and skill analysis to study the effects of heading in football. Modelling impact and skill analysis are mathematical and labour-intensive undertakings that attempt to use objective data and reasonable assumptions to form an understanding of the task of heading in football. Therefore, we decided to take a stepwise approach.

Aims of the studies

- Develop the laboratory tools needed to study the biomechanics of heading
- Identify heading strategies that might reduce the potential for injury
- Apply the tools and techniques to the study of heading using human subjects
- Attempt to identify strategies to improve heading technique

How we modelled head impacts of heading

First, it was necessary to develop the methods, mechanical and mathematical, to study heading. Second, we tested the methods in the lab for determining the biomechanical response of a human heading a football. We used biomechanical studies on seven active football players, aged 18-20. Each player underwent medical screening and then was instrumented with bite plate mounted accelerometers (Fig. 2.6.2.1) and EMG electrodes on the major neck muscle groups. Balls were delivered at two speeds (six and eight m/s or 13 and 18 mph) and the players demonstrated several specific heading manoeuvres. Bony landmarks were tracked via high speed video and motion analysis software which allowed the development of a mathematical model of heading and ball impact that was tested on one player and permitted investigation of heading technique later in the other players.

Through the use of a computer, we made modifications to how the athlete performed the skill and the outcome on impact, head and ball trajectories, as well as acceleration and loads on the head. We could also make changes to the structural properties of the ball and the closing velocity, the motion of the torso, activation of muscle as modifiers of heading skill.

Applying the model

We then looked at how severe the impact of heading is with respect to accepted head injury calculation. The human model was developed through simulated headings at 6-7m/s. The model included varying parameters such as torso/head alignment, neck muscle tensing and follow-through (Fig. 2.6.2.2). The derived mathematical model was modified by changing elements of the neck musculature. Our simulation model was then verified by comparing the model against complex video and accelerometry analysis of three skilled volunteer footballers. Finally, we took the data from our model to see if the technique of heading could be “improved” to reduce the risks of heading. We asked the players to modify their heading technique to match that of the model and used the same video analysis (Fig. 2.6.2.3).
The responses of the head were tested against current injury assessment functions of mild traumatic brain injury which come from a number of sources that have studied settings like motor vehicle accidents, bicycle accidents, falls and others. Finally, we developed a Head Impact Power Index that we hoped would have a better predictor picture of mild brain injury.

Using biomechanic modelling methods as F-MARC had applied them in this study demonstrated that the accelerations heading causes to the head of a player are below the levels associated with brain injury.

In fact, heading led to accelerations that are well within accepted tolerance limits of head injury in trauma science.

Further, changing the skill of heading led only to inconsistent benefits on a reduction of loading on the head. Consequently, no firm recommendations on changing current heading techniques could be made.

What we learned from the studies

Fig. 2.6.2.2 Positive sign conventions of the numerical model for the head, neck, and torso

Fig. 2.6.3 Trajectories of subject, landmarks and ball

References:
2.6.3 Biomechanical Analysis of Head Impacts

Why we conducted this study

Football is an aggressive game and head impacts occur. Therefore, the incidence of head injury had long been a concern in football. Our previous studies had shown that heading in itself is rather unlikely to cause head injury and the technique itself was of little importance for the impact of heading on a players head. But players may sustain head injury from impacts with the ground, post or some body part of a player. Video analysis of heading duels had shown that most injuries are caused by head-head and head-elbow impacts. More than that, there had been the impression of an escalating trend of head impact delivered by the upper extremity or head of an opposing player in world-class level football. Whether this occurrence was intentional or accidental, it seemed necessary to F-MARC to investigate the nature and potential of these impacts to cause traumatic brain injury.

Therefore, we decided to dedicate an individual study to the investigation of the impacts from the upper extremity or head to the head of an opposing player. In biomechanics, the aim is to measure the energy of impact and relate it to the disruption of tissues and other structures. The ultimate aim of such analysis is to reduce injuries by better understanding. Biomechanical data can be related to medical outcome and help to gain a better understanding of human impact tolerance.

Accordingly, we intended to investigate the biomechanical likelihood of the impacts of arm-to-head and head-to-head to result in traumatic brain injury or even neck injury. We planned to reproduce impacts similar to what we had seen during play in the biomechanics laboratory and then use the Head Impact Power Index that F-MARC had developed in our previous study to calculate the risk.

Aims of the study

- Measure head accelerations induced by upper extremity and head-to-head impact
- Relate this to the risk of mild traumatic brain injury using the Head Impact Power Index
- Measure upper neck forces and torques to indicate the concurrent potential for serious neck injury

How we modelled impacts of head/arm-to-head

This project was designed to measure the head accelerations resulting from impacts of the upper extremity (elbow or hand-to-head) and head-to-head and relate this to the risk of mild traumatic brain injury using the Head Impact Power Index developed by F-MARC.

Modelling sports impact is an extremely challenging undertaking. For many people, biomechanical data (like linear and angular velocities, moments, shear forces, etc) is far more difficult to comprehend when compared to physiological data (like heart rate) or performance data (like running speed, jump height). The first thing that needs to be done is identify those impacts to be modelled. Therefore, F-MARC provided match videos of 62 cases of head impact. Of these, 38% were caused by the upper extremity and 30% by the head of the opposing player. The video analysis revealed the typical impact points and representative impact speeds. Typically, the upper extremity hit the head of the opposing player using either an elbow strike or a lateral strike with the hand. These impacts were then re-enacted in the laboratory by six volunteer football players striking an instrumented Hybrid III pedestrian model crash test manikin (Fig.2.6.3.1).

Head-to-head impacts were re-enacted using two instrumented test manikins (Fig. 2.6.3.2 and 2.6.3.3). Mathematical modelling of the impacts was carried out using equations routinely used in monitoring motor vehicle accidents with special attention to head impact. The sensors used in biomechanical research are very sensitive and collected data at sometimes thousands of bits of information a second. With over a few hundred trials performed in this project, a considerable amount of data was collected.

The laboratory set-up used for these scenarios were representative of the video analysis of actual injuries. The elbow-to-head setting showed the impacts to occur between 1.7-4.6m/s and lateral hand strikes at 5.2-9.3 m/s resulting in a low risk of concussion (<10%) or neck injury risk (<5%). That these velocities are low and not likely to lead to a concussion does not imply that other injuries (like contusions, lacerations, etc.) are unlikely. Head-to-head impacts happened at 1.5-3.0m/s and the higher velocities represented a high concussion risk (up to 67%). Impacts from higher velocity contact would increase the risk of concussion. Finally, we measured upper neck forces and torques for the potential of con-
current serious neck injury. This revealed only a low neck injury risk (<5%).

Serious to severe neck injury due to upper extremity and/or head impact is at a low risk. Mild traumatic brain injury risk due to the same is also minor to non-existent for upper extremity impact using the model of this project. Still, this is not to excuse other relevant injuries such as contusion, lacerations, facial bone fractures, jaw dislocations or neck strains. Conversely, head-to-head impact was found to pose a high risk of concussion, whether intentional or not, and justified more stringent efforts to reduce their occurrence. However, as in any modelling study, the data only represents the constraints of the laboratory setting. In actual match play, the impacts may exceed the parameters used in the laboratory.

**What we learned from the study**

Serious to severe neck injury due to upper extremity and/or head impact is at a low risk. Mild traumatic brain injury risk due to the same is also minor to non-existent for upper extremity impact using the model of this project. Still, this is not to excuse other relevant injuries such as contusion, lacerations, facial bone fractures, jaw dislocations or neck strains. Conversely, head-to-head impact was found to pose a high risk of concussion, whether intentional or not, and justified more stringent efforts to reduce their occurrence. However, as in any modelling study, the data only represents the constraints of the laboratory setting. In actual match play, the impacts may exceed the parameters used in the laboratory.

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**Duration:** 2002 - 2003  
**Country:** Canada  
**Cooperation:** Biokinetics and Associates Ltd, Canada  
2.6.4 Biomechanical Analysis of Ball Properties

Why we conducted this study

Footballs have evolved over the years from an inflated pig’s bladder to a leather encased bladder. The first guidelines were set in 1872 with regard to the ball. The current laws of the game set standards for the ball: circumference of 680-720mm, mass of 410-450 grams and inflation pressures of 600-1100g/cm2 (0.6-1.1 bar). The current FIFA Quality Concept (FQC) sets narrower standards on circumference and mass plus restrictions on shape, size, water absorption, pressure loss, rebound and balance. FIFA-sanctioned matches must use balls that comply with the FQC requirements.

Heading is a specific and essential part of the game and yet the impacts of heading have been implicated in mild and acute neuropsychological impairment. Some published studies had suggested that ball characteristics affect the impact response of the head; however, the biomechanics of the interaction of the ball on the head were not well understood. Consequently, the next step of F-MARC in their approach to head injuries was that we wanted to study whether ball mass, pressure and construction characteristics can help reduce head and neck impact response.

Aims of the study

- Further add to our understanding of biomechanics in heading
- Determine if head responses can be changed by altering ball properties such as mass and pressure
- Extend this line of research to investigate head responses with differing variations in ball mass, pressure and construction

How we modelled ball impacts

The methods we used were the same as reported in the two previous chapters on the biomechanical modelling in head impacts. Heading responses under ball impact (6-7m/s) were modelled from controlled trials on three human subject trials. Three ball masses and four ball pressures were investigated for frontal heading. Further, using our model, we were able to look at the differences in ball construction under wet/dry conditions to determine dynamic ball characteristics experimentally. Linear and angular accelerations of the head were measured and compared to injury assessment functions and Head Impact Power. We also used the numerical model to assess neck responses.

It was interesting to see that three of the five balls used in this project gained water weight that exceeded the FQC guidelines (increases of +22% to +47%) (Tab. 2.6.4.1).

The effect of water had variable effects of ball response properties: some balls with the lowest responses when dry had the highest results when wet. If ball mass is reduced by up to 35%, the responses on the head are also decreased by up to 23%-35% in both the numerical and subject trials.

Similar decreases in neck axial (forces that try to either press or separate the head from the trunk) and shear (forces that push the head front, back, right or left) responses were observed. If the inflation pressure was reduced by 50%, head and neck responses were reduced by up to 10%-30% for the subject trials and numerical model.

<table>
<thead>
<tr>
<th>Ball Type</th>
<th>Condition</th>
<th>Pressure (bar)</th>
<th>Mass (kg)</th>
<th>Water Uptake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fevernova Tri-lance</td>
<td>Dry</td>
<td>0.8</td>
<td>0.444</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>0.8</td>
<td>0.458</td>
<td>41%</td>
</tr>
<tr>
<td>Mitre White</td>
<td>Dry</td>
<td>0.8</td>
<td>0.428</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>0.8</td>
<td>0.603</td>
<td></td>
</tr>
<tr>
<td>adidas World Cup 1974</td>
<td>Dry</td>
<td>0.8</td>
<td>0.439</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>0.8</td>
<td>0.534</td>
<td></td>
</tr>
<tr>
<td>adidas Santiago Orange</td>
<td>Dry</td>
<td>0.8</td>
<td>0.445</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>0.8</td>
<td>0.463</td>
<td></td>
</tr>
<tr>
<td>adidas Santiago Brown</td>
<td>Dry</td>
<td>0.8</td>
<td>0.412</td>
<td>47%</td>
</tr>
<tr>
<td></td>
<td>Wet</td>
<td>0.8</td>
<td>0.604</td>
<td></td>
</tr>
</tbody>
</table>

Tab. 2.6.4.1 Water absorption of different ball models.

Biomechanical response reductions up to 15% were observed between different ball constructions and the wet condition generally resulted in greater head and
neck responses of up to 20%. See table 2.6.4.2 for a summary of responses from changing ball characteristics. It was concluded that to reduce ball mass and inflation pressure would lead to improvements in both the peak linear acceleration and power index. Other ball characteristics such as stiffness and construction must be considered in conjunction with traditional ball characteristics.

<table>
<thead>
<tr>
<th>Ball Type</th>
<th>Linear Acceleration</th>
<th>Angular Acceleration</th>
<th>Power Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline mass, pressure</td>
<td>=</td>
<td>=</td>
<td>=</td>
</tr>
<tr>
<td>Lowest mass</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Low mass</td>
<td>++</td>
<td>-</td>
<td>+++</td>
</tr>
<tr>
<td>Low pressure</td>
<td>++</td>
<td>--</td>
<td>++</td>
</tr>
<tr>
<td>High pressure</td>
<td>--</td>
<td>--</td>
<td>++</td>
</tr>
</tbody>
</table>

*Data exhibited large test variability.

Tab. 2.6.4.2 Summary of head responses for various ball characteristics.

What we learned from the study

There are a number of options that can reduce impact on the head, neck or both. One option is to improve the heading technique. As described, some heading techniques provided benefits by reducing a few aspects of the head responses while providing greater player skills for controlling the ball and perhaps greater appreciation of the game. But while we can identify a set of technique suggestions than might make heading safer, inconsistent results from modified heading techniques will make any skill recommendations difficult to implement.

Another option would be to reduce ball mass and inflation pressure. Our study showed that improving the classical ball characteristics of mass and pressure might have immediate effect on heading scenarios regardless of the player’s skills. Though research on a wider range of ages, skill, sex, heading scenarios, etc. will aid in the further understanding and improvement of heading biomechanics, changes to the ball characteristics have been shown to provide on overall benefit and can be effectively implemented. The possible fall-off in playability and handling characteristics using balls with reduced mass and/or pressures would need to be balanced against the possible safety benefits. The constraints provided by the Laws of the Game and the FQC would have to be reviewed.
2.6.5 Biomechanical Analysis of Headgear

Why we conducted this study

As laid out in the previous chapters, the possibility of brain injury as a result of heading received wide media attention, creating a safety concern for football and its players. However, the body of research on the neurological, neuropsychological and cognitive impairments among active amateur and professional players as well as retired professional players has produced mixed results with no clear consensus on the reasons why a fraction of football players showed some cognitive deficits. The reported research findings based on players of the 1970s and earlier had limited applicability to the modern player because those former professionals had used older generation balls or had other influencing factors.

As F-MARC had already shown, the most common cause of head injury was from player-to-player contact, unexpected head-to-ball impacts from close range and head-to-elbow impacts. We had also documented that no concussive head injuries could be related to voluntary heading.

Still, in view of parental concerns over the safety of heading and the possibility of head injury, soft, protective headgear was developed and marketed for use by football players of all age and skill levels for protection against the impact of heading and direct contact with other hard surfaces like an opponent’s head, elbow, the ground, the post and other hard surfaces. While the manufacturers reported substantial reduction in impacts from hard surfaces, the devices were only bit by bit assessed by independent laboratories for verification of methods and results. In addition, no device had been studied in a clinical trial involving football players.

While it might make intuitive sense that a soft surface between two hard surfaces should reduce the force of impact, there is little data to support commercial products that has stood the test of peer review in the scientific literature. Completing the biomechanical analysis of heading impacts, F-MARC therefore decided to test commercial football headgear in the laboratory and determine whether they had an effect on head and neck impact responses.

Aim of the study

• Evaluate the effectiveness of three types of football headgear

How we studied headgear in the lab

We conducted controlled tests using both a human volunteer and a surrogate head/neck system to quantify the impact reduction of three commercial products (Fig. 2.6.5.1a-c) in response to ball impact speeds of 6-30m/s and in head-to-head contact with a closing speed of 2-5m/s.

Fig. 2.6.5.1a Full90

Fig. 2.6.5.1b Head Blast

Fig. 2.6.5.1c Kangaroo

Fig. 2.6.5.1 Protective headgear used in this study mounted on the surrogate head form
A single skilled player was instrumented (Fig. 2.6.5.1) to measure linear and angular head accelerations and then exposed to low severity impacts during heading in the unprotected state and the protected state wearing the headgear. The high severity impacts and head-to-head impacts (Fig. 2.6.5.2 and 2.6.5.3) were studied with a surrogate head form instrumented to measure linear and angular head responses. The subject and surrogate responses were compared with published injury assessments associated with mild traumatic brain injury.

**Results**

The data showed that at low and high speed ball impacts, whether using the human or the dummy head form, headgear failed to appreciably alter the impact response on the head during heading. The acceleration of the head, when wearing any head protection, was within the variability seen for the unprotected condition. The surface that underwent the greatest deformation was the surface that is absorbing the impact and high speed video showed that the ball, being the softer surface, appeared to absorb most of the impact of heading. The responses observed in all ball-to-head tests indicated a low risk of mild traumatic brain injury.

The findings from head-to-head impacts showed that each headgear provided a measurable improvement in reduction of impact (Tab. 2.6.5.1).

<table>
<thead>
<tr>
<th>Product</th>
<th>Head-to-temple</th>
<th>Forehead-to-rear</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Linear</td>
<td>Angular</td>
</tr>
<tr>
<td>A</td>
<td>-22.1</td>
<td>-25.7</td>
</tr>
<tr>
<td>B</td>
<td>-19.0</td>
<td>-14.1</td>
</tr>
<tr>
<td>C</td>
<td>-55.6</td>
<td>-55.9</td>
</tr>
</tbody>
</table>

Tab. 2.6.5.1 Average percent reduction in head acceleration for each headgear

of the colliding heads means that a compliant headgear helps reduce the impact by dissipating energy.

**What we learned from the study**

If headgear was to be worn in football, the effectiveness of that headgear and its limitations would need to be well understood. F-MARC tested three commercially available football headgear and these were found to offer no protection from ball heading and high speed ball impact, but did offer some protection against impact from another player’s head. The relatively high stiffness
2.6.6 S-100 Beta Serum Levels after Controlled Heading

Why we conducted this study

One problem with concussion is that it is not visible using current imaging methods in the way a fractured bone is visible on routine x-ray. Another problem was the concern by the public about whether repeated sub-concussive impacts of purposeful heading might lead to head injuries in football players, and whether these might actually be comparable to those of patients with a minor traumatic brain injury. Therefore, the medical community that studied head injury continued to look for a “test” that would be more objective than symptoms reported by the patient.

Another option for confirmation of the diagnosis would be some evidence of brain injury in the blood. If such a factor could be identified to be reliable evidence of brain injury, then another piece of the diagnostic puzzle that is heading and head injury could become available. After brain injury, the neuroprotein S-100 Beta is released into the circulation and is considered to be a reliable marker of brain damage. Brain cells are held together by a complex scaffolding of supporting cells. When the brain is injured, some of these supporting cells also become damaged and release specific compounds into the blood. In the absence of brain injury, the levels of one of these proteins in the blood, S-100 Beta, are negligible, but become measurable in the blood following brain injury. To complement the information collected in their biomechanical studies, F-MARC now intended to assess the biochemical aspects.

Aims of the study

- Measure the serum levels of S-100 Beta after a training session containing controlled heading activities
- Compare the post-heading S-100 Beta responses with normal exercise and patients who sustained a mild traumatic brain injury

How we collected the data

We decided to evaluate the neuroprotein S-100 Beta serum levels in young amateur football players early after controlled heading, compared to early measurements after normal exercise as well as in other patients who had sustained a minor traumatic brain injury.

Sixty-one male young (average age = 15 years old) amateur football players performed routine football training (that incorporated controlled heading) for 55 minutes. Data was compared to 58 other male amateur football players of similar age who performed one hour of normal exercise training without head contact and also to 81 young male patients who were seen early after traumatic brain injury and who were evaluated by computed tomography (CT) scans for detection of intracranial lesions. These head injury patients were further divided according to whether or not the CT scan showed evidence of a lesion. For the training athletes, venous blood samples were drawn before the training (Fig. 2.6.6.1), then at about one hour and six hours after training. For the head injury patients, blood was drawn at about one and six hours after injury.

<table>
<thead>
<tr>
<th></th>
<th>Pre-training</th>
<th>1 hour post</th>
<th>6 hours post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heading group</td>
<td>.15</td>
<td>.18</td>
<td>.15</td>
</tr>
<tr>
<td>Normal exercise group</td>
<td>.10</td>
<td>.11</td>
<td>.09</td>
</tr>
<tr>
<td>Patients with a + CAT scan</td>
<td>.62</td>
<td>.32</td>
<td></td>
</tr>
<tr>
<td>Patients with a − CAT scan</td>
<td>.10</td>
<td>.08</td>
<td></td>
</tr>
</tbody>
</table>

+ CAT = patients with a CAT scan positive for head injury  
− CAT = patients with a CAT scan negative for head injury

Tab. 2.6.6.1 Average S-100 Beta (ng/ml) results by time and group

Results

Routine exercise led to, essentially, no change in S-100 Beta levels. The players who were involved in heading practice had a slight elevation after one hour that had returned to normal within six hours (Tab. 2.6.6.1). It was interesting that when the subjects in the heading group were divided by age, the two younger groups (12-13y and 14-15y) had significantly higher S-100 Beta levels than the oldest group (16-17y, Fig. 2.6.6.2). Those patients whose CT scan was negative for lesions showed S-100 Beta levels similar to the exercise group while those patients with a CT scan that was positive for a lesion showed S-100 Beta levels three to five times higher than the uninjured patients or athletes. Notice that none of the exercising groups, regardless of age, reached the levels found in those patients with a CT scan that was positive for intracranial lesions.
What we learned from the study

This study showed that controlled repetitive heading in young amateur football players leads to a small transient increase of S-100 Beta levels one hour after training that returned to pre-training levels at about six hours after training. No longer lasting increase of S-100 Beta levels indicating damage of brain cells was observed after controlled repetitive heading. After heading, S-100 Beta levels were significantly elevated compared to normal exercise. The patients who had a positive CAT scan for brain lesions had both higher and longer lasting elevated levels of S-100 Beta, and no exercising player had levels consistent with that of the injured patients.

**Duration:** 2000 - 2001  
**Country:** Germany  
**Cooperation:** University of Munich  
2.6.7 Serum Levels of S-100 Beta after Minor Head Trauma

**Why we conducted this study**

Football is one of the few sports to use an unprotected head to control and advance the ball. There had been an increasing concern that heading could lead to chronic brain injury like that seen in boxing. This was first postulated in 1992 based on a series of cross-sectional studies using neurological exams, neuropsychological tests, computer tomography scans and electroencephalography exams on active and older retired Norwegian football players. Since then, the neurological deficits found in a small fraction of football players were a matter of debate as studies had shown different results. In our own studies, F-MARC had found that heading duels leading to head-head or head-elbow impact expose players to an increased risk of head trauma and had been hypothesised as the mechanism for the reported cognitive deficits rather than heading itself.

As mentioned, an important issue had always been to actually recognise that a concussion has occurred. There is no conclusive, objective test or image that verifies the presence of a concussive injury. Several different markers for brain injury had been investigated and the S-100B protein seemed to be the most promising marker for evaluation of traumatic brain injury in patients with minor head injury. Elevation of S-100B indicates some level of structural damage to the brain.

Studies in small groups of players suggested that S-100B is increased after playing a football match and appears to be related to the number of headers. The F-MARC study described in the previous chapter had shown a transient increase in S-100B levels after controlled heading. However, no large-scale prospective study had assessed S-100B levels after minor head impacts in football and we decided to address this problem.

**Aims of the study**

- Assess whether minor head impact in football could cause injury to the brain tissue, measured as an increase in the serum S-100B
- Compare S-100B concentration after a head impact occurring during a regular match, after a regular match with no head trauma, after high-intensity training session without heading and after a low-intensity training session with heading exercises only

**How we collected the data**

All players in the elite Norwegian league, the Tippeligan, were invited to participate prior to the 2004 and 2005 seasons. The total number of players followed over these two seasons were 289 (2004) and 332 (2005), meaning that the study covered 621 player seasons. Baseline morning blood sampling prior to both seasons was performed for all teams during their pre-season training camp. Post-match or training samples were obtained immediately after play or training as well as the next morning (twelve hours post-match).

The two match groups were differentiated according to whether there was no recorded head trauma or whether there was head trauma recorded during play. A head trauma was defined as follows: a player appeared to receive an impact to the head (including the face and the neck), the match was interrupted by the referee, and, the player laid down on the pitch for more than 15s. A total of 228 head impacts that met these inclusion criteria were identified on video from 352 matches and 69 of these head traumas were followed up by blood sampling. Training sessions were either of high intensity with no heading or low intensity including heading. The high intensity sessions were aimed at mimicking match play but heading was disallowed. Players were questioned after both sessions assessing their level of fatigue and how often they headed the ball during the current day’s training compared to a regular match (much less, less, a little less, the same, a little more, more or much more). This score was then divided into the two groups of “less” and “the same or more” for analysis.

**Results**

One question that is asked frequently is just how often does a player actually head a ball during a match. In the 2004 season in Norway, the average number of headers was 5.7 showing wide variability according to the playing position. Midfielders headed 2.8 times on average, central defenders 9.6 times.
High-Intensity Exercise Group | Heading Group
--- | ---
| Level of fatigue vs. match<sup>1</sup> | No. of headings vs. match<sup>2</sup>
| $S_{100}$B sample | | |
| Baseline | Less (N=19, 53%) | Same or more (N=17, 47%) | Less (N=10, 29%) | Same or more (N=25, 71%)
| One hour sample (B1) | 0.043 | 0.045 | 0.061 | 0.039
| Twelve hour sample (B12) | 0.041 | 0.047 | 0.052 | 0.041

Table 2.6.7.1 Average S-100B values* (ng/ml) by training emphasis, player perceptions and time

*0.12ng/ml = clinical value to be exceeded to document structural brain injury
<sup>1</sup> rating the level of fatigue from training compared to a match
<sup>2</sup> rating of the number of headers during training compared to a match

All the four different conditions led to moderate, but significant increases in serum S-100B concentration that returned to baseline by the next day. While the increase was higher for the two match conditions when compared to the two training conditions, there were no significant differences between the two match groups at any time point (Tab. 2.6.7.1). Had the head injury group demonstrated higher S-100B levels, there might have been some evidence of structural injury. Players who headed ten times or more during the respective match exhibited a trend towards a higher serum S-100B concentration at baseline compared to the players who headed three times or less.

**What we learned from this study**

It appeared that S-100B increases for a brief time after football training and matches. There is the possibility of an additive effect of heading and high-intensity exercise, but the minor head impacts of this study did not seem to cause any additional increase in S-100B beyond the levels seen after a regular game. Thus, this study found no evidence of significant structural injury to the brain after these minor head impacts in football. However, it may still be that S-100B might not be the ideal marker for brain injury in athletes due to the confounding effect of physical activity.
2.6.8 The Value of Neuropsychological Testing after Head Injuries

Why we conducted these studies

It had been stated that only one out of five concussions are recognised by the players after a head impact in a match, indicating that many players continue to play with undiagnosed concussions. Thus, an important issue for the sports physician when assessing and managing concussions had always been the reliance on the subjective reporting of symptoms by athletes. Cognitive function testing had been used for the study of brain function for a very long time, but the last two decades had seen a wide expansion in the use of neuropsychological testing in the evaluation of concussion injury. The idea that neuropsychological tests could be used to provide an objective measure of cognitive recovery in the concussed athlete initially arose from work in severe traumatic brain injury. Later, computerised testing programmes that can be administered to multiple people using portal computers had been introduced. These programmes were new and still needed to be validated against the long accepted and traditional paper and pencil tests. It seemed therefore critical to F-MARC to provide football physicians with guidance on the best test to use.

Aims of the studies

- Summarise the difficulties in diagnosing a concussion
- Describe the challenges in developing return to play guidelines
- Show the interaction of issues in interpreting neuropsychological data
- Summarise the issue of concussion in football

Which test is best?

Traditional approaches to cognitive assessment involving extensive testing by trained neurophysiologists, was impractical for the evaluation of large groups of athletes. At about the same time in the US and Australia, two research groups began to study the use of abbreviated neuropsychological assessment in sports concussion. The establishment of the “45’ test” battery developed for the American football team Pittsburgh Steelers proved that a brief battery of tests were a reliable and valid adjunct in the clinical management of sports concussion. From this, the National Football League, National Hockey League and many university athletic programmes began clinical concussion management programmes that featured neuropsychological testing as a critical tool.

The use of these brief test batteries serve mostly as a screening approach to cognitive assessment. Brief test batteries allow baseline assessment of many athletes in the pre-season, but do not allow for comprehensive evaluation of cognitive processes. So there are limitations to their use and questions to be answered. Questions like the most appropriate battery of tests, interpretation of the tests and the control of factors that can affect test performance.

At the sideline

The sideline clinician needs a simple and valid tool to determine whether an athlete is concussed to aid in decisions such as removal from play for detailed assessment. In the early 1990s, the so-called “Maddock’s questions” were validated using Australian Rules football and showed that a simple sideline test of recent and remote memory could be sensitive at separating concussed from non-concussed athletes (Tab. 2.6.8.1). Another option is the “Standardised Assessment of Concussion (SAC)” that can also be given on the sideline, but is more complex and takes longer than the Maddock’s questions. The most recent sideline assessment tool, the “Sport Concussion Assessment Tool (SCAT)” combining all the previous tests, was developed at the 2nd International Symposium on Concussion in Sport in Prague in 2004. A detailed summary of that conference is contained within the chapter on improving standards of care.

Tab. 2.6.8.1 The Maddocks questions for use after a head injury

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which ground are we at?</td>
</tr>
<tr>
<td>Which team are we playing today?</td>
</tr>
<tr>
<td>Who is your opponent at present?</td>
</tr>
<tr>
<td>Which half is it?</td>
</tr>
<tr>
<td>How far into the half is it?</td>
</tr>
<tr>
<td>Which side scored the last goal?</td>
</tr>
<tr>
<td>Which team did we play last week?</td>
</tr>
<tr>
<td>Did we win last week?</td>
</tr>
</tbody>
</table>
Follow-up and return-to-play issues

After a concussion is diagnosed, the strategy changes during follow-up because of known deficiencies after concussion injury. Mild or moderate deficits can occur to such brain functions as reduced planning, impaired memory and learning, reduced attention and information processing plus slowed reaction times and wider variations in their responses to testing.

Some may be tempted to use cognitive testing as the criteria for return to play. However, it has to be emphasised that neuropsychological assessment should not be the sole basis of a return to play decision. Testing is but an aid to clinical decisions. Neuropsychological testing should not be done while the player is symptomatic. Here, testing adds little to this decision because a symptomatic player is not going to be allowed to participate regardless of the outcome of cognitive testing. Over testing may confound results due to practice effects. Most clinicians wait for all symptoms to resolve at rest and during exercise before using testing as the final step in the return to play decisions. In the future, computerised testing may be a more widely applied procedure than traditional paper and pencil tests.

Interpreting the tests

Once test results have been obtained, to what are the results compared to? Should they be compared to existing norms that are available for the various test procedures? Or should they be compared with their own baseline test results? This of course means that pre-injury baseline tests were gathered. Then there is the issue of confounding factors that might influence test results (Fig. 2.6.8.1). This is where much of the controversy about suggesting that heading is a factor arises when there are so many other factors that might have affected test results.

What we learned from the studies

It has to be emphasised that neuropsychological assessment should not be the sole basis of a return to play decision. Football should follow the recommendations of the 2nd International Symposium on Concussion in Sport in Prague. The major points are that a sideline assessment of concussion that can be performed by non-medical personnel should be used such as the Maddock's questions or the SCAT. Once a concussion has been confirmed, the injury immediately becomes a medical issue requiring medical management. Finally, return to play requires a “back to baseline” performance on cognitive function tests at rest and after exercise plus following the stepwise return to play outlined by the Prague consensus.

| Duration: | 2005 |
| Countries: | Australia, Norway |
| Cooperation: | University of Melbourne, Australia; Oslo Sports Trauma and Research Center, Norway |
2.6.9 Effects of Heading Exposure and Previous Concussions

Why we conducted this study

The football community had become aware that a fraction of football players displayed some cognitive dysfunction in factors like short-term memory, information processing, concentration and more from earlier studies. As laid out in the previous chapters, these studies had since come under question because researchers raised methodological issues pertaining to alternative hypotheses other than routing heading as the reason for the noted dysfunction. Those earlier studies, while drawing attention to the issue, implicated heading the ball as the cause while ignoring alternative hypotheses. Later reports stated that the reported deficits are more likely to be the result not from routine heading, but from head injuries, specifically concussions – the most common of serious head injuries.

After having addressed the value of neuropsychological testing after head impacts more generally, F-MARC considered it necessary to further investigate the association between previous concussions and heading exposure with neuropsychological test performance. We also felt that, as all previous studies had looked at a limited number of players for a shorter period of time, it was necessary to follow a larger number of players for an entire league season in order to get a more reliable picture of the effects of heading and concussion in football. Further, we intended not to use a paper and pencil, but a computer based test.

Aim of the study

• Examine the association between previous concussions and heading exposure with computer based neuropsychological test performance among Norwegian professional football players

How we collected the data

Two hundred and seventy-one players in the Norwegian professional football league, the Tippeligaen, performed two consecutive CogSport™ baseline computer-based neuropsychological tests prior to the 2004 season and completed a questionnaire assessing previous concussions, match heading exposure (self-reported number of heading actions per match), player career, etc. The CogSport™ tests for seven different subtasks: Simple Reaction Time (SRT), Choice Reaction Time (ChRT), Congruent Reaction Time (CgRT), Monitoring (MON), One-Back (OBK), Matching (Match) and Learning (Learn). The stimulus for all tasks consists of playing cards with responses given using the keyboard. The heading actions of 18 players observed in four matches were counted and correlated with their self-reported values.

Results

A total of 137 players, that means just about more than half of players, reported having had one or more concussions and 112 players reported a football-related concussion. Defensive players reported to head the ball most frequently, followed by attackers. The manual count in 18 players showed an average of 8.5 headings per player per match.

The first thing of interest then was if there was a positive association between the numbers of previous concussions and match heading exposure. It should be expected that the players who head the ball the most should be at the greatest risk of head injury (Fig. 2.6.9.1). This assumption, based on the figure, appeared to be true – those who head the ball the most are the ones most likely to have had a concussion. The estimated lifetime heading exposure as well as the self-reported number of headings were correlated with the number of previous concussions.

The next item of interest was whether there was a relationship between how much a player heads the ball and their neuropsychological performance, but there was no association with heading exposure and test performance.
Neither match nor lifetime heading exposure showed any association with the neuropsychological test performance of these players.

When the CogSport™ data is plotted against concussion number, we see a horizontal line (Fig. 2.6.9.2), which means no relationship between test results and concussion number. If, however, cognitive performance was related to concussion injury, then test performance should become poorer in players with more concussions.

Obviously, not everyone scores the same on these tests and there will be players who perform poorly on the assessments. What about these players who had the poorest performance on these tests? Of the 271 players, 19 players scored below the 95% confidence interval for one or more of the tasks. The 95% confidence interval represents the scores encompassing 95% of people who have taken the test. These 19 players with the lowest scores were no different from the rest of the players in terms of the number of previous concussions or lifetime or match heading exposure adding more evidence against heading as a factor in low neuropsychological performance.

This study is, by far, the largest study to date on neuropsychological test performance in football players. Similar to other studies, we found an association between heading frequency and concussion. Contrary to previous findings among footballers, we found no impairments in this group of professional footballer players if compared to the normal range defined by the test manufacturers. We also failed to find a relationship between previous concussions, heading exposure and test performance. Our findings did not confirm that either concussive or the repetitive sub-concussive traumas from heading have a cumulative effect causing brain function impairments among football players.

However, as stated in the summary on injuries in FIFA competitions, studying one team or league or tournament must be expanded to give the most stable conclusions on this most important topic.

**What we learned from the study**

- This study is, by far, the largest study to date on neuropsychological test performance in football players.
- Similar to other studies, we found an association between heading frequency and concussion.
- Contrary to previous findings among footballers, we found no impairments in this group of professional footballer players if compared to the normal range defined by the test manufacturers.
- We also failed to find a relationship between previous concussions, heading exposure and test performance.
- Our findings did not confirm that either concussive or the repetitive sub-concussive traumas from heading have a cumulative effect causing brain function impairments among football players.

**Footnotes:**

- **Duration:** 2004
- **Country:** Norway
- **Cooperation:** Oslo Sports Trauma Research Center, Norway

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[Fig. 2.6.9.2 CogSport™ test results plotted against concussion history](http://example.com)
2.6.10 Do Minor Head Impacts in Football Cause Concussive Injury?

Why we conducted this study

Chronic traumatic brain injury, due to multiple head traumas, has been known to occur in professional boxing since 1928. It was presumed to be caused by a cumulative effect of concussive and sub-concussive head impacts. As reported in the previous chapters, results from studies performed in football in the nineties had led to the concern that repetitive head impacts during play could also cause cognitive impairment among footballers. These studies had several shortcomings and later studies did not produce conclusive evidence that cognitive impairment occurs as a result of general football play or normal football heading. The F-MARC studies conducted with regard to blood markers of brain injury and neuropsychological testing had clearly confirmed these findings.

However, in 2004, a study from the Norwegian football elite league revealed an incidence of events with a head injury potential of 22.0 per 1,000 playing hours. Further, it was shown that four out of five concussions were not recognised by the players. As the majority of professional footballers play more than 450 matches during their career, the total career exposure to head impacts and the potential for head injury in football is considerable indeed.

It had been stated that computerised neuropsychological tests may detect cognitive deficits in concussed athletes who were seemingly asymptomatic at the time of testing. F-MARC intended to add computerised neuropsychological test information to the clinical assessment of players and for the first time assess brain function after head impacts during football matches, irrespective of whether the impacts were diagnosed as concussions or not.

Aims of the study

- Determine whether minor head traumas in elite football cause measurable impairment in brain function
- Investigate whether there was any change in neuropsychological test performance from one year to the next in individuals who had experienced one or more minor head impacts during the course of the previous season

How we collected the data

Baseline neuropsychological testing was completed by the professional football players in the Norwegian elite league, Tippeligaen, prior to the 2004 or 2005 seasons. During both league seasons, the players were observed during all regular matches and all head impacts were recorded. A player who experienced a head impact during a league match was evaluated by the local medical personnel immediately after the match. This included completing a form assessing acute symptoms, the Glasgow Coma Scale, and the presence and duration of loss of consciousness and amnesia. All players with head impacts completed a follow-up test the following day. They were compared to a control group consisting of players who were tested the morning after a regular match where no head impacts were recorded.

A one-year follow-up with computer-based neuropsychological testing (CogSport™) was also conducted where the players who had experienced one or more head impacts were compared to the players without any recorded head impacts. The test battery consisted of seven different tasks assessing the psychomotor function, decision-making, simple attention, divided attention, working memory, complex attention, and learning and memory, all using on-screen playing cards as stimuli.

Results

Baseline neuropsychological testing results did not differ among the different groups. A total of 228 impacts to 141 players were identified on video from the 352 matches observed and 44 of these were followed up with a CogSport™ test. These cases included six concussions of which five showed loss of consciousness.

The players with head impacts had a greater change in reaction time from baseline to follow-up compared to the players who had not suffered head impacts with regard to the three simplest tasks of the test: psychomotor function, decision-making and simple attention (Fig. 2.6.10.1).

Half of the players with recorded head impacts reported one or more symptoms at the time of the incident. Headache was the most common symptom, followed by dizziness and concentration problems. The players reporting acute symptoms after the impact showed the
largest deficits when tested, but deficits were also demonstrated among asymptomatic players.

Players who experienced one or more head impacts during the 2004 season also showed a reduction in neuropsychological performance when tested prior to the 2005 season (Fig. 2.6.10.2). However, none of these footballer players were impaired when compared to results to be expected in an average population.

**What we learned from the study**

A reduced test performance was found after minor head impacts in football as compared to results prior to the impacts. The largest reductions were found for the players who showed symptoms at the time of testing. The study is also the first to demonstrate neuropsychological deficits after minor head impacts where the player did not report any acute concussive symptoms. Our findings emphasise the need for increased awareness of concussion signs and symptoms, not only among the team’s medical personnel, but also among the players themselves. Concussive symptoms are often not recognised by the players and, if recognised, symptoms are often not reported.

It is important to note however, that the impairment was found when comparing the test results prior to and after the head impacts in the respective player. But when compared to the results of an average population, there was no impairment and therefore the long term consequence of this finding is uncertain.

**Fig. 2.6.10.1** Change (%) in reaction time from baseline to follow-up for the Head Impact Group and the Match Control Group. Data are also shown for symptomatic and asymptomatic players in the Head Impact Group. *p<.05 vs. the Match Control Group; **p<.01.

**Fig. 2.6.10.2** Change (%) in reaction time from baseline 2004 to baseline 2005 for players with (Season One Head Impact) and without (Season One Control) a registered head impact during the 2004 season (N=144).
2.7 Injuries of Referees and Assistant Referees

2.7.1 Injuries in FIFA Competitions

Why we conducted these studies

According to FIFA’s “big count”, there were more than 840,000 registered referees and assistant referees in 2006 worldwide. In the last ten years, several studies had examined various aspects of performance and training of football refereeing. During a competitive match, a referee may cover a distance of between nine and 13 km, part of these with high intensity such as sprinting. Backwards and sideways running are typical movements of the referee during the course of a match. In fact, the elite level referee is generally exposed to similar physical demands as those placed on a midfielder. But, in comparison to the players they need to control, they are not only up to 15 to 20 years older and rarely full time professionals, but also cannot be substituted during a match. A referee must therefore be prepared to perform at high intensity throughout the match and clearly is exposed to a certain risk of injury.

While some studies had addressed the physical demands of refereeing, very little was known on injuries and musculoskeletal complaints in referees. In a study on elite Swiss referees, F-MARC had found that almost 90% of these had had some sort of complaint and almost a third suffered an acute injury in the twelve months under investigation. We therefore decided to further investigate these health issues in the international elite referees at FIFA’s flagship events.

Aims of the studies

- Investigate the injuries and musculoskeletal complaints of all referees and assistant referees selected for the 2006 FIFA World Cup™
- Investigate the injuries and musculoskeletal complaints in female referees selected for the FIFA Women’s World Cup 2007™

How we collected the data

During the preparation camps for the 2006 FIFA World Cup™ in Germany and the FIFA Women’s World Cup 2007™ in China, all 123 male and 81 female referees pre-selected for the competitions completed a specially developed questionnaire on their injuries and musculoskeletal complaints. The referees were also asked to report on their refereeing qualifications and experience, other medical problems and time spent in training and in matches retrospectively.

During the competitions, the characteristics and consequences of all injuries and complaints incurred by the 63 male and 36 female officiating referees were prospectively documented. During the two FIFA World Cups™, the referees and assistants travelled by air from the headquarters to their appointed matches at the venues. For each match, a physiotherapist documented the injuries and complaints. Confirmation of the diagnosis was made by a physician at the referees’ headquarters. Every acute injury incurred during match or training was recorded according to the consensus statement on injury definition described in chapter two, and also used by F-MARC in our studies on football players. All musculoskeletal complaints that received medical attention were also recorded.

Results

Compared to their female counterparts, the male referees were older (41 vs. 35 years) and had a longer career, holding their official license for on average 19 vs. 12 years, and their FIFA license for an average of eight vs. six years, during which time they had also been officiating international matches. Almost 85% of the male referees, but less than two thirds of female referees received training advice from expert staff.

More female than male referees had incurred an injury and suffered from musculoskeletal complaints during their career (Tab. 2.7.1.1). The locations of these injuries and complaints were similar for women and men. Complaints were mostly located in the hamstrings, calves, low back and knees. The most prevalent injury diagnoses for both were muscle strains which accounted for more than half of all injuries. More specifically, hamstring and calf strains as well as ankle sprains were suffered most often.

During the FIFA Women’s World Cup 2007, the fraction of female referees with an acute injury was almost twice as high as the fraction of their male counterparts at the 2006 FIFA World Cup™. However, the incidence of injuries of 20.8 for male and 34.7 for female referees per 1,000 match hours was considerably lower than compared to male and female players with injury rates
of 68.7 resp. 81 per 1,000 match hours at the respective competitions. The most common acute injuries in both genders were hamstring strains, calf strains, and ankle sprains. Musculoskeletal complaints were reported to the same degree for male and female referees. There were slight differences with regard to the most frequent locations of complaints between the two genders, but both men and women often reported low back pain.

<table>
<thead>
<tr>
<th></th>
<th>Male referees</th>
<th>Female referees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complaints during career (%)</td>
<td>62.8</td>
<td>76</td>
</tr>
<tr>
<td>Injuries during career (%)</td>
<td>40.7</td>
<td>48</td>
</tr>
<tr>
<td>Injury incidence match career (per 1000 hours)</td>
<td>0.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Injuries during WC (n)</td>
<td>14 (total 63)</td>
<td>14 (total 36)</td>
</tr>
<tr>
<td>Injuries WC (%)</td>
<td>22.2</td>
<td>38.9</td>
</tr>
<tr>
<td>Injury incidence WC match (per 1000 hours)</td>
<td>20.8</td>
<td>34.7</td>
</tr>
<tr>
<td>Complaints during WC (%)</td>
<td>34.9</td>
<td>33.9</td>
</tr>
</tbody>
</table>

Tab. 2.7.1.1 Injuries and complaints of male and female referees at FIFA World Cups™

**What we learned from the studies**

These two studies addressed the incidence of injuries and complaints of the world’s best male and female referees. The female referees suffered considerably more injuries and complaints during their career prior to and also at the FIFA Women’s World Cup™. It is possible that this difference is due to a lack of specific physical preparation of the female referees. While male FIFA referees have been systematically supported by expert fitness coaches since 2000, their female counterparts were only recently enrolled in similar programmes. Other possible explanations include general gender differences in fitness levels, neuromuscular characteristics, coping and perception of pain.

As in football players, muscle strains and ligament sprains were the most common injuries. Differently from players however, the FIFA referees reported more injuries during training than during matches. The incidence of match injuries was substantially lower than that reported for the football players at the respective competition. About two thirds of the male referees and three quarters of the female referees had some sort of musculoskeletal complaint during their career. However, due to the known problems with limited recall, these reports of complaints during a career of several years might represent rather an under-reporting than the true incidence.

Considering the high prevalence of musculoskeletal complaints, the injury profile, and the high physiological demands of refereeing, F-MARC strongly recommended the development of specific injury prevention programmes and their integration into the fitness training routine of the male and female referee.
2.7.2 Injuries of Referees at All Levels of Play in Switzerland

Why we conducted this study

The study of the 204 male and female referees selected for the recent FIFA World Cups™ (see previous chapter) alerted F-MARC to the high frequency of injuries and musculoskeletal complaints among referees and confirmed our view that this group requires the same preventive efforts as players. However, the FIFA World Cup™ group represented mainly professionals and in fact corresponds to only 0.02% of all registered referees in the 208 member associations of FIFA worldwide. In players, injury incidence varies with the level of play, therefore F-MARC also wanted to look at the next lower level of referees and decided to examine injury incidence and complaints in the elite referees of the top leagues in Switzerland.

However, the number of elite referees on national level is again small compared to the number of referees involved in amateur football. In Switzerland, the 71 referees officiating in the two top divisions represent only 1.6% of the 4452 registered referees (season 2005/06). As in players, this large number of amateur football referees contrasts with the fact that there is hardly any research done on the injuries and complaints of these referees caused by their activities in football. Therefore, F-MARC decided to additionally examine the amateur referees in Switzerland, using a similar assessment as for the elite referees.

Aims of the study

- Investigate the injuries and musculoskeletal complaints of all Swiss Top Division referees and assistant referees
- Investigate the injuries and musculoskeletal complaints of a representative group of Swiss referees and assistant referees at all levels of play

How we collected the data

During a training camp organised by the Swiss Referees Association, all 71 referees and assistant referees of the two top divisions were asked to complete a specially developed questionnaire and were subsequently interviewed to gain more information about the reported injuries. The questionnaire asked for injuries and physical complaints caused by either refereeing a match or by the training for officiating. The referees were also asked to report on their refereeing qualifications and experience, other medical problems and time spent in training and in matches retrospectively.

At amateur level, 489 active referees representing a representative sample of all Swiss referees officiating at the different levels of play including youth were interviewed by telephone using essentially the same questionnaire as above, but adapted for the specific conditions of a telephone interview.

Results

The male elite referees were on average 36 years old and held their official license for about 16 years. They had been officiating in the top leagues for about 7.5 years. The amateur referees were of similar average age (36.6 years) and had a shorter career, holding their official license for on average of twelve years. Elite match referees trained for about 6.4 hours a week, whereas the assistant referees trained less than their superiors (4.7 hours) but about the same time as reported by the amateur referees (4.8 hours).

With regard to injury and physical complaints, some important differences were observed between the two groups: In the elite referees, 44% had suffered from at least one injury during their career whereas about one quarter of the amateur referees had (s. Table 2.7.2.1). Elite referees suffered 62% of their injuries during training and 39% in matches as compared to far fewer training injuries (21%) than match injuries (79%) in referees on lower levels. In both groups, thigh muscle (hamstring) strain and ankle sprain where the most common diagnoses.

Another important difference between the two groups was the frequency of musculoskeletal complaints. Eighty-six percent of the elite referees reported complaints caused by their refereeing but only about one quarter of the referees at lower levels of play suffered from complaints.
The injury frequency in elite referees corresponded to the 2006 FIFA World Cup™ selection. Increasing incidence of injuries with the level of play is also observed in players (s. chapter 2). Sprains and strains, the most common types of injury also corresponded with the findings in players. Strains are the most frequent non-contact injuries in players, and it has to be remembered that in referees, different from players, the vast majority of injuries are non-contact in nature.

The far higher proportion of training injuries in Swiss elite (62%) and FIFA World Cup™ selection referees (82%) as compared to lower levels of play (21%) may be explained by the higher number of hours spent in training by the elite referees compared with the amateur referees of the present study.

The prevalence of musculoskeletal complaints during their career was substantially lower in amateur than in elite referees. Apart from different methodological approaches, the difference might also be partly explained by the high demands of matches and training at national and international level.

This study once more confirms the need for effective prevention programmes for referees. These have to include amateur referees, all the more as these are not subject to any age limit.

Tab. 2.7.2.1 Injuries of elite and amateur referees in Switzerland

<table>
<thead>
<tr>
<th></th>
<th>Elite referees (n=71)</th>
<th>Amateur referees (n=489)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referees injured during career</td>
<td>31 (44%)</td>
<td>110 (23%)</td>
</tr>
<tr>
<td>Injuries during career</td>
<td>41</td>
<td>155</td>
</tr>
<tr>
<td>Injuries during last year</td>
<td>19</td>
<td>44</td>
</tr>
<tr>
<td>Incidence of match injuries last year per 1000 match hours</td>
<td>6.8</td>
<td>2.1</td>
</tr>
</tbody>
</table>
2.8 Injuries in Other Sports

2.8.1 Comparison of Injuries in Football and in Rugby

**Why we conducted this study**

The difficulty of interpreting comparative injury information within one sport and across sports had been one of the first findings of F-MARC on injuries in football. In our review of the medical literature, we found only a few studies in which exposure-related incidences of injury in different types of sport were compared. Many studies focus on a single sport in a specific setting. Community and nationwide studies have difficulty in definitions, data collection and implementation while those using emergency rooms or insurance databases are limited to players seeking medical treatment. There are a few projects that have attempted to study multiple sports at the youth level using a variety of different methods. The studies of team sports typically look at ice hockey, handball, basketball, football and rugby and attempt to rank sports on injury incidence and risk. As sports participation is routinely advised for health, it is important for the medical community to be aware of the specific risks of injury in different sports.

In terms of total number of member associations, rugby ranks behind only football when considering the number of nations playing the sport worldwide. A rugby union (as opposed to rugby league) team consists of 15 players a-side. A match is two 40 minute halves with a five to ten minute half-time. Rugby union is a full-body contact game. While protective equipment is not compulsory, New Zealand Rugby Union domestic safety law requires compulsory use of mouth-guards in all matches below international class. In rugby union as in football, most injuries affect the lower limbs, followed by the head and neck or upper limbs. The incidence of rugby injuries in adult male players varies from 12–53 injuries per 1,000 playing hours, for schoolboys from seven to 65.8 injuries. The incidence of injury in youth players seems to increase with age. We now wanted to compare injuries in the two most popular ball sports.

**Aim of the study**

- Compare the characteristics and incidence of injuries in male youth amateur football and rugby players

**How we collected the data**

We opted to compare football and rugby (rugby union) in youth. This prospective cohort study followed a similar design as our earlier work in the Czech Republic and other countries and was conducted in New Zealand. The F-MARC research team (Fig 2.8.1.1) focused on twelve football school teams and ten rugby school teams of male amateurs aged 14–18 years, giving us a total of 145 football and 123 rugby players over one season. The study began with an initial baseline examination for specific player characteristics and their level of performance (Fig. 2.8.1.2). During the observation period, a physician visited the team weekly and documented all injuries related to sports participation.

![Fig. 2.8.1.1 The F-MARC research team](image)

**Results**

We have repeatedly mentioned the ratio of training to match hours as an influencing factor on injury incidence. In this study, the ratio for football and rugby was 1.57 and 2.96, both well below what was reported elsewhere by F-MARC where we saw ratios of five or higher (for example, 5.9 in German female players). When comparing the incidence of football and rugby injuries, we found that rugby union was associated with a significantly higher rate of 49.5 injuries per 1,000 player hours than football where this rate was 27.9 (Tab. 2.8.1.1 and Fig. 2.8.1.3).

The differences were pronounced for contact injuries, injuries of the head, neck and upper extremity, as well as for fractures, dislocations and strains.
concussion injury rate was nearly five times greater in rugby than in football (0.32 vs. 1.45 concussions per 1,000 hrs) and fracture/dislocation injury rates were five to seven times higher in rugby players. Rugby players suffered 1.5 times more overuse and training injuries in relation to exposure time and 2.7 times more match injuries than football players. Whereas age had no effect in rugby players between 16 and 17 year olds (50.1 vs. 50.6), the incidence of injury increased by nearly 50% in football players of similar age (23.5 vs. 35.1). Three rugby players, but no football players, had to cease from further participation in sport because of severe injury.

What we learned from the study

The incidence of injury in New Zealand school teams playing football or rugby union is high when compared with other youth team sports, probably because of the low ratio of hours spent in training in relation to the hours spent playing matches. More specifically, the incidence of match injuries was more than twice as high in rugby players compared with football players. The greater severity of rugby injuries was shown by the higher incidence of fractures and dislocations in the rugby players compared with the football players. Consequently, the development and implementation of preventive interventions to reduce the rate and severity of injury was recommended by F-MARC.

<table>
<thead>
<tr>
<th>Football</th>
<th>Rugby</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Rate/1000 hrs</td>
<td>Injury per/1000 hrs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Circumstance</th>
<th></th>
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<tbody>
<tr>
<td>Overuse/training</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Match</td>
<td>66</td>
<td>66</td>
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</table>

<table>
<thead>
<tr>
<th>Contact</th>
<th></th>
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<tbody>
<tr>
<td>No</td>
<td>52</td>
<td>33</td>
</tr>
<tr>
<td>Yes</td>
<td>48</td>
<td>67</td>
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<table>
<thead>
<tr>
<th>Location</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Head/trunk/UE</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Groin/LE</td>
<td>77</td>
<td>42</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No absence</td>
<td>69</td>
<td>79</td>
</tr>
<tr>
<td>1-7 days</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>8-21 days</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>&gt;21 days</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

UE = upper extremity  
LE = lower extremity

Tab. 2.8.1.1 Summary of injury incidence and injury rate for football and rugby union

Duration: 2001 - 2002
Country: New Zealand
Cooperation: New Zealand Soccer, New Zealand Rugby Union
Reference:
2.8.2 Injuries during the Olympic Games in Athens 2004

Why we conducted this study

It had always been the aim of F-MARC to establish and apply standard definitions and data collection procedures for the investigation of injury rates, so that these rates could be compared across different ages, levels of competition, genders, and competitions. As mentioned, numerous studies had analysed injury incidence in a variety of sports, but the results of these studies could not be compared, because of the different injury definitions, methods of data collection, observation periods, study designs and sample characteristics. Only a few studies compared exposure-related injury incidences in different sports using the same methodology, but many of these investigations were restricted to schoolchildren, nationwide sport leagues or showed other limitations. Only one project at the Australian University Games, a multi-sport event featuring 5106 participants competing in 19 sports, looked across sports at a high level of competition in 1994. It was concluded then that ice hockey, handball, basketball, football, rugby and field hockey shared a relatively high risk of injury. The great advantages of conducting a comparative study during a major international tournament are that multiple sports with players of a comparable skill level can be included and that the observation period is defined by the event. Furthermore, a high standard of environmental factors, such as the quality of the playing fields and equipment, is guaranteed.

Aim of the study

- Analyse and compare the incidence, characteristics and causes of injuries in all team sport tournaments (football, handball, basketball, field hockey, baseball, softball, water polo, volleyball and beach volleyball) during the 2004 Olympic Games

How we collected the data

During the 2004 Olympic Games, 14 team sport tournaments were contested: football, handball, basketball, field hockey, water polo, volleyball (both men’s and women’s competitions) baseball (men only), and softball (women only). We used the standardised F-MARC procedure for capturing injury information that had been productive in previous work: Before the competition started, all medical staff met to agree on the procedure and definitions for the different aspects of injury. After each competitive match, a standardised one-page injury report form was filled in by the physician of the participating teams or by the official medical representative of the sport.

The average number of injuries per match ignores the number of players in a match and the duration of a match. An exposure-time related incidence of injuries per 1,000 player hours is widely used, but the playing time is hard to determine in some team sports due to a continuous clock (e.g., football), a non-continuous clock (e.g., basketball) or no clock at all (e.g., baseball, softball, volleyball). Therefore, we decided to express a player’s individual risk of injury for the different sports as in “injuries per player matches”.

Results

We obtained data on 456 out of 488 team sport matches corresponding to a response rate of 93%, meaning we obtained records on 93% of all matches; an excellent participation for the first attempt at a multi-sport event. We could analyse 911 forms covering 6,953 player-matches. A total of 377 injuries were reported which is equivalent to an incidence of 0.8 injuries per match or 54 injuries per 1,000 player matches.

The incidence, diagnosis and cause of injuries differed substantially between the team sports leading to specific profiles of injury in each sport (Fig. 2.8.2.1 and Tab. 2.8.2.1). Handball, football, and basketball all had rates per 1,000 player hours exceeding 70 while the rates for the remaining sports were substantially lower. More than that, football and handball had nearly twice the injury rate than the next highest sport, basketball.

Half of all injuries affected the lower extremity and 24% of the injuries involved the head or neck. The two most prevalent diagnoses were contusion of the head and ankle sprain. The majority of injuries (78%) were caused by contact with another player and half of these injuries were, in the opinion of the recording physician, a result of foul play. However, a significantly higher percentage of non-contact than of contact injuries resulted in absence from match or training.
On average, 42% of the injuries were expected to prevent the player from participating in sport for some time. The incidence of time-loss injuries per 1,000 player matches was substantially higher in males (24.7) than in females (15.9). Time-loss injuries most frequently affected the ankle (20%), knee (13%), thigh (12%) and head (10%). There were 15 injuries that were of sufficient severity to keep a player out of competition for four or more weeks: eight fractures, one shoulder dislocation, four knee ligament ruptures, one meniscal injury and one ankle ligament rupture.

**What we learned from the study**

It was once more confirmed that it is difficult to compare injuries in different sports due to their different nature. For example, the total number of injuries in different sports is biased by the number of games and participants in each sport. Nevertheless, following a strictly standardised method, the risk of injury in different team sports can be compared. Even if the incidence and characteristics of injuries are not identical in all sports, prevention of injury and promotion of Fair Play are relevant topics for almost all team sports and need to be part of the respective strategy to protect the health of the players.
2.8.3 Handball Injuries during Major International Competitions

Why we conducted this study

Together with football, volleyball and basketball, handball is one of the most popular sports in Europe. Team handball is a high-intensity sport with frequent physical contact between the players. As of 2004, the International Handball Federation (IHF) officially number 150 member federations representing approximately 800,000 teams and more than 19 million sportsmen and women. As in football, several authors had analysed the incidence of handball injuries, but the results were difficult to compare because of differences in study design, injury definition, observation periods and level of play. Most studies were on adolescent players, only two studies each looked on adult amateur players and major international tournaments. The information on handball injury in top-level players however was very limited. The comparative F-MARC study on injuries in eight team sports during the Olympic Games 2004 as described in the previous chapter had shown that the incidence of injuries per 1,000 playing hours was highest in handball. As knowledge of the incidence, circumstances and characteristics of handball injuries would considerably aid in developing preventive programmes, a standardised approach as developed by F-MARC in football for recording the data was required.

Aim of the study

- Analyse the incidence, circumstances and characteristics of team handball injuries in women and men during the major international tournaments

How we collected the data

Injury incidence was recorded at six major handball competitions. The injury-reporting system applied followed the established F-MARC scheme, except for the exchange of the word “football” to “handball” in the injury report form. During a pre-competition instructional meeting, the physicians of all teams participating were asked to report all injuries incurred during the competition and were instructed about how to fill in the injury report forms. An injury was defined as any physical complaint incurred during the match that received medical attention from the team doctor regardless of the consequences with respect to absence from the match or training. For each match, both team doctors were supposed to return the completed single page form for all injuries or, where applicable, the non-occurrence of injury for their team to a medical representative of the IHF. The incidence of injury was expressed as the number of injuries per match and additionally as the number of injuries per 1,000 player hours.

Results

A total of 478 injuries were reported from the six tournaments, which corresponded to an incidence of 108 injuries per 1,000 player hours or 1.5 injuries per match. The incidence of injury varied between the different types of tournaments; it was the lowest in the 2002 Women’s European Cup and the highest in the women’s tournament of the 2004 Olympic Games. In general, the incidence of injuries increased towards the middle of each half and decreased towards their ends. Half of the contact injuries, or 45% of all injuries, were caused by foul play as judged by the team doctor and the injured player. However, only 60% of these injuries were sanctioned by the referee. The most frequent diagnosis was a contusion.

The injuries affected most frequently the lower extremity (42%), followed by injuries of the head (23%), upper extremity (18%) and trunk (14%). The most frequent diagnosis was contusion of head (14%) followed by an ankle sprain (8%). The majority of injuries were caused by contact with another player. Time loss injuries occurred on average 27 times per 1,000 player hours, and were significantly more frequent in men than in women. Less than a quarter of the injuries prevented the player from participating in a match or training for up to one week, 5% of the injuries led to a longer absence. Regarding time loss injuries only, the incidence was the highest in the Olympic Games in men and women, and the lowest in the Europe Cup and the Women’s World Cup.

Overall, the incidence of injury was similar for men and women. Furthermore, the location and type of injuries did not vary significantly between men and women. Women incurred significantly more non-contact injuries than men (20% vs 12%), but significantly less injuries of women than of men were expected to result in absence from play.
What we learned from the study

The F-MARC system proved feasible and achieved excellent cooperation of physicians in handball, too. After an initial learning phase, response rates reached almost 100%. Similar to the findings in football, the incidence of injuries in elite players was considerably higher than in adult amateur players during a season. This was probably caused by several factors, such as the higher speed of the game, the tougher play and the high number of matches during a short period of time. Different from football, incidence, location and type of injuries did not significantly differ between men and women.

Importantly, the head was the most frequently injured body part. While more research is needed in handball, the incidence of head injuries should be followed carefully in the future. In football, the Laws of the Game had been changed following F-MARC research on the risk factors for severe head injuries. Fair play proved to be an essential aspect of injury prevention in handball, too, and close cooperation with the referees will be required to make handball a safer sport.
2.8.4 Sports Injury during the 11th IAAF World Championships

Why we conducted this study

The protection of the athletes’ health by preventing injuries is an important task for any international sports federation. Injury surveillance reports on the incidence, mechanism, location and severity of injuries offer opportunities to develop specific preventive strategies. Numerous authors have analysed injury incidence in a variety of sports, but the results of these studies could not be compared, because of the different injury definitions, methods of data collection, observation periods, study designs and sample characteristics. While injury surveillance had been proven to be feasible and provided important information in several team sports tournaments, little experience existed concerning injuries in competitions for individual sports. Therefore, when the IOC decided to conduct an injury surveillance study in all sports during the 2008 Olympic Games in Beijing, the system established in team sports needed to be tested for its feasibility in individual sports.

Aims of the study

- Record and analyse all sports injuries incurred in competitions and/or training during the 11th IAAF World Championship 2007
- Use the experience to design a similar study during the Beijing Olympic Games

How we collected the data

The established injury-reporting system originally developed by F-MARC for team sports competitions was modified to be applicable for both individual and team sports. The most important principles of the system are comprehensive definition of injury, injury report by the doctor responsible for the athlete, a single-page report of all injuries, and daily report irrespective of whether or not an injury occurred. All national team doctors were asked to report all newly incurred injuries or the non-occurrence thereof on the standardised one page injury report form. In addition, the medical centre in the stadium reported daily on the injured athletes treated there.

Results

The physicians or responsible physiotherapists of 49 national teams covering 1,660 of the registered athletes took part in the study and returned a total of 333 injury report forms. The team doctors’ injury reports covered on average 68% of the registered athletes. In addition, injury reports from the medical centres were received daily. A total of 192 injuries were reported, with no significant difference between men and women regarding location, cause and severity of injury but for type of injury.

On average, almost ten per cent of the competing athletes were injured during the championship and 5.3% suffered a time loss injury. Eighty per cent of the injuries affected the lower extremity; the most common single diagnosis was thigh strain. A quarter of the injuries were incurred during training, the vast majority (71%) in competition, five during warm-up for competition and one during cool-down. In most cases the injury was caused by overuse (44%), either with gradual or sudden onset. On average, 7.2 injuries per 100 athletes were reported during the competitions with 4.2 time-loss injuries per 100 athletes. Injuries in competitions were reported from all disciplines, except hammer throw, javelin, women’s 400m, women’s high jump, women’s long jump and 1500m wheelchair. In relation to the number of competing athletes, the risk of incurring a time-loss injury during competition was highest in heptathlon (23% of the athletes), followed by women’s 10,000m, women’s 3000m steeplechase, decathlon and men’s marathon.

What we learned from the study

Even though based on the established F-MARC procedure for team sports tournaments, the injury report system proved feasible and practicable for individual sports during the IAAF’s World Championships 2007 and achieved good acceptance by the national team doctors. The data suggested that the injury surveillance system covered almost all athletes for the first six days of the championship. However, the response rate of team doctors decreased during the last three days of the championship, and thus, it is estimated that the true injury incidence of the championship was higher than reported.

It was concluded that, following further adaptations to the organisational and logistical specificities of the event, the system was suitable for implementation during the 2008 Olympic Games in Beijing.
The Congress of IAAF which approved the injury study at the 11th IAAF World Championship

IAAF - research group during the 11th IAAF World Championship 2007 in Osaka

**Duration:** 2007  
**Countries:** International  
**Cooperation:** IAAF, IOC, all physicians of the 11th IAAF World Championship  
**Reference:**
2.8.5 Injuries during the 2008 Olympic Games in Beijing

Why we conducted this study

Comparison of injury incidence between sports is difficult, not only due to lack of standardisation of methods, but also due to the different nature of sports. Major events such as the Olympic Games offer several advantages in this regard. The observation period is clearly defined, athletes of a comparable skill level compete in multiple sports and a high standard of environmental factors, such as the quality of the competition grounds and equipment, is guaranteed. At the same time, the large number of individuals and teams from different backgrounds and with varying medical support make it more difficult to obtain reliable information about the incidence, occurrence and characteristics of injury. Based on the injury reports routinely used in football, a group of experts from different international sports federations, under the leadership of F-MARC and the IOC, had developed a concise injury surveillance system for multi-sports events for both team and individual sports, that had been tested during the 2007 World Championships of the International Association of Athletics Federations (IAAF) in Osaka. The system had been accepted by experienced team doctors and shown to be feasible for single-sport and multi-sport events.

Aims of the study

- Implement the injury surveillance system in all Olympic sports
- Record and analyse all sports injuries incurred in competitions and/or training during the Olympic Games 2008 in Beijing

How we collected the data

The team doctors of all NOCs participated in an instructional meeting prior to the start of the event and were informed about how to complete the injury report forms. All National Olympic Committees (NOC) Head Physicians were asked to report all injuries or the non-occurrence of injuries daily on a specially designed injury report form. It is important that a daily statement is required regardless of whether injuries have occurred or not. In this way, the absence of injury can be distinguished from missing data; the response check is easier; and injury documentation is promoted as a matter of routine. In addition, the medical centres at the different Olympic venues and the polyclinic in the Olympic Village reported daily on the injured athletes treated there. Only injuries incurred during the period of the Games were included in the analysis.

Results

The physicians of 92 national teams took part in the study and returned a total of 1,314 injury reports on 9,672 athletes (88% of all athletes). Though some participating NOCs did not return forms on all days (response rate 80%), the injury surveillance system is likely to have covered almost all athletes. A total of 1055 injuries were reported, with no significant difference between men and women regarding the location, type and severity of injury. On average, almost every tenth athlete was injured during the Games; approximately one out of twenty athletes incurred a time-loss injury.

More than half (55%) of the injuries affected the lower extremity, 20% the upper extremity, 15% the trunk and 10% the head. The most common diagnoses were thigh strains and ankle sprains. About a quarter of injuries were incurred during training, three quarters in competition. One third of the injuries were caused by contact with another athlete, followed by overuse (22%) and non-contact injuries (20%). In relation to the number of registered athletes, the risk of incurring an injury was highest in taekwondo, football, hockey, handball, weightlifting and boxing where more than 15% of the athletes got injured.

What we learned from the study

A standardised injury surveillance system proved feasible at this multi-sports event for both team and individual sports. Acceptance and compliance by NOC physicians was good. The data suggested that the survey covered almost all athletes. However, as not all participating NOCs returned daily reports, it is estimated that the injury incidence is slightly higher than recorded. Football belonged to the six sports with the highest injury incidence with more than 15% injured players during the Games.
FOOTBALL MEDICINE PROJECTS | EPIDEMIOLOGY OF FOOTBALL INJURY

Duration: 2007 - 2008
Countries: International
Cooperation: IOC, FINA, IIHF, OSTRC, IAAF; all national physicians

Match opening ceremony at the women’s tournament in Beijing

Maradona and Ronaldinho in Beijing

Opening Ceremony of the Olympic Games in Beijing 2008

Argentina and Nigeria, finalists at the Olympic Games in Beijing
2.8.6 Sports Injuries and Illnesses during the 2009 FINA World Championships

**Why we conducted this study**

F-MARC had for some years assisted other sporting codes to establish their own injury surveillance systems based on the experiences made in football. Aquatic sports have followers all over the world and are enjoyed by many people on a recreational basis, while at the same time being among the most popular Olympic sports. Injury incidence and characteristics were first looked at as a part of investigations at multisport events such as the Olympic Games, but no studies had been undertaken during exclusively aquatic events. Also, nothing was known about illnesses in aquatic athletes apart from indications from anti-doping activities that a comparably large proportion of aquatic athletes use asthma medications. It was therefore decided to take the occasion of the so far largest aquatic sports event, the 13th FINA World Championships with almost 2,600 athletes, to investigate both injuries and illnesses among the participating athletes. Importantly, the event included five disciplines (swimming, water polo, diving, synchronised swimming and open water swimming) requiring an approach suitable for both individual and team sports.

**Aim of the study**

- Analyse the frequency and characteristics of injuries and illnesses during the 13th Fédération Internationale de Natation (FINA) World Championships 2009

**How we collected the data**

As this was the first time such extensive recording was undertaken at a FINA event, careful preparation and information of all parties was required which needed to include FINA medical staff, LOC medical staff and the medical staff of participating countries. Written information was broadly distributed in due advance, supplemented by information sessions at the venues just prior to the event. These information sessions included instructions on the completion and submission of the reporting forms.

Instructional booklets and reporting forms were distributed to all reporting parties. The team doctors or, in their absence, a team physiotherapist were asked to report daily on all newly incurred injuries and illnesses, or the non-occurrence thereof. Reporting forms could be submitted at confidential mailboxes adjacent to swimming pools, by fax and by electronic submission. In addition, the LOC medical teams at the medical stations at the venues submitted daily reports, too. Injury and illness definitions followed those recently used at the 2008 Olympic Games and only included newly incurred events requiring medical attention during training and competition. Chronic conditions were not recorded unless an acute exacerbation required medical attention.

**Results**

Overall response rate by the medical staff from participating countries was 42% with variation among the different disciplines and countries. This related to 67% of all athletes being included in the study (n=1745). The majority of injuries (83%) and illnesses (73%) were reported by team doctors, the remainder by the LOC medical teams.

In total, 171 newly incurred acute injuries were reported during the Championships, equivalent to an injury rate of 65.6/1000 athletes. Female athletes had a higher risk of injury (68.4 per 1,000 athletes) than male athletes (52.1 per 1,000 athletes). Most injuries affected the upper extremity (36.8%), followed by the lower extremity (27.5%), head/neck (19.3%) and trunk (16.4%). The most frequently injured body parts were the shoulder (14.6%) and head (12.3%). The most common types of injury were sprains and skin lesions.

Half of the injuries occurred during competition, and half during training. The most frequent injury cause was overuse (38%) followed with great distance by non-contact trauma and contact with another athlete. Only 21 (13%) of all injuries resulted in absence from training or competition. Overall injury risk was highest in diving and lowest in swimming.

A total of 184 acute illnesses were reported during the Championships, half of them concerned the respiratory tract followed by, less often, the gastrointestinal tract. The most frequent symptom was pain. Most often reported causes of illness were infections and, although to a much lesser extent, environmental. Only 30 illnesses resulted in absence from competition or training, which corresponded to 1% of all registered athletes.
What we learned from the study

For a first-time undertaking, a response rate covering about half of the athletes participating in the Championships appeared acceptable. It has to be considered, however, that this might have resulted in underestimation of overall injury and illness incidence as half of the athletes were excluded. Less than 7% of all athletes suffered injuries during the Championships, which is in line with the frequency observed in aquatics during the 2008 Olympic Games. The majority of injuries concerned the upper extremity, with the shoulder and lower back the most often injured body part. The by far most frequent injury cause was overuse, and future prevention programmes in aquatics should therefore concentrate on the prevention of overuse injuries. Contact injuries occurred only in water polo as the only contact sport in aquatics.

The most important finding however was the very low incidence of injuries that caused absence from competition or training of less than 1%. Even if underestimated, this means a very low risk of serious injury in aquatic sports.

Slightly more than 7% of registered athletes suffered from acute illness which is again compliant with findings at other elite sports events. The high frequency of respiratory tract infections in elite athletes has been reported previously and is thought to be related to training-induced immune suppression plus crowding at sports venues.

Duration: 2008 - 2010
Countries: International
Cooperation: Fédération Internationale de Natation (FINA)
2.8.7 Sports Injuries and Illnesses during the 2010 Winter Olympic Games

Why we conducted this study

Protection of the athletes’ health is a clearly articulated objective of the International Olympic Committee. In 2008, F-MARC had assisted the International Olympic Committee in implementing a comprehensive injury and illness surveillance system at the XXIX Summer Olympic Games. The comprehensive injury recording through the medical staff of the participating National Olympic Committees and the sports medicine clinics revealed that almost 10% of all athletes incurred an injury during the Beijing Games. The incidence of injuries and illnesses varied substantially between sports. Based on the findings on illness occurrence at the Championships of International Federations, it was considered important to include illnesses occurring Olympic Games at future events. Longitudinal surveillance of injuries and illnesses was hoped to provide valuable data to identify high-risk sports and disciplines where not yet done by the individual sporting codes. This would then form the foundation for introducing tailored preventive measures both in the individual sport and at multisport events in future.

Aim of the study

- Analyse the frequency and characteristics of injuries and illnesses during the XXI Winter Olympic Games in Vancouver in 2010

How we collected the data

The data collection method followed the procedure at the 2008 Summer Olympic Games taking into account the lessons learnt then as documented in the IOC Injury Surveillance system. In addition to injuries incurred during training and competitions, acute illness occurring at any time during the event and requiring medical attention was to be reported. Based on written information provided in due advance, and oral information given during a session prior to the event at the venue, all National Olympic Committees’ (NOC) head physicians were asked to report daily the occurrence (or non-occurrence) of newly sustained injuries and illnesses on a standardised reporting form. In addition, the medical centres at the Vancouver and Whistler Olympic clinics reported daily on all athletes treated for injuries and illnesses. F-MARC once more assisted in the collection, assertion of completion and analysis of data. Injury definition included any newly incurred musculoskeletal complaint, whether in training or competition, requiring medical attention and regardless of an absence from training or competition caused. Illness definition was one of any newly occurring physical complaint unrelated to injury.

Results

All 33 NOCs with more than ten registered athletes were included in the analysis of the response rate. These countries represented 2,417 of the total of 2,567 athletes (1,045 females, 1,522 males) from 82 NOCs participating at the games. The reported 287 injuries and 185 illnesses resulted in an incidence of 111.8 injuries and 72.1 illnesses per 1,000 registered athletes.

On average, 11% of athletes suffered an injury during the event. Female athletes were more often injured than male athletes. In relation to the number of registered athletes, the risk of sustaining an injury was highest for bobsleigh, ice hockey, short track, alpine freestyle and snowboard cross. In these sports, 15-35% of all registered athletes were affected.

Conversely, the injury risk was lowest for the Nordic skiing events (biathlon, cross country skiing, ski jumping, Nordic combined), luge, curling, speed skating and freestyle modules with less than 5% of registered athletes affected by injuries.

The most frequent injury cause was non-contact, followed by contact with a stationary object followed by contact with another athlete. Injury location and type differed with the sport. The head, cervical spine and knee were the most common injury locations. Injuries were evenly distributed between training (54%) and competition (46%). Less than a quarter (23%) of the injuries resulted in an absence from training or competition.

In skeleton, figure and speed skating, curling, snowboard cross and biathlon, every tenth athlete suffered from at least one illness. More female than male athletes suffered from an illness. In 113 illnesses (62.8%), the respiratory system was affected. The most frequent symptoms were pain and dyspnea/cough. About a third of illnesses were
expected to result in absence from training or competition.

**What we learned from the study**

At least 11% of the athletes incurred an injury during the games, and 7% of the athletes an illness. The incidence of injuries and illnesses varied substantially between sports, and a number of high-risk sports were identified as one of the objectives of the study. As compared to the Summer Olympics considerably more head injuries and concussions occurred, with the latter affecting 7% of all athletes. In the future, risk factor and injury mechanism analyses in these high-risk Olympic winter sports will be essential to better direct injury prevention strategies.

With regard to illnesses, education of athletes on the prevention of infectious diseases and a reduction of the risk of infection in crowded sport venues will go a long way to achieve reductions in respiratory tract diseases as the major illness group found.
2.8.8 Sports Injuries and Illnesses during the 2012 Summer Olympic Games in London

Why this study was conducted

There is a risk of injury in any sport, and irrespective of whether incurred during training or in competitions; injuries may seriously harm an athlete’s health and development. According to the Olympic Charter, one of the main roles of the International Olympic Committee (IOC) is thus to encourage and support measures protecting the health of athletes, and as previous research has shown, systematic injury surveillance is the foundation for developing effective preventive measures in sports.

Following up the injury surveillance system developed by F-MARC and routinely applied in all international football tournaments since 1998, the IOC entrusted a group of experts with the development of an injury surveillance system for multi-sports events. This injury surveillance system was successfully implemented in the 2008 Beijing and in the 2010 Vancouver Olympics, and it was further developed for the 2012 Summer Olympic Games in London as described in this study.

Aims of the study

- To analyse all injuries and illnesses during the 2012 Summer Olympic Games in London
- To compare different genders and sports

How we collected the data

All National Olympic Committees (NOCs) were informed about the study four months in advance of the Olympic Games, and one day before the opening of the Games, the medical staff of the NOCs was invited for a meeting covering the details of the study. During that meeting, the daily injury and illness report forms as well as an instructional booklet detailing the study protocol were distributed. Employing the IOC injury and illness report forms for multi-sports events, the daily occurrence (or non-occurrence) of injuries and illnesses was reported by the medical staff of all National Olympic Committees (NOC) and by the medical staff operating in the polyclinic and medical venues. Throughout the data collection the response rate of all NOCs with more than 30 participating athletes was recorded, and they were frequently visited in order to encourage continuous medical reporting throughout the Games. Seventy-four of the 204 NOCs had more than 30 participating athletes; these comprised 89% of all athletes. Throughout the 17 days of the London Games, the 74 NOCs submitted a total of 1204 of a maximum of 1258 forms (96%).

Results

A total of 10,568 athletes (44% women, 56% men) participated in the London Olympic Games. The NOCs and LOCOG medical staff reported 1,361 injuries and 758 illnesses. At least 11% of the athletes incurred an injury during the Games while 7% of the athletes incurred an illness.

The number of injuries during competition and training was similar with 55% occurring in competition and 45% during training. The four most commonly reported injury mechanisms were overuse (n=346, 25%), non-contact trauma (n=275, 20%), contact with another athlete (n=197, 14%) and contact with a stationary object (n=164, 12%). The injury rates in women and men were similar. The risk of an athlete being injured was the highest in taekwondo, football, BMX, handball, mountain bike, athletics, weightlifting, hockey and badminton, and the lowest in archery, canoe slalom and sprint, track cycling, rowing, shooting and equestrian. More than a third (35%) of the injuries were expected to prevent the athlete from participating in competition or training.

About 41% of the illnesses affected the respiratory system, and the most common cause of illness was infection (46%). Women significantly suffered more illnesses than men (86.0 vs. 53.3 illnesses per 1,000 athletes). The rate of illness was highest in athletics, beach volleyball, football, sailing, synchronised swimming and taekwondo. About one fifth of the illnesses incurred during the Games were expected to result in absence from training or competition.

What we learned from the study

The incidence and characteristics of injuries and illnesses during training and competition varied substantially between sports and gender. The continuous surveillance of injury and illness is a fundamental prerequisite for athlete health protection, and international sports bod-
ies should continue to implement reliable injury and illness surveillance systems. Only by monitoring the development over several years can changes in potential risk factors and mechanisms of injuries and illnesses be identified. This, in turn, will allow us to develop, introduce and update preventive measures, tailored for each specific sport.

**Reference:**

**Duration:** 2012
**Countries:** International
**Cooperation:** IOC and medical staff of participating countries
2.8.9 Injuries in 13 International Athletics Championships

Why this study was conducted

Participating in athletics is associated with an injury risk, which varies between age, gender, country, type of championships and discipline category. It is of interest to improve the knowledge of incidence and characteristics of injury to determine the most relevant injuries (high frequency and/or severity) and the discipline categories with the highest risk of injury.

Studies on injuries during championships and throughout training season have substantially different results. Therefore, the International Association of Athletics Federation has systematically surveyed all athletics injuries in their competitions since 2007 in order to develop strategies for health protection of their athletes.

Aims of the study

- To analyse the frequency and characteristics of injuries during 13 international athletics championships from 2007 to 2012 regarding different types of championships and discipline categories
- To compare the injuries in different types of championships and discipline categories

How the data were collected

The IAAF and EAA used the injury-reporting system developed for the International Olympic Committee (IOC) for all international athletics championships since 2007. The team doctors and the Local Organising Committee reported daily all injuries on a standardised injury report form during each championship. The 35 disciplines were summarised into eight different categories. Incidences of all (time-loss) injuries and training (time-loss) injuries were calculated as number of injuries per 1,000 registrations, whereas incidences of in-competition (time-loss) injuries were calculated as number of injuries per 1,000 competing athletes.

Results

On average 30.9% of the national teams (290 of 939) participated in the study, these included 79.6% of the registrations. The team doctors returned a total of 1,678 injury report forms, equivalent to a response rate of the participating countries of 86.3%. WIC 2010, WYC 2009, WJC 2010 and OGs 2008 and 2012 were not included in the analysis, because the necessary data were not available.

A total of 1,470 injuries were reported, equivalent to 81.1±4.2 injuries per 1,000 registrations of which 36.7±2.9 were expected to result in absence from sports (Fig. 2.8.9.1). The incidence of time-loss injuries was significantly higher in competition (29.0±2.6) than in training (5.8±1.9), and in outdoor (46.4±4.0) than in indoor (23.7±6.2) or youth/junior championships (13.2±4.0). While most in-competition time-loss injuries were reported during short distance events (32.5%), combined events had the highest incidence of in-competition time-loss injuries (106±26.5). The most frequent diagnosis was thigh strain (28.2%), followed by lower leg strain and ankle sprain. Injury location varied between different discipline categories: in long distances the lower leg, in marathon the foot and in throwing the upper extremity were mainly affected.

What are the new findings?

Overall 81.1±4.2 injuries per 1,000 registrations were documented during 11 international athletics championships from 2007 to 2012. More injuries were incurred during competition than in training. On average 58.4±3.7 (29.0±2.6) in-competition (time-loss) injuries per 1,000 competing athletes were reported. The incidence of all and of time-loss injuries was higher in outdoor than in indoor or in youth/junior championships. However, more data from indoor and youth/junior championships are necessary to draw conclusions. The incidence of all and of in-competition time-loss injuries was highest in combined events and marathon, and lowest in throwing disciplines. The highest number of injuries (30% of all) was observed in short distance events due to the high number of athletes competing in these disciplines.

Injuries affected most frequently the thigh in jumps, short and middle distances, race walk and combined events, the lower leg in long distances, the foot in mara-
Fig 2.8.9.1 Number of all and time-loss injuries during training and competition in different discipline categories (*For some injuries information on discipline (competition or training) or time loss is missing or injury occurred apart from discipline)

What we learned from the study

The incidence of injuries varied substantially between different types of athletics championships and between discipline categories. On average 4% of the athletes incurred a time-loss injury during an athletic championship. The use of uniform definitions and data collection methods is of great importance to ensure comparable results and allow pooling of data sets to reach greater sample sizes. Injury surveillance during championships should focus on in-competition (time-loss) injuries. Special attention should be paid to injuries in combined events and long distances including marathon (because of the highest injury incidence) and short distances (due to the highest number of injuries). Future prevention studies should focus on (thigh) strain to better understand the injury mechanism and risk factors and to analyse the efficacy of adapted preventive measures.

Duration: 2007 - 2012
Countries: International
3 Prevention of Football Injury

3.1 Review of Literature

What was known on prevention of injuries

There are hundreds of research articles on injuries and their prevention in sports. The challenge for any particular research group or physician is finding, reading, interpreting and finally evaluating all these papers. A review article summarises the numerous papers on football injuries in a single paper and also provides an evidence-based evaluation of their content. This way, football medicine physicians could read a single paper and get information from a large number of previously published papers without having to search, find and finally assess each paper with regard to its scientific value.

In our first review on the incidence of football injuries in 2000, F-MARC had concluded on the inconsistency of the data reported. We had also identified the problems where more research was urgently needed. In the following years, F-MARC conducted own studies in order to close these gaps and establish further details on football injuries, always in view of our aim to eventually develop evidence-based prevention strategies. As a next step, it was therefore required to once more assess the in the meantime considerably grown body of knowledge on injury incidence, aetiology and mechanisms, but in addition also the evidence on the possibilities and results of prevention in order to move forward in the direction of developing a F-MARC prevention programme.

Aims of the review

• Analyse the literature on the incidence of injuries in football
• Analyse the literature on the characteristics and causes of injuries in football
• Review the current knowledge on the possibilities for preventing injuries and the effectiveness of prevention programmes

What did the medical literature tell us about injuries in 2004?

F-MARC reviewed and reported on 62 papers that discussed injury incidence and injury prevention. Our literature review was structured in accordance with the typical methods used to prevent injuries:

1. Establish the extent of the football injury problem
2. Establish the aetiology and mechanism of football injury
3. Introduce preventive measures
4. Test the effectiveness of the preventive measures by repeating the first step

Incidence and characteristics

Several investigators had studied the incidence, causes and risk factors of football injuries in male professional players; however, epidemiological data on injuries in female football players was still limited. From the data reviewed, it could be estimated that, on average, every elite male football player incurs approximately one performance-limiting injury each year. The overwhelming majority of injuries were due to trauma, mostly during matches with between one quarter and one half of all traumatic injuries being non-contact in nature and about one quarter of all injuries being re-injuries. Injuries were a little more frequent in the second half as players become fatigued.

Football injuries predominately affected the ankle, the knee and the muscles of the thigh and calf. The most common injuries were sprains, strains and contusions. Other important factors were contact with another player and here particularly foul play.

Ways of preventing football injuries

Most prevention programmes include the following general activities:
• Warm up and cool down with special emphasis on stretching
• Adequate rehabilitation and time for recovery from an injury
• Improvement in fitness with special emphasis on proprioceptive training
• Protective equipment
• Good playing field conditions
• Fair play

Other programmes add further items to this general list such as pre-competition screening, nutrition and hydration, improved technique and better injury recording.
Tab. 3.1.1 Studies on the prevention of injury in football players

<table>
<thead>
<tr>
<th>Reference</th>
<th>Intervention group</th>
<th>Control group</th>
<th>Players Interventions</th>
<th>Intervention Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ekstrand et al. 1983</td>
<td>6 teams</td>
<td>6 teams</td>
<td>male 17-37 yrs</td>
<td>multi-modal intervention program</td>
</tr>
<tr>
<td>Heidt et al. 2000</td>
<td>42 players</td>
<td>258 players</td>
<td>female 14-18 yrs</td>
<td>Frappier Acceleration Training Program</td>
</tr>
<tr>
<td>Junge et al. 2002</td>
<td>101 players</td>
<td>93 players</td>
<td>male 14-19 yrs</td>
<td>multi-modal intervention program</td>
</tr>
<tr>
<td>Tropp et al. 1984</td>
<td>60 players, 65 players with previous ankle problems</td>
<td>171 players</td>
<td>male senior</td>
<td>Use of orthosis or Ankle disk training</td>
</tr>
<tr>
<td>Surve et al. 1996</td>
<td>117 players without and 127 players with previous ankle sprains</td>
<td>260 players</td>
<td>male senior</td>
<td>Instruction to wear a semi-rigid orthosis on the previously sprained ankle or on the dominant ankle</td>
</tr>
<tr>
<td>Söderman et al. 2000</td>
<td>62 players</td>
<td>78 players</td>
<td>female mean 21 yrs</td>
<td>Balance board training</td>
</tr>
<tr>
<td>Caraffa et al. 1996</td>
<td>20 teams</td>
<td>20 teams</td>
<td></td>
<td>Proprioceptive training</td>
</tr>
<tr>
<td>Hewett et al. 1999</td>
<td>97 players</td>
<td>193 players</td>
<td>female high school</td>
<td>Preseason neuro-muscular training program</td>
</tr>
<tr>
<td>Askling et al. 2003</td>
<td>15 players</td>
<td>15 players</td>
<td>male mean 25</td>
<td>Training with eccentric overload</td>
</tr>
<tr>
<td>Mandelbaum et al. 2005</td>
<td>1885 players</td>
<td>3818 teams</td>
<td>female 14-18 yrs</td>
<td>PEP programme</td>
</tr>
</tbody>
</table>

Nine studies on the multi-modal intervention programmes in the prevention of football injuries were found in the literature (Tab. 3.1.1). These programmes included a wide variety of exercises and were consistent in showing fewer injuries in the intervention group when compared with a control group. A common concern with general programmes is that they usually have many activities and it is unknown which combination(s) of activities are actually behind the reduction in injury.

Ankle sprains are the most common joint injury in football, and therefore should clearly be a focus of football injury prevention. Ankle sprains can be prevented by external ankle supports and proprioceptive/coordination training, particularly in players with previous ankle sprains. Proprioception is the sense of the relative position of neighbouring parts of the body. Football players often consider an ankle sprain as a nuisance and fail to appreciate what is required for the ankle to heal by returning to play before the ligaments have healed, or playing without some form of ankle support.

The knee is the next most common site of ligament injuries, but these can lead to greater time loss because they may require surgery and extended rehabilitation. Programmes that prevent injury to the anterior cruciate ligament were a subject of some scrutiny. It does appear that training of neuromuscular and proprioceptive performance as well as improvement of jumping and landing technique seems to decrease the incidence of anterior cruciate ligament injuries in female athletes.

**What we learned from the review**

Multi-modal intervention programmes may result in a reduction in injuries in general. However, more well-designed studies were required to evaluate the effects of specific preventive interventions. Proprioceptive and/or coordination training seemed to prevent severe knee injuries and recurrent ankle sprains. Prevention programmes probably have different effects in male and female players, and are more effective in groups with an increased risk of injury. Future studies should monitor compliance of players with the programme because this was found to be an essential factor for its effectiveness.

**Duration:** 1998 - 2003

**Reference:**

3.2 Development of Prevention Programmes

3.2.1 “The 11” – A Prevention Programme for Amateur Players

The need for prevention

According to our review of the literature, several preventive programmes had been developed and proven effective in reducing the incidence of football injuries. However, none of these programmes had been implemented in the everyday training routine of football life. To effectively reduce injuries on a large scale, any prevention programme clearly had to address the amateur player. Under the leadership of F-MARC, a group of international experts set out to filter the essence of injury prevention out of the large body of knowledge. Our challenge was to create a simple, catchy and time-efficient preventive programme.

The essentials of “The 11”

- “The 11” comprises ten evidence-based or best-practice exercises being enhanced by education and promotion of Fair Play.
- The programme is designed to reduce the most common football injuries identified by F-MARC, such as ankle sprains, hamstring and groin strains and ligament injuries in the knee.
- “The 11” requires no equipment other than a ball, can be completed in ten to 15 minutes and should be performed as a matter of routine.
- The programme can be performed on the field with the players wearing their usual equipment and football boots.
- The exercises can be carried out anywhere at any time, ideally daily and not only during training sessions or matchdays.

The ten exercises...

The exercises focus on core stabilisation, eccentric training of hamstrings, proprioceptive training and dynamic stabilisation with plyometrics and straight leg alignment. Core stability and strength is essential to control trunk, pelvis and the lower extremity, while an optimal neuromuscular control of the lower extremities is crucial for joint stability. Plyometric training involves practice movements to toughen tissues and train nerve cells to stimulate a specific pattern of muscle contraction so the muscle generates as strong a contraction as possible in the shortest amount of time. Sport-specific plyometrics, agility and speed are the key for responding to the football demands on the field.

Three exercises aim at core stabilisation: “the bench”, “sideways bench” and “cross-country skiing”. The so-called “Russian” or “Nordic” hamstrings were included to increase eccentric hamstring strength. Three exercises in an “active” single leg stance with weight on the forefoot were chosen to train proprioception and balance. The centre of attention is the bent knee, bent hip and straight leg alignment (“knees over toes”). Dynamic stabilisation and jump technique are trained with three exercises: “jumps over a line” (forward-backward, sideways), “zigzag shuffle” and “bounding”. These exercises include plyometric training of the leg muscles, straight leg alignment (no “kissing knees”) and landing on the forefoot with bent knees and hips.

... plus fair play

However, football injury can only partly be prevented by improved physical condition. Knowing that a substantial amount of injuries are caused by foul play, the regard for fair play is an essential aspect in the prevention of injury.

Distribution and implementation of “The 11”

The F-MARC experts offered FIFA the best available knowledge and state of the art of medical science translated into a simple programme. It was now up to FIFA, the confederations and the member associations to disseminate the messages to their players and implement the preventive programme on a broad scale.

“The 11” comes as a DVD with instructions included as a booklet to reinforce learning. “The 11” is available in five languages (English, French, German, Italian and Spanish). A poster of “The 11” and a list of frequently asked questions are also available to support the DVD (Fig. 3.2.1.1).
The insurance connection

A possible way to reinforce, stimulate and speed the implementation of this preventive programme amongst the member associations is to search for appropriate partners who have the utmost interest to reduce injuries in football, e.g. insurance companies. It was a lucky coincidence or maybe a logical development, that following publication of the F-MARC preventive study and the presentation of “The 11”, the Swiss National Accident Insurance Fund (SUVA) approached F-MARC to collaborate in a nationwide launch of “The 11” together with SUVA and the Swiss National Football Association (SFV). This was followed by a request from the Accident Compensation Corporation of New Zealand, in cooperation with New Zealand Football, to educate coaches on “The 11”.

Duration: 2003 - 2004
Countries: International
Cooperation: International experts in football injuries and prevention
3.2.2 “FIFA 11+” A Complete Warm-Up Programme

The need for an advanced version

Based on their practical experience with different injury prevention programmes for amateur players, an international group of experts developed an advanced version they called “FIFA 11+”. The advanced programme aims to prevent football injuries, with a focus on preventing the two most common injury types in female youth football, i.e. ligament injuries to the ankle and to the knee. Therefore, the advanced programme combines key exercises from “The 11” and the “PEP” programme (see 5.3). As another aim was to provide a complete warm-up programme to ease the inclusion in existing training schemes, running exercises were included, too. Hence, this advanced programme can and indeed should replace the usual warm-up prior to training.

Essentials of the “FIFA 11+”

- The programme (Fig. 3.2.2.1) starts with an eight-minute running session, with forward, backward and sideways jogging. The intensity of the running programme gradually increases, and can be very high. This part of the programme will be performed in all training sessions and matches.
- The second part of the programme comprises of certain exercises as described below.
- The third and last part of the programme consists of a two-minute intensive running session with more running, sprinting and cutting, to provide the players with a final warm-up and preparation for the training session. The second and third parts of the programme are only to be performed prior to the training sessions, not matches.
- During all exercises, the focus is on knee control and awareness, landing techniques and cutting and planting, all factors known to be important in preventing ankle and knee injuries.
- After a short period of familiarisation the “FIFA 11+” can be completed in 20 minutes, and will replace the ordinary warm-up programmes teams typically use.

The prevention exercises

The second part of the warm-up programme lasts about ten minutes and consists of strength exercises, plyometrics and exercises for neuromuscular training (balance and coordination). For each of these six exercises, there are three progression levels that will increase the degree of difficulty and also provide variation to the programme. After three to four weeks of training on one progression level, the team can move on to a more difficult level, based on the judgement of the coach. If an individual player is struggling with a progression level, and is not able to do the exercise as prescribed, she or he should stay on the previous level until she or he is able to step up to the next level. The progression for the exercises is prescribed as modifications in the execution of the exercises, and/or as increased duration and number of repetitions.

Distribution and implementation of “FIFA 11+”

F-MARC experts used their latest experience and best knowledge to further improve the F-MARC prevention programme “The 11” into a complete warm-up programme. Again, it is now up to FIFA, the confederations and the FIFA member associations to disseminate the messages to their players and implement the preventive programme on a broad scale.

“FIFA 11+” comes as a poster and a DVD with instructions, included as a booklet to reinforce learning. “FIFA 11+” is available in four languages (English, French, German and Spanish).

Duration: 2006 - 2008
Countries: Norway, USA
Cooperation: Oslo Sports Trauma Research Center, Norway; Santa Monica Orthopaedic and Sports Medicine Group, Research and Education Foundation, California, USA
Fig. 3.2.1 “FIFA 11+” - a complete warm up programme to prevent injuries
3.2.3 “FIFA 11+ for Referees”

Why we conducted this study

The physiological match demands of refereeing have increased over the years due to the development of modern football. During a high level match, a referee may cover a mean distance of 11.5km (a mix of walking, running, sprinting), which is comparable to the distance covered by a midfielder. Elite referees may perform up to 1,270 activity changes (direction changes, as an example), and take more than 130 decisions during a match. Considering the high demands put on the cardiovascular and musculoskeletal system, officiating entails a certain risk of acute and overuse injuries.

F-MARC studies (See chapter 2.7) showed that the risk of non-contact injuries for elite male and female referees is similar or lower than that of a football player. The career prevalence of musculoskeletal complaints (“overuse”) can be estimated to be at least 90%. The most common injuries were hamstring strains, calf strains and ankle sprains. Musculoskeletal complaints in the low back, hamstring, knee, calf and Achilles tendon were frequent. The injury type and location of musculoskeletal complaints were similar among referees at all levels of performance and between genders.

Aims of the project

- The basic prevention programme for male and female referees and assistant referees aims to reduce acute non-contact injuries and minimise musculoskeletal complaints throughout referees’ careers.

Development and structure of the programme

The “FIFA 11+ for referees” injury prevention programme was developed by an international group of experts based on the specific injury profile of referees and on the “FIFA 11+”. It is a complete warm-up programme and should replace the usual warm-up prior to training. The programme has three parts with a total of 18 exercises, which should be performed in the given sequence at the start of each training session. The programme takes around 20 minutes to complete. Prior to matches, only the running exercises (parts 1 and 3) should be performed.

### PART 1: RUNNING EXERCISES

1. STRAIGHT AHEAD
2. CIRCLING PARTNER
3. ZIGZAG SHUFFLING
4. FORWARDS & BACKWARDS SPRINTS
5. for MA: SLalom FORWARDS & BACKWARDS
   for AR: ALTERNATE SHUFFLING
6. for MA: FORWARDS & BACKWARDS WITH ROTATIONS
   for AR: CARIOCAS

### PART 2: STRENGTH, PLYOMETRICS AND BALANCE EXERCISES

#### LEVEL 1
1. BENCH – ALTERNATE LEGS
2. SIDEWAYS BENCH – RAISE AND LOWER HIP
3. BRIDGE – ALTERNATE
4. HAMSTRINGS – BASIC
5. CALF – BASIC
6. SQUAT JUMPS
7. for MA: SINGLE-LEG STANCE - MOVE THE OTHER LEG
   for MA: FRONT LUNGE
8. for AR: LATERAL LUNGE 45°
   for AR: LATERAL JUMP

#### LEVEL 2
1. BENCH – ONE LEG LIFT AND HOLD
2. SIDEWAYS BENCH – WITH LEG LIFT
3. BRIDGE – ON ONE LEG
4. HAMSTRINGS – ADVANCED
5. CALF – ADVANCED
6. BOUNDING
7. for MA: SINGLE-LEG HOPS
   for AR: LATERAL LUNGE 90°
8. for MA: SCISSORS JUMPS
   for AR: DOUBLE LATERAL JUMP

### PART 3: RUNNING EXERCISES

1. PROGRESSION RUN
2. LONG SPRINT
3. for MA: SHORT DIAGONAL SPRINT
   for AR: SHUFFLING AND SHORT SPRINT
4. for MA: LONG DIAGONAL SPRINT
   for AR: SHUFFLING AND LONG SPRINT
A key point in the programme is to use the proper technique during all of the exercises: correct posture and good body control, including straight leg alignment, knee-over-toe position and soft landings. For all exercises, optimal performance is of great importance (Fig. 3.2.3.1). Therefore, the coach should supervise the programme and correct the referees if necessary.

**Dissemination of the programme**

The “FIFA 11+ for referees” programme is available as manual and DVD in four languages, and will be disseminated worldwide within the courses of the FIFA Refereeing Department (Fig. 3.2.3.2).

**Fig. 3.2.3.1 Two examples of exercises of the “FIFA 11+ for referees” injury prevention programme.**

From left to right (above): sideways bench with leg lift, the bench – alternate legs
From left to right (below): eccentric hamstring (partner exercise), and the bridge-alternate legs

**Fig. 3.2.3.2 Elite Italian referees -Serie A- (here with staff and FIFA representatives) are the official ambassadors of the “FIFA 11+ for referees” injury prevention programme.**

**Duration:** 2010 - 2013

**Countries:** International

**Cooperation:** Refereeing Department of the Italian Football Federation; FIFA Refereeing Department

**Reference:**
3.2.4 “FIFA 11+ Kids”

Why we are conducting this study?

Football is the world’s most popular sport and 58% of officially registered players are younger than 18 years. Playing football can induce considerable beneficial health effects, and thus has a great potential to support a healthy lifestyle. However, football also bears the risk of injury. It is therefore necessary to implement preventive measures that reduce the risk of injury and consequently support the health benefits associated with playing football. Comprehensive epidemiological data on football injuries are currently obtained in order to develop promising prevention programmes.

Several studies evaluated injury prevention programmes in adolescent and adult players (> 13 years old). In most studies, there was good evidence that injury prevention programmes were effective. When an injury prevention programme failed to show beneficial effects, poor compliance was considered to be the main reason. Younger players seem to have partly different injury characteristics and, thus, adapted needs in injury prevention. To date, no study has investigated the prevention of football injuries in children under the age of 13 years. The prevention programme “FIFA 11+” was designed for players (> 13 years old) and has shown substantial positive effects in reducing football injuries. The development of an equivalent programme for players younger than 13 years seems necessary.

Aims of the study

- To develop an adapted injury prevention programme for football players under the age of 13
- To analyse adaptations in movement skills and physical fitness as a consequence of the programme
- To conduct a multi-centre intervention study on the “FIFA11+ Kids” programme

How we conduct the survey

In a first step, there is the need to adapt the existing programme (“FIFA 11+”) with regard to the particular characteristics of football injuries in younger children (< 13 years). The available programme was complemented with three main categories of exercises focusing on (1) spatial orientation, anticipation, and attention particularly while dual-tasking as it is a common challenge in football, (2) whole body and unilateral leg stability as well as movement coordination and (3) appropriate fall techniques. Similar to the “FIFA 11+”, a modular approach is used with exercises from the three main categories and five difficulty levels to be composed for a single training session (warm-up). The development of the programme is a close cooperation between different international institutions and experts (Dr O. Faude, R. Rößler, University of Basel, Switzerland; Dr M. Bizzini, F-MARC, Zurich, Switzerland; Prof. E. Verhagen, Amsterdam, Netherlands; Prof. T. Hewett, Cincinnati, U.S.A.; Prof. J. Chomiak, Prag, Czech Republic; N. Mathieu, Sion, Switzerland).

In a second step, the developed programme will be evaluated with regard to (a) the feasibility and acceptance among young children and coaches as well as (b) to possible beneficial adaptations in movement skills and physical fitness. For this purpose a two-armed cluster-randomised controlled trial will be conducted.

This pilot study will include 120 children between seven and 12 years who play organised football in Switzerland. Twelve teams consisting of approximately ten children each will be randomly assigned to either the intervention or the control group, respectively. Regular training should take place at least twice per week. Training and match exposure and training contents will be recorded by the coaches.

The intervention period will last 12 weeks (24 training session). The injury prevention programme is included at the beginning of the usual football training by replacing the traditional warm-up. The control group will receive the instruction to regularly perform a common warm-up programme consisting of running and ball-based exercises (sham treatment).

Before and after the training period various tests will be conducted. Tests will be performed to assess locomotor skills (e.g. balancing, running, jumping) and object control skills (e.g. controlling the ball, dribbling, passing).

In the third step, after developing the “FIFA 11+ Kids” programme, F-MARC is currently conducting a large multi-centre intervention study in four European countries: Switzerland, Germany, Czech Republic, and the Netherlands.
Duration: 2013 - ongoing
Countries: Switzerland, Germany, Czech Republic, Netherlands
Cooperation: Dr. Oliver Faude, Roland Roßler, University of Basel, Switzerland
3.2.5 Enforcement of the Laws of the Game

Why we conducted this study

The risk of injury during football matches is 1,000 times higher than high-risk industrial occupations. A recent study from Oslo Sports Trauma Research Center documented an increased incidence of acute match injuries in Norwegian professional football from 2002 to 2007. Previous studies have found that between 44% and 59% of all acute match injuries at club level are caused by player-to-player contact. Video analyses from FIFA tournaments showed that the match referee identified 47% of all injuries, and 40% of head injuries as foul play. A study in Norwegian professional football concluded that most referee decisions were correct according to the Laws of the Game, but that there might be a need for more strict interpretation of the Laws of the Game in order to protect players from dangerous play. As a consequence, The International Football Association Board gave referees the authority to severely sanction fouls that were recognised to be injurious, such as intentional elbows to the head and brutal tackles. After this, the incidence of match injuries was significantly lower in the 2010 FIFA World Cup™ for men compared to the mean incidence found in the three previous World Cups. However, the effect of rule changes and their interpretation have neither been evaluated through prospective injury surveillance systems nor through video analysis, a key element missing in the current sport injury prevention research portfolio.

Aims of the study

- Compare the rate of incidents with a propensity for injuries between the seasons 2000 and 2010
- To assess whether a stricter interpretation of the Laws of the Game could reduce the potential for injuries in Norwegian male professional football

How we collected data

We collected videotapes of league matches and injury information prospectively during the 2000, 2010 and 2011 season.

An incident was said to occur if the match was interrupted by the referee, the player stayed down for more than 15 seconds, and appeared to be in pain or received medical treatment. Each incident was classified according to the cause (opponent-player contact, teammate-player contact, ball-player contact or non-contact) and body location involved. We also categorised the referee’s decision (no foul, foul for, foul against) and the referee’s sanction (no sanction, yellow card or red card).

The methodology of the UEFA injury system has been implemented in Norwegian professional football, using the time-loss definition of injury.

To evaluate the effect of stricter rule enforcement, a pre-/post-intervention design was employed. Prior to the 2011 season video recordings of incidents and injuries from the 2010 season were analysed and refereeing guidelines were agreed upon according to FIFA regulations. This involved sanctioning of two-foot tackles as well as tackles with excessive force and intentional high elbow with an automatic red card. The plans for stricter rule enforcement were introduced to each team in meetings with referees appointed for the 2011 season. In addition, the study group and the Head of Refereeing in the Football Association of Norway held a similar meeting for the media, thereafter, a press conference with a high-profile player, a manager and FIFA representative were organised.

Results

A total of 2,140 incidents were identified during the three seasons, 419 in 2000, 868 in 2010 and 853 in 2011. The corresponding overall rate of incidents was 74.4 per 1,000 player-match hours of exposure (95% CI: 67.3 to 81.5) in the 2000 season and 109.6 (95% CI: 102.3 to 116.9) in the 2010 season, an increase from 2000 to 2010 (rate ratio: 1.47, 95% CI: 1.31 to 1.66).

We observed a higher rate of opponent-to-player contact and non-contact incidents in the 2010 season. We found no change in the awarding of yellow or red cards between the two seasons.

The rate of contact incidents was 92.7 (95% CI: 86.0 to 99.4) in the 2010 season. After the introduction of stricter rule enforcement, the incident rate was 86.6 (95% CI: 80.3 to 99.4) in the 2011 season, showing no difference between the 2010 and 2011 seasons. We found, however, a reduction in the incidence of head incidents (rate ratio (RR): 0.81, 95% CI: 0.67 to 0.99), and head incidents caused by arm-to-head contact (RR: 0.72, 95% CI: 0.54 to 0.97). We found no difference in tackling characteristics or injury rate caused by player-to-player contact.
What we learned from the studies

We found an increased rate of non-contact and opponent-to-player contact incidents in both heading and tackling duels with a high injury potential in the 2010 season compared to ten years earlier, even if there was no increase in the frequency of duels.

We found no differences in the overall rate of incidents after the introduction of stricter rule enforcement. However, the rate of head incidents and arm-to-head incidents was lower. This indicates a need for an increased focus on the effect of rule changes and regulations on injury risk. It might also lead to implementation of stricter rule enforcement in other leagues and tournaments, in order to reduce the number of situations with a high injury potential and hence the injury risk.

Fig. 3.2.5.1a (top) Characteristics of incidents (n=2140); b (middle) Characteristics of incidents due to opponent-to-player contact (n=1774); c (bottom) Characteristics of head incidents due to opponent-to-player contact (n=510) from video analysis of all games (n=240 each season)

References:
3.3 Evaluation of the Effects of Prevention Programmes

3.3.1 Prevention of Injuries in Male Youth Amateur Players

Why we conducted this study

While the incidence of football injury had been reported and investigated in several studies, there were few studies that had reported the results of an injury prevention programme. The scientific literature on prevention of sports injury seemed to support the effectiveness of preventive interventions, but there were few prospective epidemiological studies on youth that evaluated the effectiveness of such programmes.

Often, research and programmes were focused on professionals because of the investment that team owners make in their players. It had become clear that even the professional players have a limited understanding of injury prevention strategies. In consideration of the vast number of amateur players, whom one might expect to be less informed than professionals, F-MARC felt that a better instruction of recreational players and coaches was even more urgently needed.

Aims of the study

- Develop a preventive programme for youth players
- Evaluate the effect of the programme in a prospective study

How we collected the data

This was a prospective cohort study that included an initial baseline examination (for performance and risk factor evaluation) that was followed by a one-year observation period where all football-related injuries and physical complaints were documented weekly by a physician. The teams that participated were male amateur players aged between 14 and 19 years that had no physician or physiotherapist taking care of the players. Seven teams took part in an intervention programme that stressed education and supervision of coaches and players (intervention group), while seven control teams were instructed to train and play football as usual (control group). Complete weekly follow-ups were available in 101 players of the intervention group and 93 players of the control group.

The prevention programme

The prevention programme focused on improvement of the structure and content of the training by education and supervision of coaches and players. The programme was designed to reduce the incidence of football injuries in general, without emphasis on a special type of injury. Ten activities that could be considered as predecessors of the later F-MARC 11 made up the training exercises. Other factors, such as the amount of training and matches, time schedule, player's equipment and playing ground were not specifically addressed.

Results

The overall incidence of injury was 6.7 and 8.5 injuries per 1,000 hours of training in the intervention and control groups respectively, representing a 21% reduction in injuries. The prevention programme had more of an effect in the low-skill level teams where the incidence of injury was 37% lower than in the control group players while there was only a 7% lower injury rate in the high-level (Fig. 3.3.1.1). The rate of match injuries was decreased by 30% and 18% for the high and low-level teams respectively (Fig. 3.3.1.2).
The rates of overuse injuries and training injuries were unchanged in the high-level teams, however, the incidence of similar injuries in low-level was 54% lower than in the control teams (Tab. 3.3.1.1).

There were 44% fewer injuries and 21% fewer players suffering an injury for an overall 21% lower injury rate in the intervention group. Non-contact injuries are of particular interest as many feel these are the injuries most likely to be reduced by a prevention programme. In this project, the rate of non-contact injuries was reduced by nearly 20% in the high level teams and almost 40% in the lower level teams. Of particular interest was the substantial reduction in mild injuries in both groups. The most frequent football injuries are minor, so reducing the mildest of injuries will also have a considerable impact on the average injury severity.

<table>
<thead>
<tr>
<th></th>
<th>High skill teams</th>
<th>Low skill teams</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-contact injuries</td>
<td>-20%</td>
<td>-40%</td>
</tr>
<tr>
<td>Mild injuries</td>
<td>-27%</td>
<td>-39%</td>
</tr>
<tr>
<td>Match injuries</td>
<td>-30%</td>
<td>-18%</td>
</tr>
<tr>
<td>Training/overuse injuries</td>
<td>+3%</td>
<td>-54%</td>
</tr>
</tbody>
</table>

Tab. 3.3.1.1 Percent differences in selected injury rates from control teams by skill level

What we learned from the study

It is apparent that when an education and prevention programme for both coaches and players becomes a regular part of a training programme, injuries are reduced, particularly in the lower skill level teams. This prevention programme was especially effective in reducing the rate of football injury in low-level teams. Overuse and training injuries, while unaffected in the high-level teams, were reduced by over 50% in the low-level teams. For the development and implementation of prevention programmes, the initial situation of the players and their environmental risks should be considered, such as quality of pitches and equipment. Furthermore, an important aspect in the prevention of football injury concerns the observance of the Laws of the Game and especially the spirit of Fair Play. A broader view and the inclusion of other target groups (such as referees, parents, official representatives and others) will lead us all to a healthier, safer game.
3.3.2 Prevention of ACL Ruptures in Female Players

**Why we conducted this study**

Women’s participation in sports is continually on the rise worldwide. For example, in 1972, the US Congress passed a resolution that effectively allowed women to participate fully in academic and athletic events without gender discrimination. At that time, approximately 300,000 women participated in competitive sport at the high school level (age 15-18). By 2003, that number had grown to approximately two million active sports women.

This dramatic increase in participation had almost inevitably led to an increase in sports related injuries, but particularly striking was the high incidence of non-contact injuries to the anterior cruciate ligament of the knee (ACL). Numerous studies had reported females sustain non-contact ACL injuries at a rate that exceeded their male counterparts by two to eight times. Competitive team sports such as football, basketball, team handball and volleyball require dynamic stability to withstand the demands of cutting, decelerating, jumping, and landing from a jump. A number of laboratory studies had suggested that motor control of the high risk manoeuvres described was different amongst young women and this control might be closely associated with knee instability that can lead to ACL injury plus damage to the menisci and surface cartilage of the bones of the knee.

While the surgical treatment and rehabilitation from ACL injuries was well documented and many players returned to their previous level of performance, the meniscal and cartilage damage would eventually lead to progressive damage and early onset of osteoarthritis. Thus, F-MARC considered a specific prevention programme critical to keep female players in the game and protect them from the consequences of this severe injury.

**Aims of the study**

- Determine the incidence of ACL injury in a large league of young female football players
- Determine whether a neuromuscular and proprioceptive performance programme decreased the incidence of ACL injury in this population of competitive players

**How we collected the data**

In 2000, all teams of the Coast Football League in Southern California were contacted and invited to participate in the study. Those teams that chose to participate were instructed via video and printed literature about the details of the prevention programme.

All players were females between the ages of 14 and 18 and performed either their traditional warm-up (control group) or a sports-specific training intervention called “Prevent Injury, Enhance Performance” (PEP) before their athletic activity over a two-year period. A total of 1,041 female players from 52 teams received the sports-specific training intervention in a prospective non-randomised trial. The control, untrained, group consisted of the remaining 1,905 female football players from 95 teams participating in the same league who were age and skill matched. The project was continued in the 2001 season with 844 females (from 45 teams) in the intervention group and 1,913 female athletes (from 112 teams) serving as the age- and skill-matched control group.

**The PEP programme**

The specific programme used in the intervention consisted of education, stretching, strengthening, plyometrics and sports-specific agility drills designed to replace the traditional warm-up (Tab. 3.3.2.1). The programme emphasised “soft landings” with deep hip and knee flexion and lower extremity control during jumping, landing and change of direction. Video and print resources displayed examples of the proper technique. Each player in the intervention group received a videotape of the PEP programme. The programme was to be a part of each team’s and player’s warm-up before training and competition throughout the competitive seasons.

Exposure to training and match was reported weekly by the coaches and all knee injuries were reported, also weekly. The criteria for ACL injuries were history, physical examination and confirmed by MRI or arthroscopy. Copies of the MRI or arthroscopy reports were obtained for each non-contact ACL injury. The unit of analysis in this study was limited just to non-contact ACL injuries.
Prevent injury and enhance performance program

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Distance</th>
<th>Repetitions/time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Warm-up</td>
<td>50 yd</td>
<td>1</td>
</tr>
<tr>
<td>- Jog line to line</td>
<td>50 yd</td>
<td>1</td>
</tr>
<tr>
<td>- Shuttle run</td>
<td>50 yd</td>
<td>1</td>
</tr>
<tr>
<td>- Backward running</td>
<td>50 yd</td>
<td>1</td>
</tr>
<tr>
<td>2. Stretching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Calf stretch</td>
<td>NA</td>
<td>2 x 30 s</td>
</tr>
<tr>
<td>- Quadriceps stretch</td>
<td>NA</td>
<td>2 x 30 s</td>
</tr>
<tr>
<td>- Hamstring stretch</td>
<td>NA</td>
<td>2 x 30 s</td>
</tr>
<tr>
<td>- Inner thigh stretch</td>
<td>NA</td>
<td>2 x 30 s</td>
</tr>
<tr>
<td>- Hip flexor stretch</td>
<td>NA</td>
<td>2 x 30 s</td>
</tr>
<tr>
<td>3. Strengthening</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Walking lunges</td>
<td>20 yd</td>
<td>2 passes</td>
</tr>
<tr>
<td>- Russian hamstring</td>
<td>NA</td>
<td>30 s</td>
</tr>
<tr>
<td>- Single-toe raises</td>
<td>NA</td>
<td>30, bilaterally</td>
</tr>
<tr>
<td>4. Plyometrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Lateral hops</td>
<td>2- to 6-in cone</td>
<td>30 s</td>
</tr>
<tr>
<td>- Forward hops</td>
<td>2- to 6-in cone</td>
<td>30 s</td>
</tr>
<tr>
<td>- Single-legged hops</td>
<td>NA</td>
<td>30 s</td>
</tr>
<tr>
<td>- Vertical jumps</td>
<td>NA</td>
<td>30 s</td>
</tr>
<tr>
<td>- Scissors jumps</td>
<td>NA</td>
<td>30 s</td>
</tr>
<tr>
<td>5. Agilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Shuttle run</td>
<td>40 yd</td>
<td>1</td>
</tr>
<tr>
<td>- Diagonal run</td>
<td>40 yd</td>
<td>1</td>
</tr>
<tr>
<td>- Bounding run</td>
<td>45-50 yd</td>
<td>1</td>
</tr>
</tbody>
</table>

Tab. 3.3.2.1 The training programme

Results

Over the full two year period there were a total of six ACL injuries in the PEP trained group and a total of 67 ACL injuries in the control group. During the 2000 season, there was an 88% decrease in anterior cruciate ligament injury and in 2001, there was a 74% reduction in anterior cruciate ligament tears in the intervention group compared to the age- and skill-matched controls. The data were analysed according to athlete exposures, by team and by player.

No matter how the data was analysed, the reduction in ACL injuries as demonstrated was always significant (Tab. 3.3.2.2). Overall, there was an 80% reduction in ACL injuries as a result of the PEP training programme. Simply stated, the programme was successful in reducing ACL injuries.

<table>
<thead>
<tr>
<th>Per 1000 Athlete Exposures</th>
<th>PEP Trained</th>
<th>Control</th>
<th>% difference*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.09</td>
<td>0.49</td>
<td>81.6</td>
</tr>
<tr>
<td>Per 100 teams</td>
<td>6.19</td>
<td>32.37</td>
<td>80.9</td>
</tr>
<tr>
<td>Per 1000 players</td>
<td>3.18</td>
<td>17.6</td>
<td>81.9</td>
</tr>
</tbody>
</table>

*percent reduction in ACL injuries = [(control-trained)/control] * 100

Tab. 3.3.2.2 Summary of injury rates to the ACL

What we learned from the study

It is well known that young females are at risk for non-contact ACL injuries and any prevention programme must be directed at young girls, but should also be used for males to reduce the overall rate of ACL injuries.

The 80% reduction in ACL injuries as a result of the PEP programme clearly showed that a preventive training programme may well decrease the number and incidence of ACL injuries in female athletes. This work, along with a number of other prevention studies, suggested that this serious injury in females can be dramatically reduced with a specific prevention programme that stresses neuromuscular control of the lower extremity through the use of strengthening exercises, plyometrics, and sport-specific agilities. The proprioceptive and biomechanical deficits that programmes like this are designed to correct further demonstrate the high-risk present in the female player population. This project was encouraging and supported the further study of prevention programmes to decrease ACL injuries in this high-risk population.

Duration: 2003 - 2005
Country: USA
Cooperation: Santa Monica Orthopedic and Sports Medicine Group Research and Education Foundation, California, USA
References:
3.3.3 Prevention of Injuries in Female Adolescent Amateur Players

Why we conducted this study

F-MARC studies as well as the literature had repeatedly reported injury rates in female football players similar to that of their male counterparts. In spite of the urgent need for preventive programmes, there existed only a few scientifically valid studies on injury prevention in female football players. In the study described on the previous pages, we had examined the effect of the structured prevention programme “The 11” over one season among 2,000 female players aged 13 to 17 years. We had observed no difference in the injury risk between the intervention group and control group. However, these results were hard to assess due to the low compliance of the teams. Low compliance is considered an important limitation of injury prevention programmes.

This prompted F-MARC to convene an expert group to further develop the exercise programme in order to improve both the preventive effect of the programme and the compliance of coaches and players. We decided not only offer variation and progression for the original “The 11” exercises, but also to include components of the PEP programme which had proven successful in preventing injuries to the anterior cruciate ligament of the knee in female players. Further, running exercises were to be incorporated, too. The aim was to design the new programme “FIFA 11+” as a complete warm-up programme prior to training, thereby facilitating the regular performance within existing training schemes.

Aim of the study

• Examine the effect of “FIFA 11+”, a complete warm-up programme designed to reduce the risk of injuries in female youth football.

How we collected the data

We followed 93 clubs corresponding to 1,892 female players aged 13 to 17 years, randomised to an intervention group practising the new programme and a control group for one league season of eight months. Prior to the season, the coaches of the clubs allocated to the intervention group received instruction and training of the “FIFA 11+” programme. The “FIFA 11+” included key exercises from “The 11”, but was expanded with additional exercises to provide variation and progression. It also included a new set of structured running exercises that made it better suited as a complete warm-up programme (see box). We asked them to replace their usual warm-up with the complete exercise programme for every training session throughout the season, and to use the running exercises of the programme as part of their warm-up prior to every match. We asked the coaches of the clubs in the control group to warm up as usual.

*

*FIFA 11+* - a complete warm-up programme

The programme consists of three parts:
The first part is running exercises at slow speed combined with active stretching and controlled partner contacts.
The second part consists of six different sets of exercises, these included strength, balance and jumping exercises, each with three levels of difficulty.
The third part is speed running combined with planting and cutting movements.

All parts of the “FIFA 11+” constitute a complete warm-up programme and are to be performed prior to every training session. The running exercises of the programme are to be performed as part of the warm-up prior to matches. Once players are familiar with the programme, it takes about 20 minutes to complete.

An injury was defined as any injury during training or match causing the player to be unable to fully take part in the next training or match. In both groups, the coaches reported injuries and participation of individual players for each training session and match on weekly registration forms. “FIFA 11+” coaches also recorded to what extent the warm-up programme was carried out at each session throughout the study period. Further, specifically trained injury recorders called every injured player to assess aspects of her injury based on a standardised injury questionnaire. Injury type, location and severity were recorded.

Results

During the season, 301 players suffered a total of 376 injuries. Of these, 264 players injured their lower extremities, 121 players in the intervention group and 143 in the control group (Table 3.3.3.1). The overall incidence of injuries was 3.9 per 1,000 player hours. There were 80% acute injuries and 20% overuse injuries. There was a significantly lower risk of any injury, overuse injuries and severe injuries in the intervention group compared to the control group. The separate risk
of match injuries, training injuries, lower extremities injuries, knee injuries and acute injuries was reduced by 26 to 38%.

The “FIFA 11+” teams used the prevention programme in 77% of all their sessions. The more a team used the programme in their training sessions, the more the risk of injury was reduced.

<table>
<thead>
<tr>
<th></th>
<th>“The 11” group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>All injuries</td>
<td>135</td>
<td>166</td>
</tr>
<tr>
<td>Match injuries</td>
<td>96</td>
<td>114</td>
</tr>
<tr>
<td>Training injuries</td>
<td>50</td>
<td>63</td>
</tr>
<tr>
<td>Lower extremity injuries</td>
<td>121</td>
<td>143</td>
</tr>
<tr>
<td>Acute injuries</td>
<td>112</td>
<td>130</td>
</tr>
<tr>
<td>Severe injuries</td>
<td>45</td>
<td>72</td>
</tr>
</tbody>
</table>

Tab. 3.3.3.1 Injury incidence in the “FIFA 11+” intervention group and the control group

What we learned from the study

This was the first study of sufficient methodological quality to show that a prevention programme is effective in female youth players. The “FIFA 11+” - a complete warm-up programme (Fig. 3.3.3.1) prevented injuries in female youth football players. More specifically, injuries in general were reduced by about one third and severe injuries by as much as one half in the “FIFA 11+” group as compared to the group performing their usual warm-up. The new programme achieved higher compliance, presumably because it can be used as a stand-alone warm-up, includes partner exercises as well as variation and progression of difficulty. The programme’s focus on awareness and control during standing, running, planting, cutting, jumping and landing is meant to develop less vulnerable movement patterns (Fig. 3.3.3.1) and players should be encouraged to land with increased hip and knee flexion, and to land on two legs rather than one.

Exercise: single-leg balance, throwing ball with partner

Exercise: single-leg balance, test your partner

Reference:
3.3.4 Importance of Compliance with Preventive Programmes

Why we conducted these studies

Female players have injury rates similar to male players and most often suffer injuries to the knee, ankle and thigh, too. As described in our previous study, female players may even be at greater risk of serious injury than males as the rate of anterior cruciate ligament injuries is considerably higher. However, only a few studies on injury prevention in female football players had investigated the effect of structured prevention programmes in a prospective way.

F-MARC’s “The 11” and later “FIFA 11+” had been developed as football-specific prevention programmes mainly aimed at common injuries of the lower extremities on the basis of previous F-MARC research. We intended to test the actual effect of these programmes in female football players following them during one football season. The results of this first study on “The 11” made it clear that we needed to have a closer look at compliance with the advanced “FIFA 11+” programme and the influence thereof on injury frequency, too.

Aims of the studies

- Investigate the effect of “the 11” on injury risk in female youth football players
- Determine the impact of the degree of compliance with “The 11” and “FIFA 11+” on the injury preventing effect of the programmes

How we collected the data

All teams in south-east Norway registered in the under-17 league system during the 2005 season were invited to take part in the first study on “The 11”. Of 157 teams, 113 teams with a total of 2,100 players agreed to participate. The prevention programme was introduced to the teams in the intervention group at the beginning of the pre-season, with guidance and surveillance by instructors who were each responsible for two to three teams. The main focus was on performing the exercises properly. The players were encouraged to concentrate on the quality of their movements, and emphasis was placed on core stability, hip control and proper knee alignment, as well as in landing from jumps. The coaches were asked to use the programme at every training session for 15 consecutive sessions and thereafter once a week during the rest of the season. They were contacted by telephone and/or e-mail at least once a month to record all training and match activities and new injuries for their team. Injured players were interviewed by specially trained injury recorders to assess aspects of their injury based on a standardised injury questionnaire.

To assess the importance of compliance with the injury prevention programme further, we also investigated the teams and coaches of the intervention group participating in the study on “FIFA 11+” described in the following chapter. Attitudes and beliefs of 65 coaches towards exercise-based prevention were assessed as well as the individual participation of players in training and match play (meaning exposure to the game of football, in minutes) and the exact performance of the warm-up at every session, again including individual player participation.

Results

In “The 11” study, 58 teams (1,073 players) in the intervention group and 54 teams (947 players) in the control group were followed during the season lasting eight months. Every fifth player of the total of 2,020 players sustained at least one injury. No difference was observed in the proportion of injured players between the intervention group with 19.0% and the control group with 20.3%. By far the most injuries were acute (87%) and to the lower extremities (86%). An ankle sprain was the most common type of injury. In 42%, the injury occurred in a non-contact playing situation, while 58% of all acute injuries resulted from player-to-player contact (Table 3.3.4.1).

Compliance with the programme was defined as at least 20 prevention training sessions during the season. During the whole observation period, “The 11” teams used the prevention programme at 52% of their training sessions. During the first half of the season from March through June, the programme was used in 14 (60%) of all training sessions, and after the summer break in 9 (44%).

Fifty-two of the initial 65 teams and 56 coaches completed the “FIFA 11+” compliance study. Teams performed the “FIFA 11+” in 77% of their football sessions
during the season and 60% of these did so twice or even more often. Compliance was higher during the first part of the season. Based on this team compliance, individual player compliance was calculated to be 47% of the maximum programme sessions of teams. No influence of team compliance on injury risk was found, but players in the highest compliance tertile showed a 35% lower risk of injury in general (39% for acute injuries) than those in the intermediate tertile. All coaches believed that injury prevention is important and 88% perceived their players to be at either high or moderate risk for injury. Low compliance by teams was associated with coaches’ belief that the programme was too time consuming or did not include enough football-specific activities.

Our second study confirms the correctness of this interpretation since compliance with “FIFA 11+” was markedly higher. This study also confirmed the lower injury risk for players with high compliance, but it was shown that individual instead of team compliance has to be assessed. Further important findings were the influence of coaches’ attitudes on player compliance and of coaches’ experience with preventive approaches on the success of an injury prevention programme.

### Tab. 3.3.4.1 Injury incidence in “The 11” intervention group and the control group

<table>
<thead>
<tr>
<th></th>
<th>&quot;The 11&quot; group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>All injuries</td>
<td>242</td>
<td>241</td>
</tr>
<tr>
<td>Acute injuries</td>
<td>211</td>
<td>210</td>
</tr>
<tr>
<td>Match injuries</td>
<td>169</td>
<td>151</td>
</tr>
<tr>
<td>Training injuries</td>
<td>42</td>
<td>59</td>
</tr>
<tr>
<td>Lower extremity injuries</td>
<td>181</td>
<td>173</td>
</tr>
<tr>
<td>Contact injuries</td>
<td>118</td>
<td>124</td>
</tr>
<tr>
<td>Non-contact injuries</td>
<td>93</td>
<td>86</td>
</tr>
</tbody>
</table>

What we learned from the studies

In “The 11” study, there was no difference in injury rates between the teams in the intervention group who were asked to regularly perform “The 11”, and the teams in the control group who were told to warm up as usual. The compliance of the teams and coaches in “The 11” group was most likely insufficient to produce the training effects required to reduce injury risk. The average player in the intervention group had to be considered non-compliant. In our review of the literature, we had found that compliance with the programme is an essential factor for success. Volume and intensity are key determinants for training outcome, therefore effectiveness might be improved by fewer exercises with more repetitions to allow for progression and higher intensities. F-MARC felt that this would also increase motivation of players and coaches to perform the programme and put these findings into practice when developing the “FIFA 11+”.

Our second study confirms the correctness of this interpretation since compliance with “FIFA 11+” was markedly higher. This study also confirmed the lower injury risk for players with high compliance, but it was shown that individual instead of team compliance has to be assessed. Further important findings were the influence of coaches’ attitudes on player compliance and of coaches’ experience with preventive approaches on the success of an injury prevention programme.

**Duration:** 2005 - 2007  
**Country:** Norway  
**Cooperation:** Oslo Sports Trauma Research Center, Norway  
**Reference:**  
3.3.5 Effects of Different Implementations Strategies and Compliance with the “FIFA 11+”

Why we conducted this study

Adherence of coaches and players to successful injury prevention programmes is a challenge. There is also a lack of information in the literature regarding the coaches’ delivery of the programme to the team and the quality of the exercise execution by athletes on the field. Injury prevention interventions will not have a significant public health impact if they are not widely accepted and adopted by the target population, coaches, athletes and other stakeholders in the sports community.

In previous projects in community-based youth football, injury prevention programmes were largely delivered by coaches who initially were educated by clinical research personnel. Mostly, coaches were introduced to the injury prevention programme individually or through an instructional workshop where they received theoretical and practical training, including educational material.

Based on the positive effects of the “FIFA 11+” football injury prevention programme, and as part of its implementation strategy, the Fédération Internationale de Football Association (FIFA) has developed educational material and created a website where all 11+ resources can be downloaded free of charge (i.e. videos explaining the exercises, pocket-sized exercise cards for the training field, posters detailing the exercises and their common performance errors) (http://f-marc.com/11plus/11plus/). The success of delivery of an injury prevention programme implementation through an unsupervised approach (i.e. website delivery only) has not previously been evaluated. Furthermore, the added effect of a programme delivery, specifically involving regular follow-up with coaches and players on the field to ensure proper execution and progression of exercises, has not previously been examined.

Aims of the study

- To evaluate the effects of the three delivery methods of the “FIFA 11+” injury prevention programme on adherence and injury risk among female youth football teams

How we collected the data

During the four-month 2011 football season, coaches and 385 13 to 18-year-old players from 31 elite and lower level teams were introduced to the “FIFA 11+” through either an unsupervised website (“control group”) or a coach-focused workshop with (“comprehensive”) and without (“regular”) additional supervisions by a physiotherapist. Team and player adherence to the “FIFA 11+”, playing exposure, history and injuries (seeking medical attention) were recorded.

Results

Adherence of coaches to the “FIFA 11+” was high in all three groups. Teams in the comprehensive and regular intervention groups demonstrated adherence to the “FIFA 11+”-programme of 86% and 81% completion of total possible sessions, compared to 74% for teams in the unsupervised control group. These differences were, however, not statistically significant. Injury risk of players was comparable for all three groups of intervention delivery.

What we learned from the study

Following a coach workshop, coach-led delivery of the “FIFA 11+” was equally successful with or without additional resources as the on-field involvement of a physiotherapist. Proper education of coaches during an extensive pre-season workshop was more effective in terms of team adherence than an unsupervised delivery of the “FIFA 11+”-programme to the team.

Coach education should therefore continue to play an important role in the way a new neuromuscular injury prevention exercise programme is delivered to football teams and players. Experiences from our recent project in Switzerland demonstrate how an injury prevention programme can successfully be implemented countrywide by coaches. However, more evidence is needed to identify potential barriers and motivators for coaches in the use of an injury prevention programme, and to measure change of behaviour over time. This would facilitate a better understanding of coach readiness to change current practices and behaviour as well as to adopt interventions, such as the “FIFA 11+”, thus establishing effective implementation strategies outside a controlled research environment.
FIFA 11+ coaching courses in USA (Abb 1 and 2: Phoenix, Arizona) and Japan (Abb 3-5 Nagoya)

A group of Canadian football coaches participating at the first FIFA 11+ instructor course in Calgary, with the study coordinators Maria Romiti and Kathrin Steffen, University of Calgary (standing, respectively 1st and 3rd from right) and Dr. Mario Bizzini, F-MARC (first row, 2nd from left)

**Duration:** 2011  
**Country:** Canada  
**Cooperation:** Sport Injury Prevention Research Centre, University of Calgary, Canada; Department of Sports Medicine, Oslo Sports Trauma Research Center, Norwegian School of Sport Sciences, Oslo, Norway; Centre for Healthy and Safe Sport & the Australian Centre for Research into Sports Injury and its Prevention, University of Ballarat, Victoria, Australia

3.3.6 Benefits of High Adherence with regard to Performance and Injury Risk

Why we conducted this study

A protective effect on injury risk in youth sports through neuromuscular warm-up training routines has consistently been demonstrated. However, there is a lack of information regarding its impact on the physical performance of players. It is likely easier to motivate coaches and players to follow such exercise programmes if they are not only to prevent injuries, but if there also is a direct performance benefit. It might be expected that implementing a 20-minute injury prevention programme should improve physical performance. However, conflicting outcomes are currently reported. If there were a link between injury risk reduction and performance outcomes, adoption and sustained adherence to successful programmes would be likely to be easier.

Aims of the study

- To assess whether different delivery methods of an injury prevention programme (“FIFA 11+”) to coaches could improve player performance
- To examine the effect of player adherence on performance and injury risk

How we collected the data

During the 2011 football season (May-August), coaches of 31 tier 1-3 level teams were introduced to the “FIFA 11+” through either an unsupervised website or a coach-focused workshop with and without additional on-field supervisions. Playing exposure, adherence to the “FIFA 11+”, and injuries were recorded for female 13-18-year old players. Performance testing included the Star Excursion Balance Test, single-leg balance, triple hop, and jumping-over-a-bar tests.

Results

Complete pre- and post-season performance tests were available for 226 players. We found that the “FIFA 11+” can improve dynamic and functional balance performance among 13 to 18-year-old female football players. Performance outcome and injury risk was similar for players regardless of how the “FIFA 11+” programme was delivered to the team. However, better functional balance and 72% reduced injury risk was found for players who highly adhered to the prescribed exercises during the season compared to those with less adherence.

What we learned from the study

High player adherence to the “FIFA 11+” resulted in significant improvements in functional balance and reduced injury risk. Improved neuromuscular control appears to be a key element of the “FIFA 11+” injury prevention programme. These findings are good news for all coaches and players. For football players, proper functional balance and body control are essential for technical and tactical performance to efficiently position themselves in relation to the opponents. Furthermore, the findings are important for the acceptance and adoption of the programme as performance improvements should provide additional motivation to coaches to regularly deliver the programme to their players. Interestingly, performance outcome and injury risk was similar for players regardless of how the “FIFA 11+” programme was delivered to the team.

Duration: 2011
Country: Canada
Cooperation: Sport Injury Prevention Research Centre, University of Calgary, Canada; Department of Sports Medicine, Oslo Sports Trauma Research Center, Norwegian School of Sport Sciences, Oslo, Norway; Centre for Healthy and Safe Sport & the Australian Centre for Research into Sports Injury and its Prevention, University of Ballarat, Victoria, Australia
The Spain National Team, winner of the 2010 FIFA World Cup, and official FIFA 11+ representatives

The Japan National team, winner of the 2011 Women’s World Cup, and official FIFA 11+ representatives

The German National Team, winner of the 2014 FIFA World Cup, and official FIFA 11+ representatives

The Spain National Team, winner of the 2010 FIFA World Cup, and official FIFA 11+ representatives
3.3.7 Physiological and Performance Effects of “FIFA 11+”

Why we conducted these studies

The “FIFA 11+” is a complete warm-up package, which combines cardiovascular activation and preventive neuromuscular exercises. It has been developed to be administered as a warm-up routine. A good warm-up should improve the subsequent performance but should also not be so demanding as to cause detrimental effects due to fatigue-related factors. However, no studies have examined the immediate effects of the “FIFA 11+” on performance and warm-up criteria. The key element of the programme is the promotion of proper neuromuscular control during all exercises ensuring correct posture and body control. Although the main purpose of the “FIFA 11+” is injury prevention, the knowledge of training effects elicited by this programme can help in identifying the potential mechanisms behind the reported reduction in injury incidence as well. Furthermore, it might increase the consequent implementation of and compliance with the programme, if it has additional performance benefits other than injury prevention. The few previous studies, which examined the effects of the “FIFA 11+” on performance and neuromuscular control, had small sample size and/or were not very well controlled.

Aims of the studies

- Assess the immediate effects after performance of the “FIFA 11+” on various physical performance and physiological variables to verify its appropriateness as a warm-up
- Examine the training effects of the “FIFA 11+” on neuromuscular control, strength and performance in male amateur football players

How we collected the data

Two studies with a total of 101 amateur male football players were designed: a study with pre- and post-measurement examining the acute effects, and a randomised controlled trial for examining the performance effects. Twenty players (age 25.5±5.1 years) were tested twice before (control period) and once immediately after performing the “FIFA 11+” for: 20m sprint time, agility, vertical jump height, stiffness, isometric maximal voluntary contraction, rate of force development, star excursion balance test, oxygen uptake, lactate and core temperature.

Eighty-one (n=81) players were randomly assigned to the intervention (n=42; age 23.7±3.7 years) or the control group (n=39; age 23.2±3.8 years). The intervention group performed the “FIFA 11+” programme three times a week for nine weeks; the control group completed the usual warm-up. The outcome variables measured before and after the training period were: time-to-stabilisation and eccentric/concentric flexors strength, eccentric/concentric extensors strength, balance test, core-stability, vertical jump height, sprint speed, and agility.

Results

Immediately after performing the “FIFA 11+”, the players increased their ability to sprint, jump, change directions, and balance. This was probably related to physiological mechanisms such as increase in baseline oxygen uptake (+14%) and core temperature (+1%).

Players performing the “FIFA 11+” for nine weeks significantly improved in their ability to stabilise the body after landing on one leg from a jump, core stability, and leg strength (Fig. 3.3.7.1; Fig. 3.3.7.2).

What we learned from the studies

The “FIFA 11+” prevention programme can be considered a good warm-up inducing improvements comparable with those obtained from other warm-up routines reported in the literature and therefore, it can be properly implemented in the training routine of amateur football teams. Performing the “FIFA 11+” 3 times per week for nine weeks improved the neuromuscular control. In particular, the players increased their ability to stabilise after a dynamic action, which is a relevant skill for football players. Therefore, we can also speculate this is a candidate mechanism for explaining the injury prevention effect of the “FIFA 11+” and well-represents the main purpose of this programme, which is the neuromuscular control training. Indeed, statistically significant effects were also found on strength and performance measures but as the magnitude of the improvements was comparatively small, the “FIFA 11+” should not be used as
a replacement for the traditional physical strength and conditioning training but rather as a complement to it.

Duration: 2010 - 2011
Country: Italy
Cooperation: CeRiSM, University of Verona, Italy

References:
3.3.8 Prevention of Injuries in Male Amateur Players

Why we conducted the study

Soccer is the most widely played sport among both males and females, with approximately 300 million registered players globally. The growth of the sport in the United States has been unprecedented. It is currently the third most popularly played sport, with over 13 million Americans participating at the youth and adult levels (US census). Major League Soccer (MLS) is currently in its 19th season and has grown to 20 professional teams within the United States and in Canada since its inception, with further expansion on the horizon (MLS, 2013). In addition, there are approximately 412,000 male high school and 23,000 male collegiate soccer players participating in NCAA soccer in the United States (NCAA, 2012) – and the numbers of participants is increasing annually. However, there is a direct correlation between this growth of the sport, athletic exposure and injuries. In the last two decades, the risks and epidemiology of soccer injury have been well documented and numerous attempts have been made to gain a fuller understanding about the mechanism of these injuries and how researchers can prevent or reduce the incidence of such injuries.

Soccer-related injuries are not uncommon amongst males. However, many of the injury prevention efforts were focused solely on female athletes; namely on ACL injury prevention. The FIFA 11+ programme has been shown to be effective in the female soccer cohort, but there is a paucity of research to demonstrate its efficacy in the male population.

This aim of this manuscript was to describe the recent utilisation of the FIFA 11+ programme in competitive male soccer athletes in the collegiate setting. It elucidates the continuation of the international research community to refine and improve the effectiveness of these types of programmes amongst the soccer community.

Aim of the study

- Examine the efficacy of the FIFA 11+ programme in men’s collegiate soccer

How we collected the data

During the 2012 season, Division I and Division II men’s collegiate soccer teams (N=396) were solicited to participate in the study. The FIFA 11+ programme served as the intervention programme over the course of one collegiate soccer season. The warm-up was utilised three times per week for the duration of the season. Athletic exposure (AEs), injury and compliance data was recorded in the web-based system HealtheAthlette™ Injury Surveillance System (Overland Park, Kansas). Sixty-one institutions completed the study: 34 control (CG) (N=850 athletes) and 27 intervention (IG) (N=675 athletes) institutions (Fig. 3.3.8.1). A Poisson regression model based on a generalised linear model was utilised to account for cluster effects to compare the rate ratios of the risk of injury between teams.

Results

In the CG, 665 injuries were reported for 34 teams (M=20.15, SD= ±11.01), with a corresponding incidence rate (IR) of 15.04 injuries/1,000 AEs. In the IG, 285 injuries were reported for 27 teams (M =10.56, SD =±3.64), for an IR of 8.09 injuries per 1,000 AEs. There was a significantly greater proportion of injuries in the CG (70%) compared to the IG (30%), $\chi^2(1)=207.74, p < .001, \Phi=.369$. A Poisson regression was used to compare the total number of days missed between groups, IG versus CG, and for field types, grass versus turf. The model was significant, LR $\chi^2(2) =263.06, p < .001$. Total days missed due to injury was significantly higher for the CG (M =13.02, SE = 1.09) than in the IG (M=9.31, SE =.96). In addition, for each day missed in the IG, 1.4 days were missed in the CG, Wald $\chi^2(2)= 7.35, b = .335$, se = .124, OR = 1.40. There was no difference between the groups based on field type (Tab. 3.3.8.1).

What we learned from the study

The FIFA 11+ was shown to significantly reduce injury rates and time loss to injury in the competitive male collegiate soccer player. The benefits of sport participation are numerous, and far outweigh the risks associated with such. However, the likelihood of incurring an injury by virtue of participating in soccer should not be underestimated. We recognise and embrace the need for programme compliance and further randomised controlled
trials to elucidate the epidemiology, etiology, mechanism of injury(s) and the ultimate reduction and prevention of sports-related injury.

**F-MARC PROJECTS | PREVENTION OF FOOTBALL INJURY**

**Duration:** 2012  
**Country:** USA

**Cooperation:** Santa Monica Sports Medicine Foundation, Santa Monica, CA, USA, University of Delaware, Dept. of Biomechanical and Movement Sciences and Biostatistics Core Facility, College of Health Sciences, Newark, DE, USA

**Reference:**

**Fig. 3.3.8.1 Description of NCAA Team Randomization and Study Flow**

**Tab. 3.3.8.1 Control versus intervention: injury rates and days lost to injury**

US- and MLS- legends Tony Meola and Ante Razov. Video clips that featured former/current prominent US Soccer players and coaches discussing the importance of injury prevention in soccer were specially produced for this study. (http://vimeo.com/25708967 & http://vimeo.com/25708960)
3.4 Implementation of Prevention Programmes

3.4.1 Country-wide Campaign to Prevent Football Injuries in Switzerland

Why we conducted the study

In view of the comparably high number of injuries occurring in professional and amateur football we had established in our literature reviews and studies and the popularity of football, injuries are not only a concern for the individual player and their team, but as much for health care providers and accident insurers. Several attempts to estimate the costs resulting from diagnosis, treatment, rehabilitation, absence from work etc. had shown the considerable impact on national health care systems, depending on the individual setting. This holds particularly true for countries with high standards of care and elaborate payment and compensation schemes. The Swiss national accident insurance fund (SUVA) had for some time followed the development in football with increasing concern. In 2003, they had recorded 42,262 football injuries resulting in direct costs of USD 130 million and 500,000 lost working days. Alarmed by these statistics, they were looking for sustainable measures to reduce the financial burden caused by the game both for their institution and the Swiss economy.

F-MARC’s “The 11” injury prevention programme held promise to meet exactly these needs when presented to SUVA. Together with the Swiss Football Association (SFV), three parties sharing the same interest in reducing football injuries decided to launch a so far unique project, the implementation of an injury prevention programme, F-MARC’s “The 11” (see chapter 3.2.1), on a national scale in September 2004. The process and effect of this implementation would be scientifically evaluated to gain insight in the challenges of such projects, as nothing of this scale had been undertaken before.

Aims of the study

- Achieve a reduction of 10% in injuries in Swiss amateur players aged 14-65 years through use of an exercise-based prevention programme
- Assess the process and effect of the nationwide implementation of such injury prevention programme

How we collected the data

Comprehensive teaching material including posters, booklets and DVDs was developed to support the broad distribution of F-MARC’s injury prevention programme “The 11”. In Switzerland, all licensed football coaches have to undergo a basic course and biannual refresher courses thereafter. It was therefore felt that systematic inclusion of “The 11” in the training of coaches would be the most effective and efficient way to reach out to the hundred thousands of players in Switzerland. All SFV instructors learned not only the essentials of the programme exercises from a qualified sports physiotherapist, but also how to best teach “The 11” to coaches.

The intervention was planned to run over four years. A representative sample of SFV coaches was interviewed before and after this period to assess training and match frequency including other injury details, and further their knowledge of the programme and issues.

Results

Of the initially selected 1,574 coaches, 1,027 could be interviewed before the intervention. As only 30% of them were finally available for an interview after the intervention, a further random sample was drawn from the large SFV coaches’ pool to complement the post-intervention sample. Teams usually trained two times and had one match per week. Average team size was 19 players of whom about 14 usually participated in training.

Before the intervention, 72% of injuries occurred during match play, and 85% concerned the lower extremity. The most frequent injury types were thigh strains and ankle sprains. About 70% of injuries were suffered without contact with another player and 88% resulted in absence from training or match play. About a fifth of injuries each resulted in 1-2, 2-4 or more than four weeks absence.

From 2005 to 2007, 5,549 coaches were trained in “The 11”, and their rating of the programme was overall good. After the intervention in 2008, 79% of coaches knew “The 11”, and 57% said they were currently performing the programme with their team(s). Those who did not use “The 11” either did not know the programme, were employing similar exercises, or claimed a lack of time or other priorities. Coaches who employed the programme
instructed on average 3.7 exercises of the programme for a mean duration of 13 minutes either once (59%) or twice (33%) per week, and more than half of them had done so for more than six months. Basically all coaches (98%) paid attention to the correct performance of exercises.

Teams performing “The 11” in 2008 had an 11.5% lower match injury incidence during the last four weeks as compared to non-11 teams who did not perform the programme, and 17% lower than compared to before the intervention. Non-contact injuries were more markedly reduced by 27%. With regard to training injuries over the last four weeks, “The 11” teams had 25% less injuries than non-11 teams in 2008, and 19% less than what had been recorded in 2004 (Fig. 3.4.1.1).

What we learned from the study

The frequency and characteristics of injury as well as the differences between male, female, youth and senior players did not differ from what had been found in injury studies in football before. The proportion of injuries occurring without contact with another player of 70% was higher than what had been reported in other studies, however appeared to be favourable for the effectiveness of an exercise-based prevention programme.

There seemed to be a comparably high motivation of the coaches to implement injury prevention, and the proportion of coaches knowing the programme (80%) and actually performing it (57%) in 2008 was considered a success of the implementation even though compliance, meaning how regularly and how many of the exercises were performed, could have been improved. In fact, only 40% of coaches instructed exclusively the original exercises, and more than half of them only once a week. In this study, however, higher compliance did not result in fewer injuries, which was attributed to the attention paid to correct performance of exercises in this study which might actually be more important. Importantly, “The 11” was able to reduce match injuries by 12% and training injuries by 25% despite suboptimal compliance, pointing to the potential of injury prevention through exercise-based programmes in amateur players. These results are even more remarkable as they were achieved in a nationwide launch of the programme and not in a controlled research setting as in other studies. The positive impact was further reflected in the statistics of SUVA who recorded 10% more players, but only 2% more injuries in 2008 as compared to 2003, resulting in a cost reduction for the insurers and health care providers.
3.4.2 Country-wide Campaign to Prevent Football Injuries in New Zealand

The New Zealand situation

New Zealand Football (NZS) and the Accident Compensation Corporation (ACC) of New Zealand work collaboratively on injury prevention initiatives. Obviously, both have a vested interest in reducing injuries in football. In July 2004, ACC and NZS formally initiated a structured, nationwide injury prevention programme. ACC provided financial support to NZS to appoint a dedicated Injury Prevention Manager (possibly the first such appointment within a national football organisation), as well as funds to develop the injury prevention programme and strategies.

In the ACC financial year 2003, there were 1,240 new football entitlement claims. An entitlement claim is a moderate to serious injury requiring entitlement beyond medical treatment only, as defined under the New Zealand Injury Prevention, Rehabilitation, and Compensation Act of 2001. Typically, an entitlement claim will have a mix of medical, income replacement and rehabilitation costs associated with an injury. It was calculated that football entitlement claims cost ACC over four million NZ dollars each financial year. The 1,240 new football entitlement claims in 2003 meant an increase of 13% from the previous year (1,097 claims). Ninety-five percent of the people making new football entitlement claims were aged 14 or older which is also the target audience of “The 11” and as such, “The 11” fitted well within the NZS Injury Prevention Programme and initiatives.

The launch of “The 11”

To generate interest and inform the football community on “The 11”, an official launch of “The 11” was scheduled for 1 March 2005 at North Harbour Stadium, Auckland, with Professor Jiří Dvořák, FIFA Chief Medical Officer and chairman of F-MARC, present. Having FIFA representation present in New Zealand to launch “The 11” was intended to create positive media interest and to encourage more people to use “The 11”. It was proposed that the Minister for Sport, the Honourable Trevor Mallard, be invited to attend the launch as well as some football personalities (e.g. Wynton Rufer, FIFA Oceania Player of the Century) to further ensure media coverage.

Community and recreational football players and coaches also were in attendance and a selection of these individuals played a seven-a-side game on the main North Harbour Stadium pitch after having completed “The 11”. The game was used to demonstrate other injury prevention messages including fair play, safe technique and proper hydration. Press releases and invitations were sent out in due advance and the event resulted in good television and newspaper coverage. Subsequent articles were published in professional publications and magazines specifically aimed at players, coaches and medical staff involved in football in New Zealand and beyond. Copies of all “The 11” resources were distributed to all launch attendees and invited guests.

Distribution of “The 11” in New Zealand

NZS discussed distribution of “The 11” to its seven regional federations and achieved approval in principle for distribution to clubs throughout the country.

NZS and ACC chose to implement the following “The 11” resources kit that FIFA have developed: “The 11” DVD (Fig. 3.4.2.1), brochure and poster. ACC funded the reproduction of the above resources and promoted their use by making the resources available to the football community of New Zealand at no cost.

Distribution in New Zealand occurred primarily in three ways:

• Through a free phone number (paid for by ACC) for the public to call to obtain a copy of “The 11” resources
• Through New Zealand Football, the seven Federations of Football in New Zealand and NZS affiliated football clubs nationwide
• Through the New Zealand Secondary School Sports Council (NZSSSC). Every school in New Zealand has a sports coordinator and NZSSSC had agreed to distribute “The 11” via the sports coordinators to all schools where football is played.

This distribution system was meant to ensure optimal coverage of “The 11” in New Zealand.
Also identified were target coaches as well as players. Coaches have a significant influence on the training and playing technique of players and their involvement is an indispensable part of the implementation of any prevention programme. A goal was to train as many registered coaches as possible in the delivery of “The 11”, but at the same time it was recognised that “The 11” can be used without formal training and that printed and video resources had been developed with simplicity in mind. This option for independent self-education was particularly important as reportedly only 26% of New Zealand adult football players are coached. Training in “The 11” was performed by the NZS Senior Physiotherapist and directed at NZS Technical Department personnel and the National Development Officers who are responsible for “up-skilling” coaches at all levels of the game. Reference to and/or training in “The 11” became part of every NZS Coaching and Education Scheme course.

The evaluation of success

Evaluation occurred in three ways:
- A comparison of ACC new football entitlement claims data. In 2003, there were over 1,200 moderate to serious claims and 13,000 minor claims. Claims relating specifically to knee and ankle soft tissue injuries were monitored.
- A Football Surveillance Study involved telephone interviews with each of over 500 players on a weekly basis throughout the 2005 football season.
- A regular survey that measured football players’ knowledge, attitude and behaviour towards injury.

New Zealand research team with the coach of national team

Duration: 2004 - 2008
Country: New Zealand
Cooperation: Accident Compensation Company, New Zealand Soccer
3.4.3 From Development to Worldwide Dissemination

Development of injury prevention programmes

In 2000, F-MARC conducted its first study on the prevention of football injuries showing 21% fewer injuries in the intervention compared to the control group (See chapter 3). The interventions were focused on improving the structure and content of the training by educating and supervising the coaches and players. The programme included preventive interventions such as improvement of warm-up, regular cool-down, taping of unstable ankles, adequate rehabilitation, promotion of the spirit of fair play and ten sets of exercises designed to improve coordination, stability of the ankle and knee, flexibility and strength of the trunk, hip and leg muscles. Based on the experiences with this study and in cooperation with international experts, F-MARC developed a basic injury prevention programme for amateur football players called “The 11” (See chapter 3.2.1).

“The 11” was implemented in two countrywide campaigns (Switzerland and New Zealand) in cooperation with the national accident insurance company and the national football association. The results of both campaigns showed a reduction of training/match injury rates and savings of health-care related costs (See chapters 3.4.1 and 3.4.2).

Based on experiences with “The 11”, the “PEP” (Prevent Injury and Enhance Performance programme) and other exercised-based programme to prevent football injuries, an advanced version (“FIFA 11+”) was developed in 2006 together with the OSTRC and the Santa Monica Orthopaedic and Sports Medicine Research Foundation. Large RCTs showed significant lower frequency of injury in female and male football players practising “FIFA 11+” at least twice a week as a standard warm-up before training (See chapters 3.3.1 – 3.3.3).

Development of dissemination strategy

For F-MARC, the coach is the key person to promote injury prevention to their players. While the coach, especially at a low level, has to regard various aspects in the training (e.g. physical preparation, tactics, fair play, team success), it is important to raise the coach’s motivation to implement an injury prevention programme with their team (Fig. 3.4.3.1).

“FIFA 11+” is best taught in a workshop that includes theoretical background knowledge and practical demonstration of the exercises (See chapters 3.3.5. and 3.3.6). Additionally, the cooperation with famous players and coaches acting as “FIFA 11+” ambassadors (see www.f-marc.com/11plus) has helped significantly in the communication with coaches and players.

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Fig. 3.4.3.1. Guideline “11 Steps to FIFA 11+”

The national Football Associations of Spain, Japan, Italy, Brazil and Germany integrated “FIFA 11+” in their coaching or physical training/education curriculum. Thus, the world football champions took the lead and acted as role models, and other countries (see Figure 2) followed.
FIFA started the dissemination of “FIFA 11+” in its 209 member associations (MAs) in 2009. Related material includes a detailed manual, an instructional DVD, a poster, a website and a promotional booklet with DVD. All material is available in several languages on www.F-MARC.com/11plus. Based on the experience with the countrywide implementation in Switzerland and New Zealand, a guideline on how to implement the “FIFA 11+” injury prevention programme on a larger scale in amateur football was developed. The implementation is conducted either in close cooperation with MAs or via FIFA Coaching Instructor courses.

Fig. 3.4.3.2. World map with countries where coaches attended a FIFA 11+ Instructor course (18/09/2013)

Future directions

In the next years FIFA and F-MARC will continue the worldwide implementation of the ”FIFA 11+”, with particular attention on seeking the best possible cooperation with the member associations adopting the “FIFA 11+” injury prevention programme.

Fig. 3.4.3.3. Future directions

Worldwide dissemination of “FIFA 11+”

Duration: 1999 - ongoing
Countries: International
Cooperation: FIFA Technical Department, MAs of Spain, Japan, Italy, Brazil, Germany, Costa Rica, Hong Kong, Netherlands, Denmark, Poland, Hungary, Australia, England, Thailand, Liechtenstein
4 Prevention of Sudden Cardiac Death

4.1 Pre-Competition Medical Assessment (PCMA)

4.1.1 PCMA at the 2006 FIFA World Cup™

Why we conducted this study

Pre-competition medical assessments (PCMA) in sports at different levels are generally advocated by health professionals and sports organisations alike. Still, to date, there is not one specific approach to the PCMA or to establish best practices for risk factor determination prior to participation in sports. In general, a standardised, validated PCMA that meets medical standards for quality and provides sensitive screening is highly desirable. It seems, however, that the pre-competition medical assessment of athletes should be tailored to the type and scope of activity in the respective sport, gender, age and the level of performance. A particular concern is the prevention of Sudden Cardiac Death, a tragic event that might be triggered by exercise in case of an underlying heart disease in a player (See chapter 4.2). F-MARC decided to develop a standardised PCMA specifically for the world’s elite football players prior to the 2006 FIFA World Cup Germany™ as a pilot project.

Aims of the study

• Create a role model for the pre-competition medical assessment of international elite football players aimed at maximum certainty to identify cardiac risk factors
• Assess the feasibility of standardised requirements for international teams from countries with variable medical backgrounds
• Collect data on risk factors for retrospective analysis in this target group

How we collected the data

The design and development of the PCMA form was focused on the cardiovascular and the musculoskeletal system. It included a 12-lead resting electrocardiogram (ECG), a maximal exercise test and an echocardiography. The assessment of the musculoskeletal system was based on the F-MARC Football Medicine Manual. Finally, the examining physician had to conclude on the eligibility of the player for competitive football.

The performance of the FIFA PCMA was requested for all players participating in the 2006 FIFA World Cup Germany™. At the FIFA team workshop three months prior the event, the requirements for the performance of the assessment were explained to all team doctors. Prior to assessment of the data, all player and team details were anonymised by allocating fictional team and player names. In order to retrospectively analyse the paper-based data and explore possibilities to improve the questionnaire by using an electronic format, F-MARC asked the Cerner Corporation, USA, to convert the paper form into an electronic one and establish an electronic database suitable for statistical analysis. Apart from refusal or non-submission of consent by the player, no exclusion criteria were defined for the analysis of data. The criteria of analysis were as follows: Completeness of questionnaire, quality of information, positive findings on the pre-competition medical assessment form. The cardiac assessment results were reviewed by two independent sports cardiologists.

Results

Of all 32 teams participating in the 2006 FIFA World Cup™, the completed questionnaires of 26 teams corresponding to a response rate of 81% were returned by their team doctors and entered into the database. In total, the assessments of 582 players could be analysed as the forms of 16 players of four teams were no submitted. The average age of the players that took part in the 2006 FIFA World Cup™ was 26.8 years. The average degree of completeness of the whole PCMA among the different teams ranged from 78% to 94%. Average completeness of the different sections of the PCMA was by far the highest for the medical history and the general examination, indicating that the team doctor were well aware of the vital importance of these parts of the PCMA (Tab. 4.1.1.1)

Some deficits regarding the quality of the completion of the form were identified indicating the need for more detailed instruction and further improvement of the design of the form and for the provision of norm values. Free text entries were whenever possible to be avoided. In the summarising assessment of the PCMA, all players were considered eligible for competitive football. The team doctors reported suspected heart disease in three players, one of them a player with known hypertrophic cardiomyopathy. Six of the 582 players participating in the 2006 FIFA World Cup™ retrospectively had findings on echocardiography suspicious of serious cardiovascular disease demanding further investigation.
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F-MARC PROJECTS | PREVENTION OF SUDDEN CARDIAC DEATH

Duration: 2006 - 2008
Countries: International
Cooperation: All team physicians of the 2006 FIFA World Cup Germany™; Prof. Thomas Lüscher, MD, Switzerland; Simon Wallace and Samuel Geraint, Cerner Corporation, USA.
References:

<table>
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<th>Combinations</th>
<th>Training history</th>
<th>Medical history</th>
<th>General examination</th>
<th>Cardiovascular system</th>
<th>Laboratory examinations</th>
<th>Orthopaedic examination</th>
<th>Summarising assessment</th>
</tr>
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<td>Completeness</td>
<td>81%</td>
<td>98%</td>
<td>95%</td>
<td>78%</td>
<td>84%</td>
<td>90%</td>
<td>82%</td>
</tr>
</tbody>
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Tab. 4.1.1.1 Player medical questionnaire - average completeness by section

While these findings were not further commented under “notes”, further investigations might still have been conducted by the examining physician yet not reported as this had not been explicitly asked for on the form. The main limitation of the exercise stress test was that most of the players were not tested to their maximum capacity, which is a pre-condition for a valid interpretation of results.

What we learned from the study

A pre-competition medical assessment for international elite football players was implemented at the 2006 FIFA World Cup Germany™. The excellent response rate demonstrated that such a standardised approach is feasible at an international level despite of different standards of care in the home countries of teams. Based on the findings, the FIFA PCMA was further optimised. Based on the cardiological review, it was decided to remove the exercise testing from the standard PCMA as the additional diagnostic value was considered to be low and acceptance of the test within the scope of the PCMA appeared to have been low.

However, the PCMA form is only one aspect in ensuring quality of results. The varying standards of medicine worldwide, the exacting organisational aspects of national teams, the costs and liability issues have to be taken into consideration when planning a standardised implementation.
4.1.2 PCMA at the 8th African U-17 Championships

Why we conducted this study

The study on the pre-competition medical assessments (PCMA) prior to the 2006 FIFA World Cup™ had shown considerable differences in the quality of data, raising concerns on the correct performance of the examinations. Having adapted the F-MARC PCMA according to the results of this study, the idea was to standardise conditions in order to ensure consistent quality. We chose an approach where we identified a group of F-MARC experts that would conduct the PCMA on all players participating in the competition together with the medical team of the local organising committee and the team doctors prior to the start of the competition at the location. The 8th African U-17 Championship organised by CAF in March 2009 was identified as an ideal opportunity to test this approach. It would also allow us to gain insight into the medical care and conditions for performing the PCMA at a lower level of play and in youth male players where we knew from experience that the resources allocated, both financial and human, differ considerably from senior men’s national teams across member associations.

Aims of the study

- Assess the feasibility of the PCMA performed by a team of experts prior to the competition
- Screen all players participating in the 8th African U-17 Championship for cardiac risk factors using the F-MARC standardised PCMA

How we collected the data

All players were examined by a group of physicians (orthopaedists, cardiologists) during the four days prior to the start of the competition. Teams were allocated time slots where all players were guided through a circuit with different stations where the individual parts of the PCMA were performed by experienced colleagues. The assessment of the musculoskeletal system was based on the F-MARC Football Medicine Manual. The cardiac assessment consisted of a medical history, clinical examination, 12-lead resting ECG and echocardiography in accordance with the most recent guidelines.

Results

The revised version of the PCMA when performed by an independent expert group prior to the competition in the host county proved to be feasible and well accepted by team doctors, players and member associations. All eight teams qualified for the 8th African U-17 Championship 2009 in Algiers took part in the study, corresponding to a total of 155 male players. No language problems were encountered as the examining physicians spoke English and French. According to the official player list, the examined players were on average 16.4 years old (range 14 to 17). The participants originated from different ethnic groups (approximate classification): Bantu (two teams), Semitic-Hamitic (one team), Mande (one team) or a combination of different ethnicities (four teams).

In three teams, all players had been medically examined at least once before the PCMA. In the other teams, the number of players already examined was lower and varied considerably, in one team, only one player (6%) had ever been assessed before.

Nine (5.8%) players reported cardiac symptoms and two players had elevated blood pressure. A total of 40 players (25.8%) showed abnormal ECG patterns. None of the players with abnormal ECG patterns had any suspicious echocardiographic findings. The echocardiogram of one player raised suspicion of early-stage hypertrophic cardiomyopathy, another player’s heart muscle structure showed characteristics of non-compaction cardiomyopathy, but both players had normal ECGs. Thirteen (8.4%) players showed echocardiographic findings that required further follow-up.

The team doctors were informed about these findings since they were responsible for the decision on the eligibility of players to play in the competition. The percentage of players with altered ECG patterns and echocardiographic measurements varied substantially between different ethnic groups.

What we learned from the study

With adequate preparation, performance of the PCMA on the spot with a team of experts proved feasible and might be a way to avoid varying quality of examination impairing the validity of results. However, the shorter the period prior to the start of the competition, the more
restricted are the possibilities for further investigations of suspicious findings.

History taking could be of limited value as players might fear exclusion of the competition. Interpretation of ECG findings poses a challenge in black players as they are known to have significantly more alterations than e.g. Caucasians. This might account for the difficulties in identifying black athletes at risk, leading to the seemingly higher incidence of adverse cardiac events in black athletes. Furthermore, ethnic differences in the structure and function of the heart need to be considered when drawing conclusions from examination results.

**Duration:** 2009  
**Countries:** International  
**Cooperation:** All team physicians of the 8th CAF U-17 Championship; Pieter D’Hooghe, MD, Belgium; Winne Meeuwisse, MD, Canada  
4.1.3 PCMA in International Football – Feasibility and Considerations

Why we conducted these studies

Since F-MARC’s initiative at the 2006 FIFA World Cup, the literature on the pre-competition medical assessment (PCMA) in international sport had continuously grown. Experts generally agreed on the necessity of the PCMA, advocated the implementation and recommended specific approaches. Still, only a few reports were published elaborating on the actual practical performance of the PCMA in different sports, and little was known about the challenges facing sports organisations and teams when trying to meet the requirements of a standardised PCMA in their individual setting. Having investigated the feasibility of the PCMA at the highest level of play in football, F-MARC wanted to assess the feasibility of the same standardised PCMA at female youth World Cups, a level of play with comparably less funding and support as compared to the senior teams in member associations worldwide.

Aim of the studies

- Assess the feasibility and compliance with performing a comprehensive PCMA in teams participating in the U-17 and U-20 FIFA Women’s World Cups

How we collected the data

All participating teams of the 2010 FIFA U-17 and U-20 Women’s World Cups received a circular highly recommending the performance of the F-MARC standardised PCMA in all their players prior to the competition. At that time, there was not regulatory base to make the PCMA a requirement for participation, therefore the performance remained voluntary. FIFA did not provide funding for the examinations but at the U-20 World Cup offered to perform the echocardiography at the competition venues at no cost for the teams. Submission of the forms to F-MARC was also voluntary and not specifically requested. Teams were only asked to confirm if they had performed a PCMA in their players.

The F-MARC PCMA form was slightly amended with questions on the menstrual cycle and measurements of calcium and ferritin to assess specific female aspects.

Results

All U-20 teams and 89% of U-17 teams confirmed having performed the PCMA and all U-17 and slightly less than half of the U-20 teams submitted their forms. A total of 147 U-20 and 297 U-17 forms could be reviewed and analysed.

In African, Asian, Central and South American teams, the team doctor usually coordinated and supervised all examinations and completed the eligibility statement. Data was organised in separate files per player with mostly all original results included. Different from that, North American and European teams often used several physicians to complete the examinations, resulting in variable completeness and quality of data. None of the players reported any signs or symptoms, only one African player reported what was understood as an event of sudden cardiac death in her family. There were no abnormal findings on physical examination. In the ECG of players, the most often reported finding was what is called an incomplete right bundle branch block, a common finding in athletes. There were no manifest pathological findings on echocardiography. In two teams, however, the respective cardiologist reported a mild backflow from different valves of the heart in eight and nine players, respectively. One cardiologist recommended these findings for follow-up whereas the other did not.

Only one U-20 team accepted the offer to perform the echocardiography at the venue. All other teams considered this to be disruptive to their preparation.

All players were declared eligible to play.

What we learnt from the studies

The acceptance of performing the PCMA in female youth players among FIFA member associations was remarkably high, and the quality of data submitted particularly from African, Asian, Central and South American teams exceptionally good. We observed that the quality increased when the team doctor was in control of and coordinated all examinations, and completed the forms.

An important lesson learnt was the refusal of the majority of teams to perform examinations at the venues prior to the competition since they considered this to
be disruptive for their preparation. At the same time, it became clear that the interpretation of the ECG and echocardiographic findings largely depends on the experience of the individual cardiologist with changes in the athlete’s heart.

The high acceptance and compliance of member associations at the women’s youth World Cups with the PCMA proved its feasibility even at lower levels of play. This was well received by the FIFA administration, and the most important consequence of these studies was the decision of the FIFA Executive Committee to make the PCMA a mandatory requirement at all FIFA World Cups™.

References:


4.1.4 PCMA of Referees and Assistant Referees

Why we conducted these studies

FIFA and F-MARC had been pioneers in performing pre-competition medical assessment (PCMA) of players and developed a standardised PCMA which they tested at different levels as described in the previous chapters. There was a considerable body of knowledge in the literature on the different approaches to PCMA in young athletes and players. In football, the referee at a match covers distances of comparable length and speed as the player he or she supervises. Different from the players, however, referees are usually considerably older. With increasing age, risk factors and causes of sudden cardiac (SCD) tend to change. Above 35 years of age, coronary heart disease becomes the most frequent cause of SCD in athletes. In view of their age-related risk and the physical load on referees during matches and training, it did seem highly indicated to screen the world’s best referees in a similar way to players prior to the two highest level international football events for men and women.

Aims of the studies

- Screen all referees selected for the 2010 FIFA World Cup™ using the F-MARC standardised PCMA
- Screen all referees selected for the FIFA Women’s World Cup 2011™ using the F-MARC standardised PCMA

How we collected the data

All 90 referees and assistant referees selected for the 2010 FIFA World Cup™ underwent the standard PCMA examination including medical history, physical examination, blood parameters, resting ECG and echocardiography by a team of F-MARC experts three months prior to the competition. All examinations were performed at the FIFA Medical Centre of Excellence in Zurich on the occasion of a workshop for the referees at the Home of FIFA. Considering the higher age of the referees as compared to players, and the consequently higher probability of asymptomatic coronary artery disease, all referees underwent a self-limited exercise ECG in addition to the standard examinations of the FIFA PCMA.

The 51 referees and assistant referees selected for the FIFA Women’s World Cup 2011™ were examined just prior to the event at the location by a team of F-MARC experts including a female cardiologist. The screening was performed in collaboration with local clinics. The female referees did not undergo exercise testing as they tended to be younger than their male counterparts and did not exhibit cardiac risk factors.

Results

The male referees had an average age of 39 years, the female referees of 33 years.

One male referee had diabetes and one referee had hypertension, both well controlled under treatment. Approximately 40% of the referees reported a history of cardiovascular disease. About one third of the male referees showed an abnormal finding on cardiac examination such as murmurs on auscultation, suspicious ECG changes or mild valve disturbances, however none of these was shown to be of clinical relevance in the follow-up investigations. All referees demonstrated excellent physical fitness. Almost all referees showed some pathological finding in the orthopaedic examination, mainly a laxity of the ankle or knee joints, but there was also limited range of motion of the hip or local tenderness over the Achilles tendon and groin.

Among the female referees, four reported a family history of SCD. However, none of these referees had any pathological findings on examinations. In the personal medical history, the most commonly reported finding was an allergy. None of the referees had any symptoms at rest or when exercising. There were no pathological findings with regard to blood pressure measurements and only mild functional heart murmurs on auscultation. All referees were completely asymptomatic and showed no abnormal findings in the resting ECG or echocardiography with the exception of one referee with a change in one aspect of her ECG curve, which was recommended for regular follow-up.

What we learnt from the studies

None of the female and male referees screened prior to the FIFA World Cup™ showed any relevant pathological findings upon screening with the F-MARC standardised PCMA. Both approaches to the performance of the
PCMA, either at a FIFA Medical Centre of Excellence on occasion of a workshop or prior to the competition at the spot proved to be feasible.

In view of the physical work load and average age of referees in football, the PCMA should be performed regularly. The ideal interval will need to be identified based on the risk profile in referees and the progression of the underlying diseases, which differs considerably from that in younger players and athletes.

Dr. D. Keller performing an echocardiography examination on a World Cup referee. (Additionally, from left to right: Dr. C. Schmied, Dr. M. Bizzini and Prof. J. Dvořák)

A PCMA in referees should consider an additional exercise ECG, because of their higher average age (between 35-40 years old at elite level)

Duration: 2010 - 2011
Countries: International
Cooperation: Christian Schmied, MD, Switzerland; Nina Feddermann, MD, Switzerland; Dagmar Keller, MD, Switzerland
References:
4.2 Risk Factors and Management of Sudden Cardiac Arrest

4.2.1 Statement on Sudden Cardiac Death

Why we held the meeting

On the one hand, regular physical exercise helps to prevent and treat cardiovascular disease, but on the other hand sports can serve as a trigger for Sudden Cardiac Death (SCD). Participation in competitive sports in particular increases the likelihood of SCD. The vast majority of non-traumatic deaths in sports is caused by SCD that occurs up to 90% under the eyes of the public during training or competition. The international football community had to witness such tragedy when Marc Vivien-Foé died on the pitch during the FIFA Confederations Cup 2003.

Any such event, particularly in a young athlete, is not only a tragic event considerably affecting their personal entourage, but also the public in general as well as the sporting world and sports medical community. Therefore, screening of athletes to identify risk factors for SCD is a concern for all sports organisations. In December 2005, the International Olympic Committee (IOC) convened an international meeting to in detail address the problem of SCD in young athletes.

What we learned from the meeting

Sudden Cardiac Death is defined as unexpected death due to a sudden loss of heart function that occurs within one hour of the onset of symptoms in a person without previously recognised cardiovascular conditions that would appear fatal. This excludes any non-cardiac causes. Pre-existing heart symptoms or diseases may have been known to be present, but the time and mode of death are unexpected.

The rate of SCD in sportspeople in general or in football players is not exactly known. In American high school athletes, predominantly basketball and American football players, it had been reported to be about one death in 200,000 athletes. A report on 269 victims of SCD in Italy showed that 49 were in athletes and the remaining 220 were in non-athletes, accordingly, the rate was 1.6 per 100,000 athletes per year as compared to 0.8 per 100,000 inhabitants per year. Thus, SCD rate for athletes was twice as high as the rate for non-athletes. The leading causes of non-traumatic sudden death in athletes are related to pre-existing cardiac abnormality and age-dependent. In athletes under the age of 35 years, the primary cause is hypertrophic cardiomyopathy (HCM), an inherent disease of the heart muscle. Above the age of 35 years, the primary cause is coronary artery disease.

HCM as the most common cause of SCD in young athletes is characterised by hypertrophy of, essentially, the left ventricle of the heart. One to two percent of those suffering from HCM die per year, mostly due to ventricular rhythm disturbances. If there are any symptoms, they are predominantly chest pain, dyspnea, rhythm disturbances and fatigue. A resting electrocardiogramme (ECG) is important as a screening method because the overwhelming number of patients with HCM will show an abnormality. However, definite diagnosis of HCM is made with echocardiography.

Screening programmes

In American athletes, the primary cause of death was found to be HCM in 36% of the athletes. The usual pre-participation examination in the US includes history taking and physical examination. This assessment had identified only three percent of athletes with suspected abnormalities, indicating that history taking and physical examination was ineffective in identifying athletes with underlying cardiovascular disease.

Italian law requires an annual clinical evaluation for approval of athletes to participate in competitive sports. Since 1971, thousands of young athletes were screened by general history, a physical examination and a resting ECG. Abnormal or equivocal evaluations were followed-up with echocardiography, 24-hour ECG-monitoring and a maximal exercise test as needed. Following this programme, the major cause of SCD found in Italy was arrhythmogenic right ventricular cardiomyopathy, another inherited heart muscle disorder. Different from the American study, HCM caused only one death in athletes (2.0%) vs. 16 in non-athletes (7.3%) in Italy.

The overall prevalence of HCM among young non-athletes who died suddenly was similar in both countries. Among young athletes who died suddenly, however, the prevalence of HCM was very different: 2% in the Italian study versus 24% in the American study. It therefore seemed that systematic pre-participation screening in Italy effectively disqualified those at risk for SCD, primarily those due to HCM. The Italian physicians concluded that a “the identification and disqualification of affected athletes at screening before participation in competitive sports may have prevented sudden death.”
LAUSANNE RECOMMENDATIONS for Sudden Cardiovascular Death in Sport
IOC Medical Commission, 10 December 2004

Preparticipation cardiovascular screening for athletes under 35 years starting to compete should include:

**Step 1**
- Personal history taking (see table 4.2.1.1)
- Family history taking (see table 4.2.1.1)
- Physical examination with palpation of pulses and heart auscultation
- 12-lead rest ECG

**Step 2**
Selected cases with a suspicious finding on personal history, family history of potentially inherited cardiac disease, or with suspicious physical or ECG findings in Step 1 require further evaluation by an age-appropriate cardiac specialist to qualify the athlete for sport participation.

Examples of important questions to the player

- Have you ever fainted or passed out when exercising?
- Have you ever had chest tightness, cough, or wheezing which made it difficult for you to perform in sports?
- Do you have or have you ever had racing of your heart or skipped heartbeats?
- Do you get tired more quickly than your friends do during exercise?
- Have you ever been told you have a heart murmur, a heart arrhythmia, rheumatic fever?
- Are you taking any medications at the present time?
- Has anyone in your family under the age of 50 years old died suddenly and unexpectedly?
- Has anyone in your family been treated for recurrent fainting?
- Has anyone in your family suffered unexplained drowning while swimming?
- Has anyone in your family had an unexplained car accident?
- Has anyone in your family had heart surgery?
- Has anyone in your family experienced sudden infant death (cot death)?

Tab. 4.2.1.1: Some of the questions to be asked to a player as recommended by the IOC

FIFA’s responsibility to protect players

The medical community needs to focus on identifying young athletes with HCM as the most common cause of SCD. FIFA strongly supports preventive screening in football but acknowledges the difficulties in establishing standardised requirements. To date, the scientific and medical community have not reached a consensus on the ideal pre-competition medical assessment. To further investigate the matter, the FIFA Medical Committee and F-MARC developed a specific assessment for all the players participating in the 2006 FIFA World Cup Germany™ (See chapter 4.1.1; Fig. 4.2.1.1).

However, apart from the methodological and logistical problems in the implementation of cardiac assessment, the exclusion of a player from play leads to numerous personal, financial, social, ethical and legal consequences and places a high burden on the team doctor. At the same time, the reasons and circumstances in which full participation should be modified or disallowed are not clearly established.

The son of Marc Vivien Foé (who died on the pitch in 2003) speaks at the FIFA Confederations Cup 2009

Duration: 2005
Countries: International
Cooperation: IOC
4.2.2 Practical Management of Sudden Cardiac Arrest on the Field of Play

**Why we conducted these reviews**

Time and again, the football family is deeply stirred by reports of apparently healthy players dying on the pitch, or even the live broadcasting of such tragic events. Due to the popularity of the game and its broad media coverage, a series of cases involving popular players has achieved sad publicity over recent years, creating a perception in the media and the public that these events occur particularly often in football. Sudden Cardiac Arrest (SCA) is the unexpected, sudden stop of heart action which will inevitably lead to Sudden Cardiac Death (SCD) as described in the previous chapter unless immediately treated by an electrical shock. The possible causes and underlying disease have also been elaborated on in the previous chapter. It does appear from more recent studies, that the incidence of SCD might in fact be far higher than what had been estimated in 2005. The time available to save a player’s life basically is a few minutes in SCA, and there are multiple examples of incidents at football matches where these minutes elapsed without appropriate action. We therefore conducted a review of the literature and the current practice in the management of SCA in football to identify the reasons for this failure and give recommendations to improve the situation.

**Aim of the reviews**

- Summarise the current knowledge and practical management of SCA in football and conclude on recommendations for best practice

**How we collected the data**

A review of the current literature, the current regulations and rules applying to medical treatment on the pitch and recent examples of SCD and its management in football was performed.

**Results**

In a player collapsing on the pitch because of SCA, an electrical shock (called defibrillation) performed with a portable, automatic external defibrillator (AED) within 1-2 minutes has a success rate of 90% for resuscitation by converting the heart rhythm back to normal. The probability of success for any attempt to defibrillate the player thereafter steeply declines with the time elapsed (about 10% per minute), and, at the same time, the probability of permanent brain damage increases. Manual chest compressions may help to maintain minimal blood flow to the brain, but do not suffice to keep the victim alive.

In football, there are several reasons leading to a delay of treatment in incidents of SCA. The Laws of the Game are such that medical staff is only allowed to run onto the pitch and provide care to an injured player when being specifically called to do so by the referee. If a player goes down in the course of action in a match, e.g. through contact with another player, the referee is usually nearby and may assess the player immediately. If a player collapses due to SCA, this does not necessarily happen during a fight for the ball but might in fact do so far away of the current match action. Therefore, the referee needs to first become aware of an event which is not in the centre of their attention, then recognise the severity, then approach the player and assess them before he may finally call the medical team on the pitch. Given the 1-2 minute time limit mentioned above, all these actions might already take up a large part of the time available to successfully resuscitate the player.

Further, players with SCA often show seizure-like movements in the first moments, most likely due to a lack of oxygen in the brain, which might be mistaken for a seizure or even normal movement. Players may also exhibit what is called agonal breathing which is different from normal breathing but again might be mistaken for breathing still taking place. These signs and symptoms, albeit typical, might not be recognised by the insufficiently trained responder, resulting in further delay of diagnosis and treatment of SCA. Until an AED is available for defibrillation, the only indicated action in SCA is immediate chest compression to maintain some blood flow to the brain. There are also several examples where the physician called on the pitch did not take the appropriate action, most likely due to a lack of training in the specific treatment of SCA. Usual sports medicine training rarely includes the acute management of SCA, and even less so regular practice of the same under life conditions which is essential to exert the required routine precisely.
Finally, the availability of an AED within close proximity of the pitch is not yet standard at football matches all over the world. If action is to be taken within 1-2 minutes, the AED indispensably has to be at hand at the side line to allow for immediate emergency response by either the stretcher team or the team doctor.

What we learned from the reviews

These reviews were inspired by the practical experience of the FIFA Medical Committee and F-MARC and several tragic examples of SCD in football. The requirement of an AED being available at the side-line was standard at FIFA competitions for several years, but it became clear that this availability needed to be extended to lower levels of play and be amended with hands-on training of team doctors and side-line stretcher teams in the diagnosis and treatment of SCA. Training of other individuals present at the pitch such as referees, coaches and other staff in at least chest compression is highly recommended. Further, the action to be taken in case of SCA on the pitch needs to be planned ahead and the plan of action has to be laid down in writing and duly communicated to all medical staff involved in order to clearly identify tasks and responsibilities.

Recommendations for emergency planning for SCA on the pitch

- Every team and venue hosting football training or a competition should have a written emergency response plan for SCA.
- Potential responders to SCA on the field (i.e. coaches, referees, physiotherapists, athletic trainers, and other medical staff) should be regularly trained in cardiopulmonary resuscitation and AED use, and demonstrate skills proficiency in this regard.
- An AED should be immediately available on the pitch during competitions.
- Both teams should review prior to the match the location of the AED and details of the emergency response plan.

A course programme was consequently launched based on the deficits identified in the practical management of SCA. Emergency courses were held at both FIFA Medical Conferences 2009 and 2012, at AFC and CAF Medical Conferences and in Brazil in preparation of the medical staff prior to the 2014 FIFA World Cup Brazil™. CAF in 2012 provided an emergency medical kit to each of their member associations and practical training at courses to the national football physicians. The recommended change in the provisions of medical treatment on the pitch necessitates discussions on executive level that have to be informed by medical advice. A reasonable rule-of-thumb in the meantime for referees and side-line staff might be to consider every player who collapses without contact with another player or a steady object, and who is unresponsive, to be suffering from SCA. Importantly, movement or breathing does not exclude SCA.

References:
4.2.3 FIFA 11 Steps to Prevent Sudden Cardiac Death and the FIFA Medical Emergency Bag

**Why we initiated this project**

Life-threatening medical emergencies are a rare but possible event in football, and sudden cardiac arrest (SCA) remains the leading cause of death during football. Proper prevention strategies, emergency medical planning and timely access to emergency equipment are required to prevent fatal outcomes. FIFA and F-MARC are committed to protecting the health of players worldwide. By formulating the FIFA 11 steps to prevent sudden cardiac death in football and providing the FIFA Medical Emergency Bag (FMEB), FIFA and F-MARC propose a standard for emergency preparedness and medical response to serious or fatal on-field injuries in football.

**Aims of the project**

- To support and promote a standardised and consistent level of advanced life support and emergency medical care on the football field
- To prevent and manage sudden cardiac arrest on the football field

**How we developed the programme**

The FMEB was developed in a process of expert consultation and consensus encompassing a group of football-experienced and actively involved medical specialists from the fields of neurology, cardiology, orthopaedic surgery, sports and emergency medicine from countries including Switzerland, England, the USA, Brazil and South Africa. Drawing from their extensive experience with the medical management of international football events, the experts brought together their knowledge to allocate the appropriate contents of a football medical emergency bag that would be universally applicable and suitable in a multitude of locations worldwide. They moreover established the FIFA 11 steps to prevent sudden cardiac death (SCD), which is a comprehensive action plan for the management of life-threatening emergencies on the field of play.

**FIFA Medical Emergency Bag (FMEB)**

As the consensus meeting revealed, about 13 emergency medical conditions can be defined that are likely to occur on the football field (Box 4.2.3.1). Taking these conditions into account, it was agreed by the experts that the contents of the FMEB should primarily be designed to medically manage a player for approx. 60 minutes, and that it should be aimed at players older than 14 years of age and with a weight of 50 kg or more. The inclusion of a rigid durable immobilisation-carrying device was considered mandatory, and the specialists recommended that a pressurised metered inhaler and volumetric spacer should be used for acute asthma rather than a nebuliser system as this might be difficult to apply in some stadiums due to logistical difficulties of having stored oxygen routinely available on scene during training or competitions. The contents of the FMEB have been selected mainly in a generic format such that all of the items can be replaced if used in an emergency or expired using the equivalent locally available stocked items. A key feature of the FMEB is that the automated external defibrillator (AED) is stored in the FMEB in such a way that it is immediately visible and ready to be applied in an emergency.

**FIFA 11 steps to prevent sudden cardiac death (SCD)**

The FIFA 11 steps to prevent SCD in football reflect the insight that a consistent approach to prevention, planning and protocol are of utmost importance when it comes to managing life-threatening medical emergencies on the field. The specialists agreed that a pre-participation screening, which identifies athletes with pre-existing conditions placing them at risk of SCD should be universally supported, and that a Pre-Competition Medical Assessment (See chapter 4.1) should be routinely undertaken. They also suggested that an exercise test should be considered in athletes older than 35 years of age and when otherwise indicated. Moreover, the experts pointed out the crucial importance of regular and appropriate training measures to ensure that the on-duty medical personnel is familiar with the emergency medical protocol (EMP) and can function efficiently in life-threatening emergencies on the field. It was agreed that a FMEB with AED must be in position at the field-side before the commencement of all training sessions and all games, and that an adequately staffed and equipped ambulance must be positioned at the field-side before
starting of all games. In case of an emergency, immediate recognition of any collapsed player was defined as the initial primary responsibility of the field-of-play medical team, and any football player who collapses and is unresponsive, particularly if this occurs without contact with another player, should be regarded as a SCA and subjected to immediate AED treatment. A detailed overview of the FIFA 11 steps to prevent sudden cardiac death is presented in Box 4.2.3.2.

By providing the FMEB and the FIFA 11 steps to prevent SCD, F-MARC is making yet another key contribution to the health protection of football players worldwide. Realising the utmost importance of a timely, effective and universally applicable medical emergency plan for life-threatening occurrences on the field and offering the FMEB to all FIFA Member Associations worldwide, FIFA contributed to the prevention of SCA and other life-threatening occurrences in football in the future.
4.2.4 Cardiac Findings and the Athlete’s Heart in African Adolescent Players

Why we conducted these studies

The analysis of the forms of the P-Competition Medical Assessment (PCMA) performed prior to the 2006 FIFA World Cup™ had revealed a high percentage of ECG findings in black players that as per the standard criteria used for ECG interpretation at the time would have been termed abnormal. It was known that black athletes had a higher risk of Sudden Cardiac Death (SCD) than Caucasian athletes. Therefore, identifying black players at high risk of SCD appeared particularly important, yet there were no criteria how to achieve this as the defined standard criteria produced a lot of “false positive” results in black athletes, meaning the ECG would be rated abnormal, but further investigations did not show any abnormality. This implied that there was probably a need to develop specific interpretation criteria for the ECG of black players and athletes to be able to distinguish normal from abnormal findings. We therefore decided to examine the young black African players at the CAF U-17 Championship in detail and with a particular focus on the heart investigations to gain more insight into this matter.

Aims of the studies

- Screen all players at the 8th CAF U-17 Championship 2009 in Algeria for cardiac risk factors using the standardised F-MARC PCMA
- Define the ECG and echocardiographic characteristics found in African adolescent athletes
- Collect data on cardiac risk-factors in this target group

How we collected the data

All eight qualified teams for the 8th CAF U-17 Championship 2009 respectively their 155 players were examined by a team of F-MARC physicians prior to the competition. All examinations were performed according to the revised F-MARC PCMA form and included medical history, family history, physical examination, 12-lead resting ECG and echocardiography. All heart examination findings were assessed by three cardiologists to minimise individual error.

Results

There were numerous different African ethnic groups represented among the eight teams. One third of the players had never been examined by a physician before. Only 9 of the players reported heart symptoms, and two had elevated blood pressure in the clinical examination. Slightly more than a quarter of the U-17 players showed abnormal ECG findings, but none of them had any signs of abnormality on echocardiography. There were certain changes that were found particularly often. Black African players particularly often showed ECG signs of left ventricle hypertrophy. The most frequent finding in about half of the black African players concerned what is called an R wave, and one fifth had a particular change in what is called the T wave. It was not possible to assign structural abnormalities to these changes, meaning that these players need further follow-up.

Thirteen players had an abnormal echocardiography, two of them showing signs compatible with beginning cardiomyopathy. Athletes typically show left ventricle hypertrophy. In our study population, Caucasian and African players had comparable left ventricle dimensions, but African players showed markedly thicker walls of the ventricle, which were more often above the upper normal limit than in Caucasian players. In the same way, the mass of the left ventricle was larger and more often above the upper normal limit (Fig. 4.2.4.1)

What we learned from the studies

Among African players, abnormal ECG changes were more frequent in black African than in non-black African players. These ECG changes could however not be related to distinguishable structural changes or diseases of the heart. To establish ECG interpretation criteria for black players, it is important to know the interpretation criteria in black non-athletes which so far have not been identified. Therefore, there is a need to establish population–based data of normal ECGs in adolescent black Africans and correlate it to echocardiographic findings.
Compared to Caucasian players, black African players have similar left ventricle cavity, but more often left ventricle wall thickening and larger left ventricle mass. This finding of disproportionate wall thickening might be a genetically determined reaction to athletic training in black Africans.

Whenever examining players from different ethnic backgrounds, race-related ECG and echocardiography need to be known in order to avoid false positive findings. Further studies in larger populations are needed to establish the differences between different ethnic groups and develop interpretation criteria for the respective ethnicity.

Fig. 4.2.4.1: Flow chart showing the echocardiographic findings in African athletes according to ECG abnormalities, that is, “training-related” (benign) and “training-unrelated” (possibly expression of cardiac disorder). Among athletes showing ECG abnormalities unrelated to training, one hypertrophic cardiomyopathy was diagnosed.

**Duration:** 2009 - 2012

**Countries:** International

**Cooperation:** All team physicians of the 8th CAF U-17 Championships; University of Cape Town, Cape Town, South Africa; University of Zurich, Zurich, Switzerland

**References:**
5 Other Recognised Matters

5.1 Assessment of Player Characteristics

5.1.1 Medical History and Physical Examination

**Why we conducted this study**

The physical demands of football on players become more pronounced the higher the level of competition. A 25-year-old professional plays much harder than a 25-year-old hobby player. Without the adequate physical and psychological prerequisites, the individual player will not be able to cope with the stresses of play. An unfit player will play at a far lower intensity than a fit player will. A poorly nourished player, regardless of their level of fitness, will tire earlier than a properly fed, well-nourished player. A player with an incompletely rehabilitated injury will likely “favour” that injury and not play at their uninjured potential. The player with joint instabilities, lower strength or reduced flexibility, etc. will not play to their best potential and could well be at risk for an injury.

Within the level of play, the demands of the game increase as the player ages – a 14-year-old plays harder than a ten-year-old. In either case, it is important to know the player’s history and status of current complaints as they prepare to train and compete. F-MARC had found that while there are studies that outline physical, physiological, and injury profiles of sporting participants, most of them showed weaknesses in their subject selection (e.g. only one team with a limited number of players) and assessment methods (various studies measure the same factors with different methods). In football in particular, data on for example the prevalence of abnormal findings in the joints of players have seldom been investigated. Also, very little was known about complaints of active players. Therefore, F-MARC decided to systematically investigate how these factors relate to each other.

**Aims of the study**

- Study the medical history and physical findings in players from different levels of play
- Determine the relationship between pathologic findings in the joints of the lower extremities and the player’s medical history

**How we collected the data**

We examined 588 football players from Germany, France and the Czech Republic. Players were grouped according to the age and skill level of their team. The 144 adult players were categorised into four skill-level groups: top-level adults (first and second league), third league, amateur teams (Division), and local teams. The 444 youth players were divided into two age groups (14- to 16-year-old players and 16- to 18-year-old players) and two skill-level groups (high and low). Medical histories were obtained by a written questionnaire and physical examinations were conducted by specially trained physicians. Furthermore, the players were asked about currently existing symptoms, limitations in performance and their medical treatment.

The physical examination incorporated different aspects: anthropometric and body fat measurements, and examination of the most important joints. The anthropometric measurements taken consisted of height and weight, the length and circumference of the extremities, and the circumference of the chest and hips. Body fat was assessed by means of skinfold thickness measurements taken at seven sites: chest, axilla, triceps, subscapula, abdomen, suprailiac crest, and thigh. For the spine, the degrees of lordosis, kyphosis, and scoliosis (if present) were measured as well as the active and passive rotation of the cervical and the thoracic and lumbar spine. The knee joint was assessed for possible pathologic findings by means of the Lachmann test, valgus and varus stress in extension and in 30° of flexion, and the anterior and posterior drawer signs (Fig. 5.1.1.1). With the subject in the standing position, the knee joint axis was judged as straight, varus, or valgus, and the distances between the medial femoral epicondyles and between the medial malleoli were measured. For the ankle joint, the degree of supination and pronation, as well as the extent of dorsiflexion, total supination, and total pronation, were assessed using a goniometer. Possible pathologic signs were documented by performing tests of comparative supination of the ankle joints and anterior drawer signs. The extent of passive extension and flexion of the great toe joint was also measured and expressed in degrees.

**Results**

The players ranged in age between 14 and 41 years of age with an average age of 18.4 years. The most obvious finding was the high prevalence of physical complaints at all levels of play (Tab. 5.1.1.1) with only one-quarter
prior injuries and most of the injuries were to the non-dominant leg. It is obviously not advisable to play with an incompletely healed injury under the false sense of security that tape and bandages will have a preventive effect. F-MARC concluded that in our future research to ensure and maintain the health of football players, we would need to pay more attention to the current pathologic findings and complaints as well as the secondary structural changes that may occur as a result of playing football.

### Tab. 5.1.1.1 Prevalence (percent of players) of complaints in football players of different age and skill levels

<table>
<thead>
<tr>
<th>Complaint</th>
<th>Adult players</th>
<th>Youth 16-18y</th>
<th>Youth 14-16y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top 3rd league</td>
<td>Amateur Local</td>
<td>High level</td>
</tr>
<tr>
<td></td>
<td>High level</td>
<td>Low level</td>
<td>High level</td>
</tr>
<tr>
<td></td>
<td>Low level</td>
<td></td>
<td>Low level</td>
</tr>
<tr>
<td>Headache</td>
<td>10</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>47</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>Neck pain</td>
<td>30</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>40</td>
<td>38</td>
</tr>
<tr>
<td>Low back pain</td>
<td>28</td>
<td>41</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>47</td>
<td>39</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>31</td>
<td>38</td>
</tr>
<tr>
<td>Muscletendon</td>
<td>38</td>
<td>39</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>42</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>31</td>
<td>38</td>
</tr>
<tr>
<td>Joint pain</td>
<td>33</td>
<td>46</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>37</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>40</td>
<td>44</td>
</tr>
<tr>
<td>any complaint</td>
<td>78</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>74</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>81</td>
<td>84</td>
<td></td>
</tr>
</tbody>
</table>

### Tab. 5.1.1.2 Percent of players with pathologic signs of knee or ankle ligament injury

<table>
<thead>
<tr>
<th></th>
<th>Adult players</th>
<th>Youth 16-18y</th>
<th>Youth 14-16y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top 3rd league</td>
<td>Amateur Local</td>
<td>High level</td>
</tr>
<tr>
<td></td>
<td>High level</td>
<td>Low level</td>
<td>High level</td>
</tr>
<tr>
<td></td>
<td>Low level</td>
<td></td>
<td>Low level</td>
</tr>
<tr>
<td>Any sign of ACL injury</td>
<td>12.5</td>
<td>7.3</td>
<td>16.0</td>
</tr>
<tr>
<td></td>
<td>15.6</td>
<td>2.4</td>
<td>23.1</td>
</tr>
<tr>
<td>at least 1 sign of any ligament injury in either knee</td>
<td>18</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>Ankle instability in either ankle</td>
<td>20</td>
<td>28</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>23</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>

### What we learned from the study

The high prevalence of physical complaints at all levels of play was impressive. It is remarkable that almost one-quarter of the players still felt the effects of a previous injury at the time of the examination. Current pain in players with pathologic findings was related to prior injuries and most of the injuries were to the non-dominant leg. It is obviously not advisable to play with an incompletely healed injury under the false sense of security that tape and bandages will have a preventive effect. F-MARC concluded that in our future research to ensure and maintain the health of football players, we would need to pay more attention to the current pathologic findings and complaints as well as the secondary structural changes that may occur as a result of playing football.
5.1.2 Psychological Characteristics

Why we conducted this study

Playing football demands not only good physical performance, but also mental preparation and most probably specific psychological qualities. The nature of the game requires particular gifts and features that draw people with specific personality traits to participate. Within the game, only certain players advance up the ladder of the sport. It might be that players at different levels of play might vary not only in their football skills and their way of playing, but also in psychological factors like concentration, reaction time, or competitive anxiety.

F-MARC had produced troubling statistics showing that more than one-quarter of all football injuries were due to foul play. While some injuries are accidental, intentional foul play is an issue in all sports and might be a result of a certain willingness of a player to make a conscious attempt at committing a foul. Changes in the rules of ice hockey and American football to restrict foul play had led to reductions in injury. We hypothesised that a player’s psychological traits might just influence how they approach playing football, especially with respect to fair play, and also their risk of injury. Therefore, F-MARC decided to further investigate these traits.

Aims of the study

- Examine psychological and football-specific characteristics at different levels of play
- Analyse the relationship between psychological characteristics and attitudes toward fair play

How we collected the data

A group consisting of 588 football players from Czech Republic, Germany and France filled out questionnaires (Fig. 5.1.2.1). As in our previous study, adult players were categorised into four skill level groups: top-level (first and second league), third league, amateur teams (division), and local teams. Youth players were divided into two age groups (14- to 16-year-old players and 16- to 18-year-old players) and two skill-level groups (high and low). A total of 13% of the players were professionals. We assessed psychological characteristics using three established self-evaluation questionnaires: the Athletic Coping Skills Inventory, the State Competitive Anxiety Test, and the State-Trait-Anger-Expression-Inventory. Test results were compared with historical results in the scientific literature. We also asked for a series of football-specific characteristics that included playing experience, positions played, style of play, number of training hours and games, as well as aspects of fair play. We also tested the reaction time of players. Simple reaction time to an optical stimulus was tested twice: once without the influence of physical exercise and once with the effect of exercise by testing reaction time after completion of a 12-minute run.

Results

At rest, reaction time was slower for the lower level players, most pronounced in youth players. After exercise, reaction time was significantly shorter in high-level than in low-level players of all three age groups. When comparing groups, the top level adults and the top level 16-18-year-old youth players had the shortest reaction times of all (Tab. 5.1.2.1)

Essentially, the psychological traits were the same across the age groups in this study. Coping skills (such as coping with adversity, amenability to being coached, confidence, mental preparation) were similar regardless of age and level of play. Yet, there were a few differences within...
the age groups. High level youth had fewer worries about their performance and high level 14-16-year-old youth had more mental strength under pressure and better concentration than lower level players of the same age. Neither the Sport Competitive Anxiety Inventory (SCAT) nor State-Trait-Anger-Expression-Inventory was different across the other football groups.

When comparing the football players against other groups reported in the literature, the football players had higher levels of anger, outward expressions of anger, and competitive anxiety, but lower levels of anger control. The football players scored lower on all aspects of coping skills with the exception of “freedom from anxiety”. We also looked at the interaction of personality traits and fair play statements. For example, players who refrained from verbal interaction with the opponents were usually better prepared, had more focused concentration, were easier to coach, and coped better with adversity and anger. Those who would react to a hidden foul had higher levels of anger and less control of it. In addition, those players had lower levels of concentration, poor coping abilities, and were difficult to coach. Ninety-two percent of the players said they would commit a so-called “professional foul” if necessary. Half of the players had responded physically when provoked by an opponent, and nearly 60% would pay back a hidden (unpenalised) foul.

The reaction time seemed in general to be longer in low-level players than in high-level players. The replies from the questionnaire regarding fair play clearly indicated that the rules of the game, its regulations and the spirit of fair play is not paid sufficient respect by football players.

The willingness to commit a “professional foul” was alarmingly high and not associated with any specific personality trait. The players felt that depending on score and match importance, a “professional foul” might just be needed and they would be willing to commit such a foul. To the psychologist, this means that the “professional foul” is not a spontaneous act. On the other hand, retaliation would be committed by those with high levels of anger and poor control over anger expression.

**What we learned from the study**

<table>
<thead>
<tr>
<th>Adult players</th>
<th>Youth 16-18y</th>
<th>Youth 14-16y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Top</td>
<td>3rd league</td>
</tr>
<tr>
<td>Age started playing (y)</td>
<td>6.6</td>
<td>6.4</td>
</tr>
<tr>
<td>Years playing</td>
<td>17</td>
<td>16.1</td>
</tr>
<tr>
<td>No of games last season</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>Training hrs per week</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Preferred foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right (%)</td>
<td>38</td>
<td>48</td>
</tr>
<tr>
<td>Left (%)</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Both (%)</td>
<td>54</td>
<td>45</td>
</tr>
<tr>
<td>Field leader? (% yes)</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td>Physical player? (% yes)</td>
<td>44</td>
<td>58</td>
</tr>
</tbody>
</table>

Tab. 5.1.2.1 Reaction Time of Football Players of Different Age and Skill Levels

**Duration:** 1996 - 1998  
**Countries:** Czech Republic, Germany, France  
**Cooperation:** Czech Football Association  
**Reference:**  
5.1.3 Assessment of Performance

Why we conducted this study

All sports are a combination of technique, tactics, physical fitness and psychological fitness. The complexity of football is such that the relative importance of each of these variables can change from match to match. Probably one of the reasons that football is played by so many is that the game requires no specific gifts in order to be successful. Some games have traits that are unique to their sports, such as strength and power for American football, height for basketball, speed for sprinting or endurance for distance running. In contrast, football, while not requiring any specific trait for success, does require some ability in all aspects of physical fitness. The most important variables for measuring performance in team sports in general are physical condition and technical and tactical performance. However, in football, it was difficult to ascertain the relative importance of each of these variables.

Aim of the study

- Develop a standardised test battery to evaluate physical performance characteristics in football players

How we collected the data

Again, the 588 football players from Czech Republic, Germany and France of multiple ages and playing levels were examined. The three hour session to assess performance included a warm-up procedure, tests of flexibility, football skills, power, speed and endurance and ended with a cool-down. Some additional stretching was done prior to the flexibility tests.

F-MARC’s battery was prepared to test the various physical demands of a football player’s normal activity.

Flexibility

Examples are:

**Suptine straight leg raise:** The player lies on their back, then raises one leg up as far as possible. A partner then helps raising the leg even further. The angle of the leg to the ground is measured.

**Lengthwise leg splits:** The player stands on the board and uses the chair for support. He kneels on the board and extends the other leg straight in front. The distance from the groin to the ground is measured.

**Single leg knee bend:** The player stands on the board and uses the chair for support. They kneel on the board and extend the other leg as far as possible behind them. The distance from the groin to the ground is measured.

**Forward trunk bending:** The player stands on a bench. With straight legs, the player bends as far forward as possible. The distance from the fingertip to the ground is measured.

Football skills

Examples are:

**Speed dribbling:** The player dribbles the ball around a specific course for time. The course is laid out over a 50m linear distance, but the multiple changes of direction increase the overall running distance (Fig. 5.1.3.1).

**Long passing:** The player gets five attempts to see how many times he can kick a stationary ball into a 2m radius circle which centre is 36m away.

**Short passing:** The player gets five attempts to see how many times he can pass a dribbled ball into a hockey goal that is eleven metres away.

**Shooting:** Using a stationary ball 16m from a goal, the player gets three attempts to shoot into each upper corner. All scoring tests have a progressive scoring system for accuracy.

Fig. 5.1.3.1 Dribbling at speed test
Examples are:

**Two-footed vertical jump:** The player stands next to a wall, reaches as high as possible and makes a mark with a piece of chalk. Then he jumps as high as possible and touches the wall with the chalk. After three attempts, the maximum distance from the reach and jump chalk marks are measured.

**Triple jump:** Each player stands on one leg, and then executes three successive jumps with that one leg as far as possible and the distance is then measured. Three attempts are made for each leg.

**Four-line sprint:** Four lines are drawn on the ground. The player lies on the ground at line B. On command he gets to his feet and sprints to Line A (10m), turns and sprints to line C (20m), turns and sprints back to line B (10m), turns and sprints to line D (30m). The time is recorded by a stopwatch (Fig. 5.1.3.2). Each player runs as far as possible in 12 minutes. The distance in metres as well as the pulse rate are recorded.

A large amount of data was generated to establish standards for fitness and skill across a wide range of ages and abilities (Fig. 5.1.3.3). In youth players, dexterity tests such as juggling and passing differed significantly between high- and low-level groups. All power, speed, and endurance tests discriminated between age and skill-level groups, especially in youth players. The significant differences between the quality of the warm-up performed by the different skill-level groups possibly reflected the lower standard of training in less skilled players.

**What we learned from the study**

In summary, the F-MARC test battery proved to be a feasible instrument for assessing physical performance as well as football-specific skills. The best predictor of football ability was the speed dribbling test. Our findings suggested that analysis of an individual player’s physical profile, in relation to mean values for a similar age group and skill level, might be of assistance to the coach in objectively evaluating the effects of a specific training programme. It may also be of use to the responsible physician and physical therapist in monitoring progress during rehabilitation after football injuries.

**Reference:**
5.2 Ramadan and Football

5.2.1 Influence of Ramadan on Performance

**Why we conducted this study**

Islam is a major religion with over one billion people living under Islamic laws. One of the most important periods for Muslims is Ramadan when healthy adult Muslims fast from sunrise to sunset for the four-week period. The original objectives of this fasting period are physical and mental regeneration combined with intensified praying. Muslims are invited to abstain from all types of liquid or solid nutrient intake as well as undesirable behaviour during this period of purification with the exact timing of food and liquid intake depending on the times of sunrise and sunset. So Ramadan is a phase shift of food intake and sleep and less a traditional fast where food is generally avoided.

Football is the largest spectator sport and as a means of physical exercise the most popular leisure activity in many Muslim countries. While there had been a number of studies on the physical and clinical effects of Ramadan with regard to metabolism, hormones and behaviour, little was known on the influence Ramadan has on athletic performance. There were also reports on the effects of food restriction and sleep deprivation on performance in the laboratory. With Muslim footballers playing worldwide and the increasing chance of international matches involving Muslim and non-Muslim teams being contested during Ramadan, it seemed appropriate to F-MARC to assess how the Islamic competitive player is affected by this religious period.

**Aims of the study**

- Determine the effects of Ramadan on physical performance and football performance
- Assess the subjective opinions of the players on symptoms, behaviour and performance

**How we collected the data**

Ramadan is based on the lunar calendar and in 2004 occurred between 15 October and 13 November. During that period, two professional football teams in Algiers, with a total of 55 players, were followed. Data were collected two weeks before, at the end, and two weeks after Ramadan. Each player was tested for endurance, agility, power, speed and a dribbling task. The timing of tests corresponded to their usual match time in the early afternoon. Each player was interviewed regularly during the study for their subjective opinions on sleep quality, eating, symptoms and their perception of their training and match performance.

**Results**

In the fourth week of Ramadan, performance was reduced on a wide range of tests (20m speed, speed dribbling, agility, endurance and recovery) and was below the initial values when tested two weeks after the end of the fasting period (Fig. 5.2.1.1). Nearly a quarter of all players felt they ate more during Ramadan while half felt they ate less. Weight did not significantly change. Food volume returned to normal after Ramadan. About 70% of players reported that the quality of their training was poorer during the fast, and just over 75% of the players thought that their match performance was reduced during the fast.

Sleep volume was reduced by just over 30 minutes during Ramadan, but nearly three quarters of the players said that the quality of their sleep was poorer than before Ramadan because the sleep cycle was disrupted to accommodate food intake.

Finally, a series of symptoms changed during the fast, especially an increase in headache and vertigo (Fig. 5.2.1.2). In most cases, after the fast, subjective ratings by the players had either returned to pre-Ramadan values or rebounded above pre-fasting levels. Importantly, nearly all the players believed that their training and match performance had improved to close to pre-Ramadan levels once the fast had been concluded (Fig. 5.2.1.3).
What we learned from the study

This was the first study to focus on competitive football players during Ramadan. Ramadan is different than the laboratory studies of performance during fasting because this religious period is less a fast and more a phase shift in calorie intake and change in sleep patterns. Our results showed that several parameters of physical performance in football players were affected during Ramadan. The players did believe that their training and performance were both below normal. However, why such short tests like sprint and ability would be affected by Ramadan is curious as neither is limited by fuel availability so the change in sleep patterns and their mood during this period might be a more likely explanation. F-MARC recommended that the Islamic competitive athlete needs to develop specific strategies to maintain optimal performance during Ramadan.

Fig. 5.2.1.1 By the end of Ramadan, there was poorer performance on speed, agility, endurance and dribbling ability

Fig. 5.2.1.2 Players reported an increase in symptoms by the end of Ramadan such as an increase in increases in headache, fatigue, and vertigo

Fig. 5.2.1.3 The player’s opinion of their training and match performance declined through Ramadan, but returned to acceptable levels after Ramadan has concluded

Duration: 2004 - 2005
Country: Algeria
Cooperation: Centre d’Evaluation et d’Expertise en Medecine du Sport, Alger.
5.2.2 Influence of Ramadan on Physiological and Performance Variables

Why we conducted this study

During Ramadan, healthy adult Muslims fast from sunrise to sunset for a four-week period. Ramadan is a phase shift of food intake and sleep and less a traditional fast where food is generally avoided. The time between the morning prayers and the midday prayer is used for regular activities. The afternoon time allows for light intellectual and physical activities including sports and exercise such as football. Within the professional clubs and in national teams, Muslim players might have to play high profile matches during the fasting period of Ramadan. The combined effects of food and fluid restriction and of changes in the eating and sleeping patterns are therefore of considerable importance to these players.

In our previous F-MARC study, we had studied Algerian professional football players and found a decline in performance for speed, agility, dribbling speed and endurance. Players were also queried on sleeping habits and personal perception of performance and nearly 70% of the players thought that their training and performance were adversely affected during the fast. The phase shift of food intake and disruption of sleep patterns therefore appeared to affect actual and perceived physical performance in these players. These players had been living at home and were therefore following the eating and sleeping habits of their families. In order to achieve data of high scientific value, we would however need to conduct a so-called controlled study with adequate numbers of trained players comparing performance in those who observe Ramadan and those who do not under specified conditions.

Aim of the study

- Gain additional information to allow optimisation of the daily training and dietary regimen in relation to the mental and physical performance of football players during the month of Ramadan under controlled training camp conditions

How we collected the data

Two years after our first Ramadan study we set out to follow four male junior teams, along with their coaches and trainers in Tunis, Tunisia, during the 2006 Ramadan period from 23 September to 22 October. All players attended a residential training camp at the Tunisian Football Federation’s training centre three weeks before the start of Ramadan and throughout the study. The team coaches designed and ran their own training programmes for their specific squad, and the teams were involved in the programmed competitive matches. It was up to the individual players if they observed the Ramadan fast or not, and 64 players chose to observe the fast while 36 players did not. Throughout the study, all meals were prepared in the kitchens of the camp and were designed to be similar to the diets usually eaten. To account for regional and cultural differences, 16 football players in Oman fasting during Ramadan were assessed at the same time.

On specific test days three weeks before Ramadan, during the second and fourth weeks of Ramadan and into the third week after Ramadan, performance tests (sprint, dribbling, vertical jump, agility, passing, shuttle run) were conducted together with blood tests. In addition, all players completed the daily questionnaire on subjective feelings and perception of training difficulty in the three weeks before and the four weeks of Ramadan. Food and fluid intake was recorded by 24-hour recall three times during each phase of the study before, during and after Ramadan.

Results

There was an increase in daily energy intake during Ramadan in the non-fasting group with a concomitant increase in body mass over the month. Energy intake was relatively stable in the fasting group, but there was a small decrease of approximately 0.7 kg in body mass during Ramadan. Ramadan fasting had some effects on diet composition with intake of some specific nutrients decreased, but the effects were generally small even though the pattern of eating was very different. The daily water intake was high throughout the study period, reflecting the training load and high temperatures. Water intake increased on average by 1.3 l/day in line with the greater energy intake in the non-fasting group. After Ramadan, the dietary variables reverted to the pre-Ramadan levels.
In the youth football players observing Ramadan during the Tunisian residential training camp, none of the performance variables was negatively affected by fasting while nearly all variables showed significant improvement at the third test session. Changes in performance were most likely due to the effects of training and familiarity with the tests. The results of blood tests showed that the changes in eating time and frequency during Ramadan fasting, along with the continuation of normal training load, had no important effect on metabolism.

Finally, fasting players reported that they felt slightly less ready to train during the Ramadan fast. However, there was no increase in their perceived effort during training or in their assessment of training difficulty compared with their ratings before Ramadan, or with that of the non-fasting players during Ramadan. The fasting group consistently reported having about one hour less sleep per night throughout Ramadan without noticing their sleep quality to have altered. However, the fasting players reported an increased feeling of tiredness and a slight decrease in their ability to concentrate. During the two week period after Ramadan, the modest changes reported by the fasting subjects reverted back to their pre-Ramadan levels.

The 16 fasting players in Oman following their usual lifestyle during the month of Ramadan confirmed that the shift in food intake and the changes in sleep habits during Ramadan had varied effects on physical performance. Their perception of training and other perceptual feelings were constant over the eight weeks and most of the performance tests were unchanged throughout the study.

We recommended that players should ensure adequate sleep and good nutrition during Ramadan to preserve football performance and general health. The effect of changed sleeping and eating patterns will depend on the length of the daylight period, weather conditions and other environmental and cultural factors.

What we learned from the study

Previous studies by others and our own study in 2004 had shown decrements in performance and subjective variables during Ramadan. In this F-MARC study however, biochemical, nutritional, subjective well-being and performance variables were not adversely affected in young male football players who followed Ramadan fasting in a controlled training camp environment. Based on our data, the changes in the timing of food intake and sleep patterns during Ramadan had little effect on objective tests of physical performance. In fact, physical performance generally rather improved, but match performance was not measured.

**Duration:** 2006 - 2007

**Countries:** Tunisia, Oman

**Cooperation:** School of Sport and Exercise Sciences, Loughborough University, Loughborough, United Kingdom; National Center for Medicine and Scientific Research in Sport, Tunis, Tunisia; Orthopaedic Sports Medicine Unit, Khoula Hospital, Muscat, Oman

**Reference:**
5.2.3 Ramadan and Sports Performance

**Why a consensus on Ramadan and Football?**

Fasting during Ramadan is one of the five pillars of Islam faith when Muslim believers are asked to refrain from eating and drinking from sunrise to sunset. Ramadan is held in the ninth month of the Muslim lunar calendar, and includes a phase shift in the cycles of eating and sleeping. Fasters eat a large meal to break the fast (Iftar after sunset), and an equally important meal before sunrise (Sohour) to get them through the morning hours. Depending on day length this can result in a sleep deficit, however, most surveys have shown that there is little change in the caloric intake of 24 hours during Ramadan.

The decision to compete, train and observe Ramadan during the holy month should always be the athlete’s individual choice. The manner of observance of Ramadan varies between cultures. Athletes who are training or competing should aim to minimise the disruptions to their lifestyle while following culturally appropriate practices.

It is easy to assume that an athlete’s performance will be affected if he or she is unable to eat or drink before, during or after training and/or competition. There has, however, been surprisingly little attention paid to the potential implications of Ramadan fasting for elite athletes. Studies carried out under the auspices of the F-MARC have suggested that effects on the performance of football players who pay careful attention to training, nutrition, and lifestyle factors are less than might be expected (see also chapter 5.2.1 and 5.2.2).

The purpose of the meeting was to collate and review the evidence relating to all aspects of Ramadan and sports performance with the aim of establishing practical recommendations for athletes, support staff, and sports governing bodies.

**What we learned from this consensus meeting**

Where possible, players should move the schedule of training to a time of day that allows for appropriate nutrition support. Iftar provides an opportunity to adapt or supplement meals in quantity/quality to meet specific needs for fluid, carbohydrate, and protein, especially for recovery after a recent exercise session as well as needs for the day. The athlete should make use of special sports foods and beverages to reduce gastrointestinal discomfort from eating around exercise sessions. Carbohydrate-rich foods should be consumed at the break of fast, at the meal before dawn, and at other meals during the evening, especially where these meals represent intake before, during or after exercise. Athletes should, if possible, eat immediately after exercise to enhance refuelling rate and should consider low carbohydrate choices at the meal consumed before dawn to allow slow release of glucose. Athletes should try to consume at least 20g of rapidly digested and absorbed high-quality protein soon after exercise, as well as high-quality protein-rich foods at each meal opportunity during the evening and before dawn. Consumption of “slow” proteins at meals consumed before dawn to help with protein balance over the day is advised. Souhour should be eaten as close as possible to sunrise and players should choose foods that contribute to sports nutrition needs for the day.

Where hydration is likely to be compromised, athletes should minimise unnecessary water losses by avoiding or limiting heat exposure and unnecessary exercise. Strategies to limit requirements for sweating during training and competition should include careful choices of clothing, cooling strategies, and limitations to warm-up. To limit the risk of development of progressive hypo-hydration, regular monitoring of hydration status of athletes should be undertaken using one of the recognised markers of hydration status. The Souhour meal should be chosen with a view to fluid requirements over the day. Adding energy and inorganic solute (in particular sodium) will reduce the post-meal diuresis and promote fluid retention. Fluid intake should be spread over the waking hours after sunset, with frequent small drinks rather than few large drinks.

Athletes should ensure adequate sleep during Ramadan, possibly including an afternoon nap if night-time sleep is delayed or interrupted. Athletes should avoid napping at an inappropriate time for prolonged periods, as this will make subsequent sleep more difficult and prolong the adjustment of the biological clock. Training in the
early evening may speed the onset of sleep, but training at that time should be followed by adequate food and fluid intake to promote recovery and to support training goals.

**Summary**

Currently, there is no single strategy for adaptation, and the best advice is the individual approach. The available evidence indicates that high-level athletes can maintain performance during Ramadan if physical training, food and fluid intake, and sleep are appropriate and well controlled. Individualised monitoring of athletes may help to prevent fatigue and overtraining and to reduce the risk of consequent illness and injury. However, competition organisers should consider the needs of Muslim athletes who are fasting, when choosing the dates of events and the scheduling events in the month of Ramadan to begin 2–3 hours after sunset is encouraged.

**Duration:** 2011  
**Countries:** International  
**References:**  
Ramadan and Football (2012). Supplement of the J Sport Sci 30(S1) (for details see Bibliography)
5.3 Use of Medication and Nutritional Supplements in FIFA Competitions

Why we conducted these studies

Public interest in the intake of medication by sportsmen focuses on doping, meaning the abuse of illegal substances such as anabolic steroids with the aim of performance enhancement. FIFA was one of the first international federations to adopt stringent anti-doping measures in 1970, and since then has meticulously recorded illegal abuse. The extremely low incidence of positive doping tests in professional football is testament to the success in protecting players from this health risk. However, legal substances prescribed for treatment may also endanger players’ health due to adverse effects, accentuated by excessive use over an extended time period. Eighty percent of the athletes participating in the Olympic Games 2000 were found to use some sort of medication. Studies in professional footballers had indicated a rather high intake of both supplements and of non-steroidal anti-inflammatory drugs (NSAIDs). The FIFA Medical Committee had since long been concerned about the extensive use of prescribed drugs in elite football. Therefore, just before the 1998 FIFA World Cup™ in France a new initiative was launched to record the use of medication and nutritional supplements in each player prior to each match on the doping control form. F-MARC then decided to analyse these data not only for FIFA’s flagship event, but also for the youth and women’s competitions to get a clearer picture of the magnitude of the use of medication and the health risks associated with this practice in elite football.

Aims of the studies

- Examine medication use in male top-level football players prior to and during FIFA World Cup™ competitions
- Examine medication use in FIFA Women’s World Cup™ and FIFA U-17 and U-20 World Cups

How we collected the data

On the form to be completed prior to doping control at the 2002, 2006 and 2010 FIFA World Cups™, the FIFA Women’s World Cups™ 2003 and 2007, and the FIFA U-17 and U-20 World Cup 2005 and 2007, all team doctors were asked to list any medication taken by the players or administered to them in the 72 hours preceding the match. The team doctors also had to note down any non-prescription medicines or food supplements taken by the 23 players of their team.

Substance intake was calculated as follows:
- substance / player / match (mean intake per player)
- number of individual players reported to be using a substance
- substance / player / competition

Results

At the two FIFA World Cups™ (2002, 2006), a total intake of 10,384 substances was documented, of which more than half were classified as nutritional supplements. The average consumption in 2002 and 2006 per player was 1.8 substances or 0.8 medications prior to each match; the same was reported in 2010 (Tab. 5.3.1). Some players took as many as seven different substances. Only one out of five players did not take any medication. NSAIDs were the most frequently prescribed substances, accounting for almost half of all medications used. More than half of the players took NSAIDs at least once during the competition and almost one third prior to a match. By 2010 the number of players taking NSAIDs per match increased significantly (p<0.01). The range of medication reported was from 0.22 to 3.13 per player per game; NSAID prescription ranged nearly 20-fold – from 0.06 to 1.17 NSAIDs per player and per match. Differences in prescription practice varied enormously among countries.

Significantly more nutritional supplements were prescribed in 2006 than in 2002 (not reported in 2010), mostly vitamins (41.1%), followed by minerals (21.2%). There was no correlation between the final ranking of the team and the mean number of medications taken per match.

In the two women’s and four youth competitions, a total use of 6,577 medical substances was recorded with an average consumption of 0.63 substances per player per match, the maximum being nine substances in one player. In 37.9% (3,959 out of 10,456) of all player reports, the consumption of at least one form of medication prior to the match was declared. In female players, the intake of medication per match (50.1%) was significantly higher than that of youth footballers in either age category (U-17 34.2%, U-20 33.2%; Fig. 5.3.1). NSAIDs
were the most frequently prescribed group of substances, representing 38.9% of all reported medication.

**Recommendations on NSAID use:**
- Lowest possible dose and for shortest possible period
- One preparation at a time
- Prudent application in asthmatic patients
- Avoid long-term use
- Lower gastro-intestinal adverse effects by using paracetamol

Notably, female players used significantly more medical substances compared with adolescent and adult male football players. Of particular concern was the extensive use of NSAIDs in all groups, which is not supported by scientific evidence. While these drugs have an uncontested painkilling effect, the high prevalence of considerable side effects, particularly with extensive and long-term use, is well known. More than that, their influence on the healing process is controversial and alternative substances are well known. However, despite the recommendations for their restrictive use, the use of NSAIDs appears to have been broadened to almost any painful condition in football. Similarly, there was a high consumption of nutritional supplements though very little scientific evidence exists regarding their beneficial effects in football.

These timely data suggest that medications are widely prescribed in elite sport and this may not be consistent with guideline advice. Given that elite players and physicians working at the elite level are role models, it is time to seek better and safer alternative management methods for performance continuation in professional athletes.

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**What we learned from the studies**

The data from the 2002, 2006 and 2010 FIFA World Cups™ showed that there was no change in the high use of medication despite several preventive measures. It had been postulated that there are four types of medication use in professional athletes: legitimate therapeutic use, performance preservation (treatment of sports injuries), recreational/social use, and performance enhancement. While the high intake of medication at the five FIFA World Cups™ and the four youth World Cups was alarming indeed, F-MARC could not scrutinise the underlying motivations for such use.

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**References:**
5.4 Age Determination using MRI

5.4.1 Developing a Methodology and Application in FIFA U-17 Competitions

Why we conducted these studies

FIFA as well as the confederations have established age limited competitions to guarantee equal competitive opportunities to the different age groups. Unfortunately, registration at birth is not compulsory in some African and Asian countries, and suspicion has been raised that some players might be older than the documented age stated in their eligibility documents. Obviously, this discrepancy leads to unequal competition as physical maturity, and thus age, have a strong influence on the physical performance of adolescent athletes. Further, it had been shown that age, experience, body size and stage of puberty considerably contribute to the variance of some football skills. Early-maturing players are more likely to be viewed as being more “talented” because of their physical advantages over their “younger” team mates.

The discussion about age determination was initiated by the President of the Asian Football Confederation (AFC), Mr Mohammed Bin Hammam, who asked F-MARC and the AFC Sports Medical Committee for a scientific approach using valid methods in age determination.

The traditional way to estimate the age of adolescents had been the use of x-rays of the wrist as this gives an indication of the maturity of the skeleton. The problem however was that x-rays use ionising radiation and such exposure as a screening tool for chronological age in football was neither allowed by international law nor by the World Health Organization (WHO). Therefore, F-MARC wanted to assess whether the newer imaging technique of Magnetic Resonance Imaging (MRI) of the wrist, which avoids the danger of ionising radiation, might be a scientifically valid alternative as a means of determining bone age (Fig. 5.4.1.1).

Aims of the studies

- Analyse and validate the MRI examination of the wrist to determine the bone age in the age groups from 15-18 years
- Establish age-related normative values for the male population in different ethnicities and different countries
- Evaluate the age of a representative sample of football players from international U-17 competitions using MRIs of the wrist
- Compare the MRI findings of the players of U-17 competitions with the age-related normal population

How we collected the data

As a first step, a 1-VI-point rating scale for grading of fusion of the wrist bone was developed: a grade of I means no fusion at all and a grade of VI indicated completely fused bone of the wrist. A VI would indicate that the skeletal growth of the individual has been completed.

For the main study, a total of 496 healthy young football players in the age group between 14-19 years were examined in four distinct geographic and ethnic countries (Algeria, Argentina, Malaysia, Switzerland). Three independent experts assessed the MRIs without any knowledge of the age of the examined players (Fig. 5.4.1.2).

The F-MARC grading of fusion of growth plates

I. Completely unfused
II. Early fusion: minimal hyperintensity within physis
III. Trabecular fusion of less than 50% of radial cross-sectional area
IV. Trabecular fusion of more than 50% of radial cross-sectional area
V. Residual physis, less than 5mm on any one section
VI. Completely fused

In a second step, MRIs were done at four international youth competitions to compare the results. In total, 189 players were examined during the four U-17 competitions; 48 players from each of the FIFA U-17 World Cup Finland 2003, the AFC U-17 championship Japan 2004, and AFC U-17 championship Singapore 2006, and 45 players from the FIFA U-17 World Cup Peru 2005. In the last of these, three players from one team could not be examined for logistic and technical reasons.

Results

In the general player population, the average age as documented increased significantly with a higher category of fusion meaning that each increasingly older age group showed more mature bone age (Tab. 5.4.1.1). For the U-16 age group, none of the 127 players showed complete fusion, and in the U-17 group, only one player out of 130 was fused (0.8%). Meanwhile, in the U-18 group 13%, and in the U-19 group 28% of players showed complete fusion. The evaluation of the MRIs by the different experts corresponded to a high extent with each other indicating that the fusing criteria and the readability of the MRI images were appropriate.

Due to the different definitions for U-17 competitions, all players in the AFC competitions were under 17 years of age according to their document, whereas in the FIFA competitions 71% were already 17 years old. Fourteen players (15%) in the AFC and 25 players (27%) in the FIFA competitions had complete fusion of the distal radius (grade VI; Tab. 5.4.1.3). The respective values of the normative population were less than 1% of under-17-year-old players and 10% of 17-year-old players. In all four U-17 competitions, more players had the two highest degrees of fusion (grade V and VI) than in the age-related general population (AFC, 48% vs. 14%; FIFA, 61% vs. 37%).

What we learned from the studies

In consideration of the biological variability, an estimation of “true” age of an individual can only be made with a certain probability. However, in the general player population, the grades of fusion of the wrist as determined by MRI proved to be a reliable method for age determination. Age indicated by the birth certificate highly correlated with degree of fusion, and at the same time there were significant differences between age groups. But for football players from four international U-17 competitions, there was no correlation between age and grade of fusion. U-17 football players seemed in general to be more mature than a normative population of football players of the same age category. If U-17 players were categorised in age-groups according to their official documents, a higher degree of fusion was observed in all groups. Based on the MRI results of the wrist, the age stated in the official documents of the U-17 players examined might not be correct in all cases.

<table>
<thead>
<tr>
<th>Age Fusion</th>
<th>14-15y</th>
<th>15-16y</th>
<th>16-17y</th>
<th>17-18y</th>
<th>18-19y</th>
<th>19-20y</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>11</td>
<td>40</td>
<td>16</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>10</td>
<td>62</td>
<td>65</td>
<td>37</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>11</td>
<td>16</td>
<td>10</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>8</td>
<td>15</td>
<td>21</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>6</td>
<td>17</td>
<td>32</td>
<td>28</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>VI</td>
<td>1</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Tab. 5.4.1.1 Grading of fusion in different age-groups

Fig. 5.4.1.3 Percentage of subjects by age and fusion level

Duration: 2003 - 2006
Countries: Switzerland, Malaysia, Algeria, Argentina
Cooperation: Prof. Juerg Hodler, Balgrist Clinic, University of Zurich, Switzerland; Dr John George, University of Kuala Lumpur, Malaysia; Dr G Singh, Asian Football Confederation; Dr R Madero and Dr P Ortega, Buenos Aires, Argentina; Dr AY Zerguini and Dr N Abed, Algier, Algeria

References:


5.4.2 Age Determination in U-20 Players

Why we conducted these studies

In soccer, age-related tournaments play an important role in guaranteeing equal chances to the competitors for different age groups. Giving an incorrect age to compete in a lower age class allows a player to benefit from physical advantages that older players often have over their peers. An older player with advanced maturity may also increase the risk of injuries to their opponents, especially in contact sports such as soccer.

However, over-age participants are not always intentionally cheating when they play in an inappropriate team. In particular, players from developing countries in Africa, Asia, or South America often cannot guarantee the accuracy of their birth certificates, or their countries do not even issue such certificates. Therefore, the problems of international sporting federations are similar to those of judges in criminal proceedings when the adolescents accused have neither a valid identification document, nor a reliable birth certificate, or they simply do not want to give their correct age.

Today, age diagnostics of living individuals is well established in forensic sciences as well as in competitive sports, to ensure that athletes are competing fairly and with sufficient health protection. However, age estimations in this field should not rely on imaging methods that include exposure to radiation. Thus, determination of skeletal age is significantly complicated. Moreover, especially for U-20 competitions, novel morphological criteria are sought, as the skeletal maturation of hand and wrist bones is complete well before the age of 20 years.

The iliac crest apophysis has recently been shown to be of value in forensic age estimation settings using conventional projection radiography as well as sonography [20, 21]. In an anthropological approach, Coqueugniot and Weaver demonstrated that complete fusion between the apophysis and iliac bone occurs at the age of 22 years in women and 20 years in men. Therefore, the present pilot study addresses the question of whether the investigation of this skeletal region by means of a modern cross-sectional technique, such as the magnetic resonance imaging (MRI), might serve as an additional criterion for age diagnostics in U-20 soccer competitions.

Aim of the study

- Investigate the possibilities of MRI of the iliac crest apophysis for the purpose of evaluating skeletal maturation in under-20 (U-20) football players

How we collected the data

Magnetic resonance (MR) scans of the iliac crest apophysis were prospectively evaluated in 152 German male tournament soccer players aged between 18 and 22 years. The study was approved by the local ethics committee and is in compliance with German ethical standards. Written informed consent was obtained from all participants. A four-stage classification system was applied for the assessment of the apophyseal ossification.

- Stage 1 Ossification center has not yet ossified.
- Stage 2 Ossification center has ossified, physeal cartilage has not ossified.
- Stage 3 Physeal cartilage has partially ossified.
- Stage 4 Physeal cartilage has completely ossified.

If possible, further sub-classification of stages 2 and 3 into a, b, and c modified according to Kellinghaus et al were performed.

Between February and June 2011, T1 gradient echo 3D FFE sequences of the whole pelvis were performed with a 3.0 T MR system (Achieva, Philips) and an 8 elements SENSE cardiac coil. Multi-planar reconstructions allowed a simultaneous view of multiple dimensions. Ossification stages were determined for both the right and the left pelvic side. MR assessments were done by one examiner, who was unaware of the age of the individuals before and during the examinations. Results are expressed as minimum, maximum, mean ± standard deviation, and median with lower and upper quartiles. Comparison of left versus right side was done by means of Wilcoxon test. Significance was assumed at p \ 0.05 (exact, two-sided).

Results

In all subjects examined (n = 152), a reliable MR assessment of the apophyseal iliac crest ossification was possible on both pelvic sides. The ossification stages 1 to 4 were demonstrated in (Fig. 5.4.2.1 a–c). A determination of sub-stages according to Kellinghaus et al did not appear feasible because of movement artefacts, the relatively large
The key point of the study were summarised as follow:

1. There is a growing demand for establishing radiation-free imaging techniques for age diagnostics in living individuals.
2. This is the first study investigating the iliac crest apophysis for the purpose of age estimation by means of a modern cross-sectional imaging method.
3. Major ossification stages, known from forensic X-ray studies of the iliac crest, could be visualised by MRI and revealed increasing age medians with increasing stages.
4. Sub-classification of stages 2 and 3 according to Kellinghaus et al. did not appear feasible.
5. Since the statistical parameters obtained in this study did not allow for further differentiation in the cohort considered, examinations should be done in a larger cohort aged between 10 and 20 years.

MRI of the iliac crest is a suitable method in age diagnostics of living individuals. However, it does not represent an applicable criterion for age estimations in U-20 soccer players.

What we learned from the studies:

and complex anatomy of the iliac crest and its surrounding structures, as well as an insufficient image resolution. The statistical parameters according to the four-stage classification were presented in Table 5.4.2.1.

Developmental differences between the right and the left pelvic side were only found in 14 cases and were not statistically significant (p = 0.013). In these cases, the pelvic side showing the more advanced development was chosen for evaluation.

Within the five age groups investigated, ossification stage 1 was not found. Only one case showed stage 2 and can therefore not be considered as representative. Both stage 3 and stage 4 were observed between 18 and 22 years. The means steadily increased by about one year from stage 2 (18 years), via stage 3 (19 years), to stage 4 (20 years).

What we learned from the studies:

MRI of the iliac crest is a suitable method in age diagnostics of living individuals. However, it does not represent an applicable criterion for age estimations in U-20 soccer players.

<table>
<thead>
<tr>
<th>Stage</th>
<th>n</th>
<th>Min-max</th>
<th>Mean ±SD</th>
<th>Median; LQ; UQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1</td>
<td>18.1-18.1</td>
<td>18.1</td>
<td>18.1; -; -</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>18.1-22.6</td>
<td>19.5±1.3</td>
<td>19.1; 18.5; 20.6</td>
</tr>
<tr>
<td>4</td>
<td>119</td>
<td>18.0-22.9</td>
<td>20.8±1.3</td>
<td>20.9; 19.7; 21.9</td>
</tr>
</tbody>
</table>

Min age minimum, Max age maximum, SD standard deviation, LQ lower quartile, UQ upper quartile

Tab. 5.4.2.1 Statistical parameters (expressed in years)

The key point of the study were summarised as follow:

1. There is a growing demand for establishing radiation-free imaging techniques for age diagnostics in living individuals.
2. This is the first study investigating the iliac crest apophysis for the purpose of age estimation by means of a modern cross-sectional imaging method.
3. Major ossification stages, known from forensic X-ray studies of the iliac crest, could be visualised by MRI and revealed increasing age medians with increasing stages.
4. Sub-classification of stages 2 and 3 according to Kellinghaus et al. did not appear feasible.
5. Since the statistical parameters obtained in this study did not allow for further differentiation in the cohort considered, examinations should be done in a larger cohort aged between 10 and 20 years.

Duration: 2011
Country: Germany
Cooperation: University Hospital Muenster, Germany
5.5 Cartilage Injury in the Football Player

Why we conducted these studies

Football is a high-impact contact sport, which may trigger significant acute and chronic joint contact forces with potential detrimental effects on the joint surface. Due to the limited spontaneous regeneration of articular cartilage, injuries often lead to significant symptoms under the continued high demands of football ultimately resulting in the players’ inability to play. Besides loss of playing time, progressive articular cartilage degeneration and osteoarthritis have been found in up to 32% and present a major cause for disability and retirement from the sport. Sharing a deep concern for cartilage injuries in football, F-MARC and the International Cartilage Repair Society (ICRS) collaborated on research projects devoted to cartilage issues in football.

Aims of the studies

- Provide a comprehensive overview of the current knowledge of cartilage injury pathophysiology, epidemiology, and etiology
- Help advance the science and understanding of articular cartilage injury and degeneration in the football player and to investigate options for future treatment and prevention methods of articular cartilage in football
- To reduce the incidence of cartilage injury and risk of osteoarthritis in football players of all ages and skill levels

How we collected the data

A number of studies were conducted by researchers worldwide to investigate the issue of articular cartilage injury in football players. Research findings were presented in 12 scientific papers and jointly published as supplement in the journal Cartilage in 2012. While all studies made individual contributions to the illumination of the subject, they may be subsumed under the “spectrum of care” paradigm. This paradigm has been formulated for the management of articular cartilage injury and degeneration in football players with the aim of facilitating and accelerating an injured athlete’s return to play. The paradigm rests on four cornerstones: (1) prevention; (2) surgery; (3) cartilage supplementation, and (4) rehabilitation (Fig. 5.5.1).

Results

Steinwachs, Engebretsen, and Brophy established the scientific evidence base for cartilage injury and repair in the athlete. These injuries and the inherent risk of the game create an overall prevalence of knee articular cartilage lesions of 36% and up to 72%. The football player with articular cartilage injury is often faced with a significant challenge because of the high demands placed on the normal, repaired, and regenerated tissue by the game over time. The doctors showed that cartilage defects in athletes could be treated with microfracture, osteochondral autogenic or allogenic tissues but that the ultimate challenge is the quality of the repair tissue, as this must closely resemble and function like normal hyaline cartilage.

Mithoefer and Steadman investigated a case series of professional, injured football athletes, concluding that the microfracture technique followed by appropriate rehabilitation provides restoration of the knee joint function and may thus allow for a high rate of return to play. However, the doctors also pointed to the issue of deterioration of clinical results in some cases after two years.
Panics, Hangody, Baló, Vásárhelyi, and Gál established that autologous osteochondral mosaicplasty in competitive elite and recreational football players is a good alternative procedure to repair cartilage damage with best results in younger athletes with smaller lesions.

Mithoefer, Peterson, Saris and Mandelbaum demonstrated that articular cartilage repair with autologous chondrocyte implantation especially in elite football players often allows for successful return to play with excellent durability at 5 years and beyond. However, the doctors also pointed out that the disadvantage of this technique lies in the long time for tissue maturation and consequent return to play.

Görtz, Williams, Gersoff, and Bugbee described osteochondral allograft reconstruction as an increasingly popular treatment option for osteoarticular lesions in athletes. These allografts provide mature and immune-privileged hyaline cartilage on an osseous scaffold that serves as an attachment vehicle. This is rapidly replaced via creeping substitution, leading to reliable graft integration that allows for simplified rehabilitation and accelerated return to sport.

Bekkers, de Windt, Brittberg, and Saris provided a critical review of the “state of cartilage repair” in football athletes as well as a critical review of the best available evidence for cartilage surgery and treatment selection. They furthermore evaluated specific patient profiles for professional and recreational athletes and proposed a treatment algorithm for the treatment of focal cartilage lesions in football players.

Hambly, Silvers, and Steinwachs pointed out that the evidence base for rehabilitative practice after articular cartilage repair is increasing but remains sparse in areas. Articular cartilage repair may allow return to sport but rehabilitating time scales can be lengthy.

Kirkendall and Garrett developed a strategy based on the available evidence and clinical practice guidelines that includes a regiment of patient education, self-management, weight control, and exercise supported by individualised pain management strategies.

Lee and Chu revealed that the probability of developing osteoarthritis in soccer players is 5 to 12 times more frequent than in the general population. It is higher than for most elite athletes and responsible for retirement in about a third of professional players and diagnosed four to five years earlier.

What we learned from the studies

The probability of developing osteoarthritis in football players is five to 12 times more frequent than in the general population. Factors determining a successful return to football after articular cartilage repair of the knee include player age, time between injury symptoms and treatment, competitive level of participation, defect size, and repair tissue morphology. Sports and exercise participation after cartilage repair may facilitate joint restoration, functional recovery, and fitness levels. Promoting the “spectrum of care” paradigm for the management of articular cartilage injury in football players as well as encouraging players and coaches to actively incorporate the “FIFA 11+” programme into their training practice are therefore promising moves towards a reduction of articular cartilage injuries and their consequences in football. It must be noted, however, that not all players will return to football after articular cartilage repair. The next step in the FIFA/ICRS initiative will be to investigate how this progression of osteoarthritis can be delayed, with research s. a. presented by Zaslav et al in their evaluation of new frontiers for cartilage repair and protection leading the way.

Duration: 2012
Countries: International
Reference:
6 Improving Standards of Care

6.1 Football Medicine Manual and Website

6.1.1 Football Medicine Manual

**Background**

In our continuous effort to protect the health of players worldwide, F-MARC had realised that FIFA member associations were in need of a comprehensive educational tool that dealt with all medical aspects of football. While the information was mostly published, anyone interested had to go to multiple sources in sports medicine, identify and then modify the findings so that they became more applicable to football.

In spring of 2003, the preparations for the F-MARC Football Medicine Manual started. Our objective was to create a single and practically orientated resource for the medical care of the football player. In order to improve the standards of care for the millions of players worldwide that have no access to the sophisticated medical services available to elite players, the Football Medicine Manual had to primarily address those who take care of the players at grassroots level (Fig. 6.1.1.1).

As a first step, the main focus and individual topics of the publication needed to be identified. Following F-MARC’s research strategy, prevention was clearly one of the most fundamental concerns. Therefore, after addressing the epidemiology of injuries and risk management in football, one chapter was dedicated to injury prevention, but also to nutrition and doping control in order to demonstrate the comprehensive F-MARC definition of prevention. According to our findings on the frequency and characteristics of injury in football, the treatment and rehabilitation as well as return-to-play considerations of the most relevant injuries were described in individual chapters. Finally, the diagnosis, treatment and return-to-play issues of diseases being important in football were explained.

The next step was to identify the respective experts for the different topics. A list of individuals was developed not only to encompass the breadth of football medicine, but also to ensure comprehensible and practically orientated reporting on research findings to those members of the medical profession less exposed to scientific literature (Fig 6.1.1.2). In an intense workshop, the identified experts created drafts of their respective chapters, and then presented the drafts to their peers to react, to criticise and to complement on. One year later, a smaller group of the original authors gathered to edit the manuscript and finalised the English version. Football medicine colleagues from around the world were then asked to translate the Football Medicine Manual into the other three FIFA languages of French, German, and Spanish. Since then, the manual has also been translated into Arabic, Czech, Japanese, Mandarin, Polish, and Russian with more language versions being prepared.

However, the body of knowledge in football medicine continuously grows, not least because of the initiatives and activities by F-MARC. In June 2008, preparations for a completely revised second edition of the F-MARC Football Medicine Manual started. We reviewed the content of the first edition and asked the authors of the first edition for an update of their chapters. We further
assessed the need for information on additional topics that had accumulated in the meantime, and new authors were identified as needed. After editing of the original English drafts, the new edition was published at the FIFA network conference in October 2009 explicitly organised and dedicated to demonstrate the importance of medical issues to the presidents or general secretaries and one physician of all FIFA member associations. Print copies of the F-MARC Football Medicine Manual in English, French, Spanish and German are available to any sports physician and member association on request, and also distributed at F-MARC conferences and courses. Member associations who are interested in translating and publishing the manual in their individual language can enter into an agreement with FIFA that entitles them to translate and publish a specified number of copies within their language region. A pdf-file is available as a download from the football medicine extranet of F-MARC.

![Fig. 6.1.1.2 Cover of the second revised edition of the F-MARC Football Medicine Manual](image)

**F-MARC PROJECTS | IMPROVING STANDARDS OF CARE**

**Duration:** 2003 - ongoing  
**Countries:** International  
**Cooperation:** International  
**References:**  
6.1.2 Emergency Medicine Manual

Why we conducted this project

Large-scale football tournaments are cheerful celebrations of the world’s most popular sport. However, multiple casualty management may be needed when such mass gatherings take place, and that there is a demand for a structured football emergency medicine education for all health care providers involved. The Football Emergency Medicine Manual, published in the forefront of the 2010 FIFA World Cup™ in South Africa, reflects FIFA’s dedicated and comprehensive approach to the protection of players, spectators and actors involved, or present, in mass football events. Written for and from the perspective of the team and event physician to facilitate their work, the manual carefully addresses matters to be considered in the planning and organisation of medical services for mass football events, and offers scientific advice as well as hands-on guidance for a variety of incidents that may occur on, or around, the pitch.

Events leading to the publication of the FIFA Emergency Medicine Manual

In 2004, upon its nomination as host of the 2010 FIFA World Cup™, South Africa and its Local Organising Committee carried out an analysis, which revealed that the country would have to manage not only large numbers of constituents, but also an extensive geographical area and a range of conditions. Also, it became obvious that there would be overlapping and common interests between the sports medical and emergency medical staff operating during the upcoming World Cup, and that football medical practitioners would have to be able to “convert” from sports practitioners to “emergency” practitioners in case this was needed. The introduction of a preparatory education programme in the form of a three-day Football Emergency Medicine course was a first step taken as a consequence of these insights. In a next step, and with the support of FIFA and F-MARC, it was then agreed to write a specific manual that would provide prospective event physicians with the required knowledge and skills enabling them to function with confidence in the positions assigned to them during the World Cup: the idea for the Football Emergency Medicine Manual was born.

What the manual offers

The Football Emergency Medicine Manual comprises four chapters, each of which offers valuable insights and guidance on different aspects of football emergency medicine in the scope of mass football events (Fig. 6.1.2.1):

(1) A thorough introduction in chapter one identifies and explains the need for football emergency medicine, and presents a structured approach to planning. According to this approach, there are eight matters to be considered in the planning and organisation of medical services for football events of different sizes and at different levels of play nationally and internationally: (a) Constituents; (b) Locations; (c) Conditions to cover; (d) Jurisdiction; (e) Duration; (f) Services; (g) Personnel; and (h) Facilities.

(2) The second chapter provides an overview of the basic principles of multiple casualty management in football; of the principles of football stadium mass gathering medicine; and of emergency medical logistics at FIFA competitions. Furthermore, the basics of managing life-threatening incidents are conveyed for acute instances such as acute cardiac arrest, acute anaphylaxis, acute hypoglycaemia, acute generalised seizure, and acute potential spinal injury. Key definitions, checklists, step-by-step explanations and helpful advice in the form of memo boxes are provided as well, thus allowing readers to immediately apply the newly acquired knowledge to their medical practice. A risk classification of football matches presented under the headings “low”, “moderate”, and “high” aids the reader in gauging the degree of risk prior to a football match. Furthermore, advice regarding the minimal standards in medical mass gathering services, as well as regarding the recommended number and qualifications of health care providers in football stadium mass gathering are given, and detailed suggestions concerning the necessary equipment are made.

(3) Chapter three outlines the possible spectrum of medical emergencies on the pitch. It gives detailed guidance for team and event physicians on how to handle the most frequent life-threatening injuries and incidences on the pitch, musculoskeletal injuries requiring emergency treatment and facial injuries. In this context, reference should be given to sudden cardiac arrest (SCA), which is known as the most important cardiac emergency in football, potentially leading to sudden cardiac death (SCD). SCD during a football match should be avoided at all
costs, and the most effective way of preventing SCD is a cardiovascular screening through a thorough pre-season or pre-competition medical assessment (see chapter 4.1). The most definite and effective form of treatment for SCA on the pitch is defibrillation within one to three minutes. The Football Emergency Medical Manual offers valuable advice on the diagnosis and treatment of concussion and SCA, as well as on a number of other potentially life-threatening injuries.

(4) The fourth chapter looks at environmental factors such as weather, altitude, pollution and aeroallergens, and explains which effects different playing environments may have on the condition of players and teams. Because of the particularities of geographic locations, visiting national teams may be confronted with playing situations that are not only at different altitude, but also under different environmental conditions such as heat, cold and different relative humidity, as compared with their home country. The Football Emergency Medicine Manual lists risk factors, gives advice on how impairment and illnesses due to, e.g. heat, can be prevented, and outlines signs and symptoms of conditions induced by environmental factors and how they should be treated.

**Availability and distribution**

In order to disseminate the knowledge compiled in the Football Emergency Medical Manual, print copies are made available in English, French, Spanish, and German to any sports physician and member association on request. Furthermore, the manual is distributed at F-MARC conferences and courses.

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**Fig. 6.1.2.1 The FIFA Emergency Medicine Manual**

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**Duration:** 2004 - 2009  
**Countries:** South Africa, Switzerland  
**Cooperation:** Department of Emergency Medicine of the University of Witwatersrand, Johannesburg, South Africa  
Players should always be approached and managed by the “ABCDE (Airways-Breathing-Circulation-Disability-Expose/Examine)” approach. This approach is applicable for assessing all injuries you encounter on entering the football or training field of play for player injuries and is not just applicable to Basic Life Support (BLS).

The aim of the First Aider is to ensure what is known as the 3Ps:
- Preserve Life - Prevent deterioration of the player’s health situation - Promote Recovery

Wounds and bleeding
This chapter focuses on the ability to recognise that bleeding (external/ internal) is taking place and on how to stop it. It is one of the most important aspects of first-aid casualty survival.

The assessment of the severity of the bleeding and the management of a wound centres on:
- Control of bleeding
- Prevention of infection
- Prevention of further complications

Soft tissue injuries
This chapter describes signs and symptoms of a soft tissue injury, which can be very similar to those of a fracture (broken bone). A fracture must be ruled out by careful evaluation before continuing to manage the injury. This may require the player being first seen by a doctor or therapist.

For treatment of soft tissue injuries use the P.R.I.C.E. (Protection, Rest, Ice, Compression and Elevation) regime.

Bone injuries
This chapter focuses on the signs and symptoms of bone injury. All fractures, even if only suspected, should be immediately referred to the hospital for investigation and management.

A fracture can be classified into different types: (1) “Closed”, (2) “Open”, (3) “Complicated” and “Greenstick fracture”.

Signs and symptoms of fractures are:
- Pain at the site of the injury (can be severe pain).
- Weakness/loss of power
- Abnormal/unnatural movement
- Swelling
- Deformity/irregularity
- Crepitus

6.1.3 First Aid Manual

Why we conducted this project
This booklet is designed for use by coaches and non-medically qualified First Aiders working within football around the world and specifically in the developing countries. It is a short and practical guide to dealing with injuries and illnesses, mainly on the field of play, both in training and in matches (Fig. 6.1.3.1). It provides a comprehensive guide to immediate first aid management of player injuries and illnesses from critical to minor. The intentions have been to provide a “holistic” view of first aid because of the limited medical resources that may exist. It also advises on appropriate return to play guidelines for a wide range of conditions and advises on equipment the First Aider should carry to all events when dealing with players (Fig. 6.1.3.2). This manual may be of use to those therapists and doctors just starting out in their football medical careers.

What the manual offers
This manual outlines firstly the roles, duties and responsibilities of the First Aider under any circumstances and level of resources. It recommends the “best first aid practice within the limited resources of a developing country”, if it is not possible to practice at this level, do the best you can whilst you slowly increase the standard of first aid practiced. In order to achieve this, each of the following points should be followed by the First Aider in charge of training or a match: (a) Scene safety, (b) providing a safe environment – hygiene and hand washing, (c) content of a first aid kit, (d) clean water, (e) injury recording and (f) prevention.

Secondly, the First Aid Manual comprises six chapters, each of which offers practical insights and guidance for any First Aider to dealing with different aspects and levels of injuries and illnesses.

• Assessment of the unresponsive casualty and basic life support
This chapter describes the approach and management of the many potential causes of a player becoming unresponsive on the field of play. The most common causes are: Sudden Cardiac Arrest, Asphyxia (Choking), Shock, Head Injury, Heat Exhaustion, Epilepsy, Diabetes, Fainting.
• **Injuries to the head and neck**
  This chapter focuses on the potential head and neck injuries. It is important to have an awareness of the potential problems that can occur to a player who suffers an injury to the head and/or neck. It is important that you deal with all known or suspected spinal injuries (fractures) and dislocations quickly and correctly. Proper immobilisation and player management may mean the difference between complete recovery and lifelong paralysis, or even death.

  Injuries to the head and neck can be very serious and occasionally fatal. A neck injury should be considered for:
  
  • any injury occurring above the collar bone;
  • any head injury with loss of consciousness;
  • and where abnormal flexion or extension of the neck has occurred; or
  • a clash of heads, resulting in the player having an altered level of consciousness.

• **Medical emergencies that may occur in football**
  This chapter outlines “other” conditions that might require first-aid attention that are not a direct result of football participation but are conditions that the player may suffer from (such as asthma, diabetes, epilepsy, heart disease) during football training or matches.

  It is advisable when working as a First Aider in a team environment, that for every new player signing, and also at the start of each season, First Aiders ask the players to complete a questionnaire asking about their previous medical history and illnesses so that they are aware of any underlying medical conditions the players might have as well as previous injuries that they have suffered. If the players are below the age of 16, the parents may need to complete the form.

**Availability and distribution**

In order to disseminate the knowledge compiled in the Football First Aid Manual, print copies are made available in English to any sports physician and member association on request. Furthermore, the manual is distributed at F-MARC conferences and courses.
6.2 Consensus Statements and Recommendations

6.2.1 Recommendations for Diagnosis and Treatment of Concussion in Sport

A revision and update of the recommendations developed following the first (Vienna 2001), second (Prague 2004) and third (Zurich 2008) International Consensus Conferences on Concussion in Sport is based on the deliberations at the fourth International Conference on Concussion in Sport held in Zurich in November 2012. At each conference, a number of experts in the field were invited to address specific issues of concussion in sport such as epidemiology, basic and clinical science, injury grading systems, cognitive assessment, new research methods, protective equipment, management, prevention and long term outcomes. At the conclusion of each conference, a small group of experts drafted a document describing the position reached by those in attendance at the meeting. These consensus documents were then co-published in different journals of sports medicine. Further, a practical tool for physicians was developed, aiding in the systematic assessment of a player with a head injury at the sideline, whether at the recreational, elite or professional level.

The new 2012 Zurich Consensus Statement is designed to build on the principles outlined in the previous documents and to develop further conceptual understanding of this problem using a formal consensus-based approach.

This consensus paper is broken into a number of sections
1. A summary of concussion and its management, with updates from the previous meetings;
2. Background information about the consensus meeting process;
3. A summary of the specific consensus questions discussed at this meeting;
4. The consensus paper should be read in conjunction with the SCAT3 assessment tool, the Child SCAT3 and the CRT (designed for lay use).

What we learned from the meetings

At the fourth conference in Zurich 2012, a panel discussion was held regarding the review of the definition of concussion and its separation from mild traumatic brain injury (mTBI). Minor revisions were made to the “Definition of Concussion”, which is defined as follows:

• Concussion is a brain injury and is defined as a complex pathophysiological process affecting the brain, induced by biomechanical forces. There are several common features that incorporate clinical, pathologic and biomechanical injury constructs that may be utilised in defining the nature of a concussive head injury.
• Concussion may be caused either by a direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head.
• Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.
• Concussion may result in neuropathological changes but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury.
• Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follows a sequential course.
• Concussion is typically associated with grossly normal structural neuroimaging studies.

Return to play guidelines

One of the critical issues in “Concussion Management” are the “Return to Play (RTP)” guidelines, which were already a focal point at the Prague Conference. The cornerstone of the most updated concussion management is physical and cognitive rest until the acute symptoms resolve, and then a graded programme of exertion prior to medical clearance and RTP follows (Tab. 6.2.1.1):

In the case of complex concussion, rehabilitation will be more prolonged and return to play decisions will be more cautious. Such complex cases should be managed by physicians with a specific expertise in the management of concussion injury.

The Sport Concussion Assessment Tool (SCAT) was developed as part of the conclusions of the second consensus conference. This tool represents a standardised method of evaluating players after a suspected concussion in football. SCAT2 was created following the third consensus meeting and has two forms – a sideline assessment form for team doctors and coaches and a more detailed medical evaluation form (Fig. 6.2.1.1).

A future SCAT test battery (ie. SCAT3) should include an initial assessment of injury severity using the Glasgow Coma Scale (GCS), immediately followed by observing and documenting concussion signs. Once this is complete, symptom endorsement and symptom severity, as well as neurocognitive and balance functions, should be
assessed in any athlete suspected of sustaining a concussion. It is recommended that these latter steps be conducted following a minimum 15 minute rest period on the sideline to avoid the influence of exertion or fatigue on the athlete’s performance. Although it is noted that this time frame is an arbitrary one, the expert panel agreed nevertheless that a period of rest was important prior to assessment.

It was further agreed that the SCAT3 would be suitable for adults and youths aged 13 and over and that a new tool (Child SCAT3) be developed for younger children.

Duration: 2001 - ongoing

Countries: International

Cooperation: Concussion in Sport Group

References:


6.2.2 Nutrition for Football

Why we held this meeting
Whenever highly talented, motivated and well trained players meet in competition, the margin between victory and defeat is small. Attention to detail can make that vital difference. Diet affects performance, and the food that we choose in training and competition will affect how well we train and play. While the basic components of nutrition are a constant, food selection and preparation varies considerably around the world. Therefore, F-MARC convened a consensus group of experts in the field to meet in Zurich in September 2005 to discuss the state of the art and the body of knowledge in nutrition and performance in football in order to prepare information material that would improve the health and performance of players worldwide. This group presented papers about the vital topics of nutrition and sports performance, which were then discussed by all experts.

“The food and drink that players chose to consume can affect how they perform in sport and help them to stay fit and healthy. All players should choose food wisely to help achieve their goals in sport.”
FIFA President Joseph S. Blatter

What we learnt from the meeting

Diet affects performance
A diet rich in carbohydrates supports the running demands of the game. The player who has chosen a nutrient-rich diet with plenty of carbohydrates will run farther and faster late into the game, execute skills accurately, make better decisions and prevent injuries.

Every player is different
There is no single diet plan that will meet the needs of every player in every circumstance. Training demands, match and travel schedules, injuries and more require considerable flexibility in food selection.

A good diet will support consistent training
The greatest emphasis on nutrition and performance is usually directed at match performance, but a sound nutrition plan has its greatest impact on training. The well-fuelled player will be able to handle more intense training that will improve fitness while reducing the risk of illness or injury. In addition, the foods chosen affect the adaptive processes by the body.

Get the right amount of energy
It’s not just making the right choices. The volume of food is important. The demands of training mean the player will eat a large volume of food. The hard part is matching the calorie intake with the energy output. Eat too much and body weight increases. Eat too little and body weight decreases leading to poor performance, illnesses and injury.

Choose the right foods to meet energy needs
The bulk of the diet should be carbohydrates and there are different kinds of carbohydrates. The nature of the carbohydrate influences how fast it is taken in by the cells. There is an interaction of the type of carbohydrate and the time from the last and to the next exercise session. Optimal recovery strategies need to consider not only choosing carbohydrates, but what type of carbohydrate and when it is eaten in relation to training and matches.

A varied diet supplies adequate protein
Carbohydrates are the primary source of energy for exercise. But after physical work, the body needs to repair damaged tissues and adapt for the next workout. Repair and adaptation occur in the cells and require protein. Most diets consumed by athletes contain sufficient protein so eating more protein is not necessary for most players. Even a well thought out vegetarian diet will be adequate to meet protein needs.

Energy needs are met with a varied diet of nutrient-rich foods
Athletes who pay attention to their diet tend to focus an unreasonable amount of attention just on carbohydrates. A varied diet also included vegetables, fruits, beans, legumes, cereals, lean meats, fish and dairy products. Only with a wide selection of foods will the player realise intake of all the necessary vitamins and minerals. Excluding any food group in an attempt to regulate calories intake is discouraged.

Hydration is important for performance
Fluid intake before, during and after exercise is critical, especially in hot environments. When temperatures are extreme or when sweat losses are high, food and drinks are needed in order to replace vital fluids and salts. Small amounts of dehydration will affect performance and the player needs to be aware of the role dehydration plays in performance and work to keep sweat losses to a minimum.

The indiscriminate use of dietary supplements is discouraged
When a player makes good choices from all food groups, there is little need to add supplements to their diet. This is especially important in players who might be com-
peting at a level where doping controls are taken. A substantial fraction of supplements contain unlabelled ingredients that might trigger a positive doping test and end up with painful sanctions.

**Nutrition in lay terms**

The members of the consensus group published their findings in the Journal of Sport Sciences in 2006 (Fig. 6.2.2.1). The level of detail and scientific depth was clearly beyond the level of understanding of the football family. A working group therefore synthesised the information and prepared an easy-to-read lay summary of the conference in the booklet “Nutrition for Football” (Fig. 6.2.2.2). This summary is available in English, Spanish, German and French and posted on FIFA.com as a free download. This booklet also contains special messages for the elite player, the semi-professional, the amateur, females, the young player, the referee and suggestions for eating while travelling. From this, the football family now has an accessible summary of the importance of nutrition in football performance and health.

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*Fig. 6.2.2.1 Supplement: “Nutrition and Football”*

*Fig. 6.2.2.2 “Nutrition for Football. A practical guide to eating and drinking for health and performance”*

**References:**

6.2.3 Medical Issues of the Female Football Player

Why we conducted this project

FIFA staged the first FIFA Women’s World Cup™ in the People’s Republic of China in November 1991. Ever since then, the standards of play had risen, new youth competitions at world level were created, professional leagues were established in various countries, public interest grew and women’s grassroots football continuously broadened. In 2007, according to the Big Count survey, there were some 26 million girls and women who played football in over 180 countries.

When F-MARC did their first review of the literature on injuries, it became clear that the body of knowledge with regard to women’s football was scarce. In FIFA’s view however, it went without saying that in terms of medical research and instruction, women’s football deserves the same attention as the men’s game. F-MARC conducted several studies that added to what was known on injuries and their prevention in the female player. Prior to the FIFA Women’s World Cup China 2007™, we wanted to establish and update the current evidence of football medicine in women and asked experts worldwide for their contributions. The scientific supplement covered all aspects of injury causation, incidence on different surfaces and of course prevention, particularly addressing ACL tears and head injuries, and nutrition, as well as the problem of the female triad in football (Fig. 6.2.3.1).

Female football medicine in laymen terms

Following the strategy of translating scientific information into an easily comprehensible language that had proved successful with the nutrition booklet, F-MARC created a new publication for the female player, adding information on bone health and specific women’s issues. From this, the female player can now learn everything they need to know about e.g. their specific risk of ACL tears and how to prevent them, what to eat prior to and after a match or how to protect their bones. The booklet was published and distributed on occasion of the FIFA Women’s World Cup 2007™ (Fig. 6.2.3.2) and is available in English, Spanish, German and French and posted on FIFA.com as a free download.
Duration: 2006 - 2007
Countries: International
Cooperation: Schulthess Clinic and University of Zurich, Zurich, Switzerland; University of Nottingham, UK; Loughborough University, UK; Santa Monica Orthopaedic Sports Medicine and Research Foundation, US; National Collegiate Athlete Association and Indiana University, Indiana, US; University of North Carolina, Chapel Hill, US; Duke University, Durham, US; Oslo Sports Trauma Research Center and Norwegian School of Sports Sciences, Oslo, Norway; University of Melbourne, Australia

References:
Health and Fitness for the Female Football Player. A guide for players and coaches (2007). FIFA, Zurich, Switzerland
Why we conducted this project

Whenever a team needs to compete in a location that is either at considerably higher or lower altitude than their home address, they will note differences in their performance. If they have been travelling from low to high altitude, they may also suffer from health impairments such as headache, impaired sleep and nausea. The international match schedule often does not allow for extended stays at one spot in order to enable acclimatisation. Questions related to health, performance and fair play under these circumstances had been a matter of intense debate within the football family for a long time.

The FIFA Sports Medical Committee and F-MARC therefore invited twelve international experts to a meeting in Zurich from 25-27 October 2007. The major focus of the meeting was the current body of knowledge on hypoxia, athletic performance, and playing football at different altitude. All experts prepared an overview article on their respective subject. According to the results of the discussion at the meeting, the individual articles were reviewed and published in a scientific supplement, providing a unique summary of what is known on playing football at different altitude (Fig. 6.2.4.1).

What we learnt from the meeting

The experts agreed on a new classification of altitude, the rationale being based on the effects of hypoxia on exercise performance and health:

- near sea level (0-500m)
- low altitude (>500m – 2000m)
- moderate altitude (>2000m – 3000m)
- high altitude (>3000m – 5500m)
- extreme altitude (>5500m)

Players living at sea level or low altitude will have to cope with a reduction of their performance when playing at moderate and high altitude which continually increases with the level of altitude. Highly trained players suffer higher reductions in performance than untrained individuals.

Recommendations on playing at different altitude

For players ascending from sea level to low altitude, a short acclimatisation period of three to five days may be useful to approach peak performance as from 1500m and above. In players ascending from sea level to moderate altitude, an acclimatisation period of one to two weeks at the location of the match is recommendable to approach peak performance. In players ascending from sea level to high altitude, an acclimatisation period of at minimum two weeks at the location of the match is required to achieve peak performance.

Acute Mountain Sickness (AMS), High Altitude Pulmonary Edema (HAPE) or High Altitude Cerebral Edema (HACE) do not occur below 2000m. HAPE and HACE are life-threatening diseases that can, however, be easily treated by supplemental oxygen and descent.

At moderate altitude, the risk of AMS for players living at sea level or low altitude is low and the illness usually mild, HAPE and HACE hardly ever occur. At high altitude, the risk of AMS is considerable for players living at sea level or low altitude and the illness can be more severe. Without proper treatment AMS may progress to HACE. HAPE may occur, particularly above 4000m. The risk of AMS for players living at sea level or low altitude depends on their individual susceptibility, the degree of acclimatisation, the rate of ascent and the intensity of exercise. AMS symptoms such as mild headache, loss of appetite, impaired sleep or dizziness do not prevent a healthy player from playing, but might still impair performance.

Staged ascent will prevent severe high altitude illnesses in players from near sea level or low altitude when playing a match or competition at high altitude. For each 300-500m above 2000m, one day of acclimatisation should be spent at an intermediate moderate altitude. In susceptible individuals, AMS can be prevented by drugs such as acetazolamide or glucocorticosteroids, but these are both prohibited substances in sports.

Limitations of the findings

Most studies on sports at high altitude involved individual athletes in specific sports which cannot always be generalised for team sports such as football. When playing at different altitude not only the absolute level of
altitude, but also the difference between the starting (living) level and the playing level are of importance. There is a high individual variability in the adaptation process to altitude, which has to be considered when analysing the performance of an entire football team. Further, studies with sufficient statistical power are seldom available as regards elite players and studies on recreational athletes or untrained subjects may not be relevant for the elite athlete. Further, while we have a fairly good knowledge about performance and training at moderate to extreme altitude with regards to aerobic exercise, little is known about intermittent high intensity exercise such as playing football. Finally, it is important to understand the influence of environmental conditions such as heat, cold and humidity on the health and the performance of players.

The organisers of the consensus meeting on football at different altitude, (Dr M. D’Hooghe, Prof. P. Bärtsch, Prof. B. Saltin, Prof. J. Dvůřák)

Experts of the consensus meeting on football at different altitude 2008 in Zurich

**F-MARC PROJECTS | IMPROVING STANDARDS OF CARE**

**Duration:** 2007 - 2008  
**Countries:** International  
**Cooperation:** Prof. Bengt Saltin, Denmark, Prof. Peter Bärtch, Germany, and all experts participating

**Reference:**  
6.2.5 Playing Football in Hot Environments

Why we supported these studies

Today’s international competition schedules in football require elite players to perform throughout the year and world. In addition to dealing with the challenges of long-distance travel and multiple time-zone crossings, extreme environmental conditions at the destination may pose considerable additional challenges to players and support staff. The issue is further complicated by the fact that the host team is acclimatised to the respective environment and therefore does not experience the stress of travelling or climate change, possibly leading to a performance advantage.

In 2008, the FIFA Medical Committee and F-MARC were mandated by the FIFA Executive Committee to study the different environmental conditions football players may be exposed to while training or playing football. This was meant to include a review of the literature, carrying out new research where necessary, and developing recommendations for organisers of competitions and match officials who have to deal with matches being played in extreme conditions. Heat is one of three environmental conditions raising most concerns in relation to performance issues and the health of players, together with high altitude and cold.

Aims of the study

- Investigate the effects of dry versus humid heat conditions
- Assess best practice for acclimatisation to hot environments and develop evidence-based recommendations

How we collected the data

The proceedings of a conference on sporting activities in extreme heat conditions organised and hosted by ASPETAR – Qatar Orthopaedic and Sports Medicine Hospital, a FIFA Medical Centre of Excellence in Doha, together with a number of studies investigating the impact of hot environments when playing football supported by F-MARC formed the base for a position statement by international experts on playing football in hot environments.

Results

The capacity to exercise is considerably reduced in hot as compared to cool environments, most likely due to a combination of what is called a “central fatigue” induced by the brain and reduced oxygen delivery to the muscles by limitations in heart function. In the heat, body temperature rises. This is aggravated by exercise since muscle function leads to further heat production. The body needs to dissipate this heat to keep its equilibrium, which in the heat mainly happens through sweating. With low wind speed and high humidity, sweating may be impaired, increasing the risk of heat illness. Different degrees of heat illness are observed, ranging from heat syncope over heat exhaustion to heat stroke, all related to increasingly higher body temperature.

There are large inter-individual differences in heat tolerance among players, meaning that one player may suffer heat exhaustion before another does have any symptoms. Further, a number of substances may reduce a player’s ability to cope with heat stresses, as they are used in medications for allergies, colds, sleep or hyperactive disorders. As continuous body temperature measurements are not feasible, the best approach to individual risk assessment is a pre-participation examination.

Environmental factors influencing the ability to cope with high temperatures are most importantly high humidity, which impairs sweating, but also wind speed and direct sun radiation. Therefore, environmental risk cannot be properly assessed by dry air temperature measurements alone. The currently best method to assess heat illness risk is to measure the Wet Bulb Globe Temperature (WBGT), a composite of air temperature, humidity, wind speed and sun radiation. Special devices are available for measuring the WBGT at the spot. Where these are not readily available, WBGT may be calculated based on a formula derived from shaded dry bulb temperature and humidity.

A natural protection mechanism against heat illness is to reduce exercise intensity. In football, this is reflected in less sprinting, less high-intensity running and smaller distances covered during the second half of matches. Preventive measures further include adequate hydration to avoid fluid losses of more than 2% of body weight, which needs to be practised by each individual player. Further strategies are half-time cooling measures, or the introduction of additional fluid breaks.
What we learnt from the studies

The capacity to exercise is markedly reduced in hot environments, with high humidity posing further physiological strain on the body. The combination of exercise and hot environments increases the risk of heat illness and heat stroke.

Recommendations for players
- Drink enough fluid to restrict body mass loss to <2% of pre-exercise mass
- At least 1-2 weeks of acclimatisation are recommended for players from different climates before playing in hot environments

Recommendations for organisers (Table 6.2.5.1)
- Perform pre-participation screening
- Carefully observe at-risk individuals (e.g. sickle-cell trait, cardiovascular disease) and signs and symptoms at >28°C WBGT
- Introduce additional fluid breaks and provide medical coverage if >30°C WBGT
- Reconsider starting event if >32°C WBGT

<table>
<thead>
<tr>
<th>WBGT (°C)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted</td>
<td>&lt; 22 Normal activity</td>
</tr>
<tr>
<td>Low risk</td>
<td>22-28 Monitor fluid intake</td>
</tr>
<tr>
<td>High risk</td>
<td>28-30 Observe signs and symptoms Watch at-risk individuals</td>
</tr>
<tr>
<td>Very high risk</td>
<td>30-32 Additional fluid breaks added Medical coverage mandatory</td>
</tr>
<tr>
<td>Stop play</td>
<td>&gt;32</td>
</tr>
</tbody>
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Further research is required to assess use of different cooling strategies, the influence of acclimatisation on performance, the impact of heat on decision-making and the risk for spectators from different climates.

Practical impact on football practice: Based on a study in Turkey, which had shown that the critical rise in body temperature occurs after 30 minutes into the first half, with no major increases thereafter, F-MARC proposed the introduction of an additional cooling break at exactly this time for official FIFA matches with WBGTs higher than 31°C, based on measurements by the FIFA Medical Officer responsible for the medical services prior to the match. This was first practiced at the final of the Men’s Olympic tournament in Beijing, and thereafter introduced by the FIFA administration as an important measure to protect players’ health at all FIFA competitions.
6.3 FIFA Regulations

6.3.1 Gender Verification Regulations

**Background**

The division of athletes into male and female categories is widely accepted practice throughout sports. The rationale behind this separation is that there are sex differences resulting from differences in testosterone and oestrogen levels. Testosterone, the major male sex hormone (androgen), increases muscle mass and strength, bone size, mineral and haemoglobin content. Based on numerous studies demonstrating the performance enhancing capacity of testosterone, the use of artificially produced androgens (and of drugs which raise the body’s natural androgen levels) in sports is prohibited. The previous use or current exposure to androgens is considered as criteria for unfair competition in general.

While this argumentation might appear straightforward and the differences between men and women obvious, there are a number of important considerations if we are to ensure a level playing field for all players, but also, and at least as importantly, protection of the dignity and privacy of the individual.

Deliberate cheating by men masquerading as women to gain an advantage in football is nowadays highly unlikely and, moreover, would be easily revealed. A by far larger and much more complicated problem is constituted by individuals having what is, albeit controversially, called “disorders of sexual development”. This term includes a broad variety of conditions where the sex of a person cannot easily be defined due to either a discrepancy between the sex as defined by their chromosomes as opposed to their bodily characteristics, an ambiguity of their chromosomal sex itself, an underdevelopment of their adrenal glands leading to hormone disturbances, and several other conditions. In all these conditions, the concerned individual is, rightly or wrongly, or out of ignorance, assigned a sex at birth defining the person’s gender identity. To complicate matters further, all these conditions occur to a different degree, rendering correct sex assignment even more difficult.

While all these conditions represent constellations different from what is normally found in women and men, there is no scientific evidence as to whether a performance advantage actually exists, respectively results, if the concerned person participates in sports. There is also no evidence to define, if such advantage existed, how large it may be. In this regard, it has to be further noted that among healthy men, the actual levels of circulating testosterone and also their determination of muscle mass and strength vary considerably.

Finally, as all these individuals have grown up with a certain gender identity, suddenly challenging this identity may potentially disrupt their concept of life. Doing so through publicly exposing them without respecting their gender identity means a humiliation and trauma that should be prevented at any cost.

The FIFA Medical Committee and F-MARC therefore decided to develop a proposal on gender verification regulations in football based on current standards of best practice in medicine and science.

**Objectives**

- Ensure a level playing field
- Protect the privacy and dignity of players

**Major stipulations**

The FIFA Gender Verification Regulations apply for all FIFA competitions and consequently have been adopted by the FIFA confederations. They major responsibility on the FIFA member associations to prevent exposure of players at an international level.

For FIFA men’s competitions, only men are allowed to play. For FIFA women’s competitions, only women are allowed to play. Each FIFA member association shall ensure the correct gender of all their players by actively investigating any perceived deviation in secondary sex characteristics and by keeping complete documentation of the findings. A gender verification procedure may only be requested by either the player concerned, a FIFA member association, the appointed FIFA Medical Officer or the FIFA Chief Medical Officer. The formal requirements for requesting a gender verification procedure are strictly regulated, but one of the most important points is that in case of an unfounded or irresponsible request, the FIFA Disciplinary Committee may impose sanctions on the requesting body/person.

If a request for initiating a gender verification procedure is accepted by FIFA, the respective team doctor and player have to provide the medical documentation estab-
lishing the gender of the player. If further investigations are justified based on these files, the player shall undergo an examination by an independent expert. If the gender is confirmed as being consistent with the one declared, the case is closed without possibility of appeal. If the gender found is considered inconsistent with the one declared, the case will be deferred to the FIFA Disciplinary Committee. If further investigations seem required, the case is referred to an expert panel.

An expert panel to investigate a gender verification case may include, but is not limited to, a gynaecologist, an endocrinologist and a genetic expert. They have to be provided with the whole documentation to evaluate the same for completeness and ask for further information as necessary. Their task then is to conclude on the consistency or inconsistency of the gender of the player with the one declared. If considered consistent, the case will be closed with no possibility of appeal. If considered inconsistent, the case will be referred to the FIFA Disciplinary Committee.

**Conclusions**

The major objective of the FIFA Gender Verification Regulations is to raise awareness of the complexity of gender verification matters and to sensitize all involved parties of the potentially traumatizing effect of questioning the sex of a player as not being consistent with the gender the player identifies with. All FIFA member associations should aim to comprehensively address any unclear or suspicious cases prior to promoting a player to national and international level.

**References:**
The FIFA Gender Verification Regulations entered into force on 1 June 2011, prior to the FIFA Women’s World Cup™ (available from: http://www.fifa.com/mm/document/footballdevelopment/medical/01/45/42/02/genderverification_eifs.pdf)
6.4 FIFA Medical Centres of Excellence

Why we are conducting this project

When football players are injured, all they care about is returning to action as soon as possible. This is not always wise, and a doctor who enables players to do that is not necessarily the best choice. A better option would be to find a doctor who will allow players to come back just at the right time in their recovery process to make sure they can enjoy playing for many more years – and at their personal best level of performance. This already implies that optimum care for football players requires experience not only in state-of-the-art diagnosis and treatment of injuries, but also in aftercare and prevention. However, the term “football medicine” coined by F-MARC means much more than that. Doctors trained in this highly specialised field also offer their expertise in football-specific health assessment including mental and psychological strategies and diet, as well as comprehensive advice on doping matters.

The problem for players, parents, and coaches however, is finding these truly qualified football medicine experts. FIFA therefore intends to officially accredit established centres that have demonstrated medical, educational and research expertise and have a history of commitment to football. By recognising these elite centres, players worldwide will know which centres they can turn to when the need for specialised services is required. In addition, FIFA will recognise established clinics that have demonstrated expertise in the care and prevention of football-related injuries and illnesses.

Duties and benefits

In order to achieve this, FIFA Medical Centres of Excellence will:

- Implementing (and collaborating with) applied ongoing and novel research and development within the framework and long-term strategy of F-MARC.
- Educating and training the next generation of clinical specialists and scientists committed to football medicine.

Vision and Aims

FIFA Medical Centres and Clinics of Excellence will promote injury prevention and the improvement of physical and mental health and well-being of the football player by:

- Fostering collaborative relationships with individuals, institutions and organisations to improve player health and support the mission of FIFA and F-MARC.
- Providing state of the art clinical management of football medicine issues including surgical and non-surgical expertise in musculoskeletal medicine for recreational through elite professional players of all ages and genders.

To achieve this, the FIFA Medical Committee and F-MARC started an exacting accreditation process for FIFA Medical Centres and FIFA Medical Clinics of Excellence. A comprehensive application has to be submitted and is reviewed by the respective F-MARC evaluation group.

Centres have to submit standardised annual reports on their achievements that will be reviewed by F-MARC. Accreditation is valid for five years, when the centre has to reapply to maintain its status as a FIFA Medical Centre of Excellence. The FIFA Medical Centres of Excellence will generally be open to everyone and will offer a football-specific diagnostic service, as well as therapy, with second opinions on specific illnesses and injuries forming a key part of the service.

Since 2005 until the end of 2014, 42 FIFA Medical Centres of Excellence have been accredited worldwide so far (Fig. 6.4.1).
FIFA Medical Centres of Excellence

1. Schulthess Clinic Zurich, CH
2. UniSports Sports Medicine, Auckland, NZ
3. Centre for Exercise Science and Sports Medicine, Johannesburg, RSA
4. St Marianna University School of Medicine, Kawasaki, JPN
5. Orthopädische Klinik, Munich, GER
6. Santa Monica Orthopaedic and Sports Medicine, Santa Monica, USA
7. UCT/MRC Research Unit for Exercise Science and Sports Medicine Cape Town, Cape Town, RSA
8. ASPETAR – Qatar Orthopaedic and Sports Medicine Hospital, Doha, QTR
9. Oslo Sports Trauma Research Center, Oslo, NOR
10. University Medical Centre, Regensburg, GER
11. Isokinetic Medical Group, Bologna, ITA
12. Institut für Sport- und Präventivmedizin, Universität des Saarlandes, Saarbrücken, GER
13. Instituto de Ortopedia e Traumatologia da FMUSP, Sao Paulo, BRA
14. Clinique Chahrazed – Département Médecine et Traumatologie du Sport, Algiers, ALG
15. Duke University Medical Center, Durham, USA
16. Sport Med ‘Clinica de Medicina del Deporte’, Guadalajara, MEX (FIFA Medical Clinic of Excellence)
17. Department of Orthopaedics of the 1st Faculty of Medicine of Charles University and Teaching Hospital na Bulovce, Prague, CZ
18. Royal Netherlands Football Association Sports Medical Centre, Zeist, NED
19. Brugge – Roodeare AZ St-Jan av, Department Sports Medicine, Brugge, BEL
20. Uziscki Hospital, Budapest, HUN
21. Villa Stuart Sport Clinic, Institute of Sport Medicine – CONI – FMSI, Rome, ITA
22. Capio Atrio Clinic, Stockholm, SWE
23. Cardiff Sport and Exercise Medicine Centre, Cardiff School of Sport, Cardiff Metropolitan University, Cardiff, UK
24. Bangkok Hospital Medical Center (BMC), Bangkok, THA
25. Olympic Park Sports Medicine Centre Pty Ltd, Melbourne, AUS
26. Albert Frilatt Centre, Croix-Rousse Hospital, Centre Orthopédique Sancy, Lyon, FRA
27. FC Barcelona, Medical Services, Barcelona, ESP
28. HOME – Hospital Ortопédico e Medicina, Especializada, Brasilia, BRA
29. ‘Centre Technique National de Football’ Medical Centre, Clairefontaine, FRA
30. Acibadem Fulya Orthopedics and Sports Medicine Clinic, Istanbul, TUR
31. Intermédica, Medical SA Ideas de CV, Pachuca, MEX
32. Clínica Espregueira-Mendes (Clínica EM), Porto, POR
33. OSM Research Foundation, Innsbruck, AUT
34. The Football Association Sports Medicine & Sports Science Department, St. George’s Park, UK
35. Ripoll y de Prado Sport Clinic, Murcia, ESP
36. Hospital for Special Surgery, New York, USA
37. Juntendo University Hospital, Tokyo, JPN
38. Kobe University Graduate School of Medicine, Hyogo Prefectural Rehabilitation Centre, Center Hospital, Kobe, JPN
39. Clinica CEMTRD, UCAM-Universidad Catolica San Antonio, Clinica Traumatológica, Madrid, ESP
40. Fortius Clinic, London, UK
41. Refasport Clinic sp. z o.o., Poznan, POL
42. Carolina Medical Center, Warsaw, PDL (FIFA Medical Clinic of Excellence)

Duration: 2005 - ongoing
Countries: International
Cooperation: International
7. The Fight against Doping in Football

7.1. FIFA’s Approach to the Fight against Doping in Football

Fuelled by some prominent cases, the debate on doping in amateur and professional sport raised public awareness of a problem that had not been fully appreciated during the rapid development of various sports disciplines in previous decades. Prior to the 2014 FIFA World Cup™, FIFA introduced a completely new approach in the fight against doping with the implementation of the biological profile (or so-called passport). FIFA tested all the players from every team prior to the competition in unannounced controls. During the competition, two players from each team were tested after each match for blood and urine. Additional controls were performed under certain circumstances. With this procedure, FIFA was one of the first international sports federations to introduce such a passport, including blood and urine parameters, in a major competition.

### Definition of doping

Doping is any attempt either by a player themselves, or at the instigation of another person, such as their manager, coach, trainer, doctor, physiotherapist or masseur, etc. to enhance mental and physical performance not physiologically or to treat ailments or injury – when this is medically unjustified – for the sole purpose of taking part in a competition. This includes using (taking or injecting), administering or prescribing prohibited substances prior to or during a competition. These stipulations also apply for out-of-competition testing of anabolic steroids and peptide hormones, as well as to substances producing similar effects.

Other prohibited methods (e.g. blood doping) or manipulation of the samples collected, are likewise classified as doping. The detailed definition as related to the anti-doping rule violations are presented in the annually updated FIFA Anti-Doping Regulations.

### Aims of doping controls and the anti-doping policy

- Uphold and preserve the ethics of sport
- Safeguard the physical health and mental integrity of the player
- Ensure that all competitors have an equal chance

FIFA introduced doping controls in 1970 to ensure that the results of matches played as part of its national and international competitions were a fair reflection of the ability of those taking part. The FIFA Medical Committee has the overall responsibility for not only implementing doping controls at all FIFA competitions but also for the harmonisation with confederations and member associations. It is supported by the FIFA Doping Control Sub-Committee, and since 2007, by the TUE advisory group. The administrative management of the doping controls is overlooked by the FIFA medical office, and since May 2009, by the FIFA Anti-Doping Unit.

Over the years, F-MARC has developed a worldwide network of specialists, who are involved in the educational process within the confederations and member associations as well as in the practical approach for the domestic, international and FIFA competitions. The physicians play the key role in FIFA’s long-term strategy of prevention and education in the fight against doping, following their Hippocratic Oath as well as their professional and ethical values.

### Statistics

The confederations and/or member associations that come under FIFA’s umbrella carry out their own doping controls at the competitions they stage. Also National Anti-Doping Organisations (NADOs) are allowed to conduct testing of national players (in- and out-of-competition), as well as of players from other countries competing within that nation’s borders. Urine and/or blood samples collected must, however, be analysed at WADA-accredited laboratories. These laboratories send reports on any “chemically positive” A samples – so called Adverse Analytical Findings (AAFs) or Atypical Findings - to the member associations, FIFA Anti-Doping Unit for management and to WADA for information.

Once the FIFA Anti-Doping Unit receives a positive A sample result, follow-up information is required by the member association and/or confederation in question to be informed on the results of the B sample and particularly the respective disciplinary committee decision. If the information is not provided, the FIFA Disciplinary Committee takes appropriate action. Between 1994 and 2013, 11,086 doping tests were performed at FIFA competitions (Tab. 7.1.1). Of these, 13 samples tested positive: five samples of anabolics, two of...
nandrolone, one each for ephedrine, cannabis, tuaminoheptan, methylhexanamine and dexamethasone accounting for an incidence of 0.12%. Doping tests conducted during confederations’ and associations’ competitions are the responsibility of the organisers.

The total number of football samples analysed per year allows the calculation of incidents for the positive samples in total and for the calculation of the most commonly detected prohibited substances. In this respect, FIFA developed its own database to keep track of records on the samples being reported as positive. This allowed control of the management of these samples within the different confederations and member associations.

Over the last nine years (2005–2013), 258,494 doping tests were performed in football, worldwide. According to the FIFA doping control database, 808 samples (0.31%) tested positive and, of these, 111 samples (0.04%) were positive for anabolic steroids and hormones. Over the years, cannabis have accounted for about 40% of positive test results. In addition, other stimulants (e.g. cocaine, diuretics) accounted for 46% (Fig. 7.1.1). During 2013 WADA increased the level for reporting of cannabis in players from 15ng/mL to 150ng/mL with a direct impact of positive results found. In 2013 only 17% tested positive for cannabis (data not yet finalised). The data for 2014 are still to be finalised, but so far there is a strong indication of a further decrease of positive cannabis tests. Due to the decrease of the use of the substance cannabis, the remaining substances counted in percentage increases in the statistics automatically, although the positive cases counted in numbers did not increase compared to previous years. The relatively low incidence of positive doping samples particularly for the truly performance enhancing drugs such as anabolic steroids and hormones (2011 0.06%, 2012 0.04%, 2013 0.05%) and stimulants allows FIFA to state that there is no evidence for systematic doping in football. However, this does not mean that doping does not exist in football.

Harmonisation within the confederations and member associations

In 1999, a comparative study of the doping control regulations issued by the confederations showed a high level of agreement as far as the lists of prohibited substances and methods were concerned. This was primarily because the Confederations simply decided to adopt in the FIFA Anti-Doping Regulations.

A detailed survey of the doping control regulations issued by national football associations however revealed some differences in the procedure and the inclusion of certain individual substances in the categories of prohibited drugs. Following this comparative study, F-MARC and the FIFA Medical Committee proposed to the FIFA Executive Committee that the doping control regulations of all member associations were harmonised, and that they would automatically adopt the list of prohibited substances and methods.

Following the FIFA Executive Committee recommendation, the FIFA Congress ratified this decision at their Ordinary Congress in May 2002. This again paved the way for the decision of the FIFA Extraordinary Congress...
in December 2003 in Doha/Qatar to extend sanctions by the FIFA Disciplinary Committee of member associations (being expelled) for all international matches following the same method of individual case management. In 2009 it was further decided to establish a new administrative body, the FIFA Anti-Doping Unit to coordinate the activities of the different departments involved and ensure and survey implementation of the WADA Code in 2009 at all levels of the organisation. With the implementation of the new World Anti-Doping Code in 2015 and the FIFA Anti-Doping Regulations 2015, further measures and procedures were institutionalised to ensure that all FIFA member associations comply with the WADA Code.

## Prohibited substances prescribed for medical reasons – Therapeutic Use Exemption (TUE)

In a player who has a medically confirmed pathological condition, drugs containing prohibited or partially prohibited substances could be permitted in exceptional cases if:

- The player’s health would be impaired if the prohibited drug were withheld
- No performance enhancement could result from the prohibited substance being administered as medically prescribed
- No permitted or practical alternative drug is available in place of the prohibited substance

In such a situation, a player or their doctor must submit a formal application, requesting a so-called “therapeutic use exemption” for the respective substance. The FIFA TUE Advisory Group was created in 2007 as the body responsible for granting all TUE approvals within FIFA. As the International Standard for Therapeutic Use Exemptions (ISTUE) 2015 is an extensive document that leaves options for the Anti-Doping Organisations (ADOs) to define by themselves, FIFA developed its own document which clarifies all TUE issues that remained unresolved after the ISTUE 2015 came into force. The FIFA TUE policy ensures a clear and consistent approach to medication use in football.

## FIFA-WADA cooperation

On 4 February 1999, the Lausanne declaration on Doping in Sport called for an independent International Anti-Doping Agency to be established. The aim was to coordinate the various programmes necessary to realise the objectives of all stakeholders in the fight against doping.

From the beginning, the medical and legal representatives of FIFA developed a close collaboration with the representatives of the World Anti-Doping Agency (WADA). On 21 May 2004, at the 54th Ordinary FIFA Congress in Paris, FIFA, the IOC and WADA signed a declaration regarding the collaboration in the fight against doping following a warranty that WADA would respect the autonomy of the international federations (Fig. 7.1.2). FIFA however always strongly opposed the sanctioning system of WADA of two years for every doping violation, independent of factors such as the substance, fault, intention, age of the player, individual circumstances, etc. FIFA and WADA both asked the Court of Arbitration for Sport (CAS) for a legal opinion on their different views. CAS explicitly confirmed FIFA’s practice of individual case management when sanctioning doping offences. In addition, CAS noted that FIFA’s principle of individual case management complied with the WADA Code. At the same time, CAS ruled that FIFA’s provisions with regard to the fight against doping and the sanctioning of doping offences were, to the greatest possible extent, in line with the WADA Code.

## FIFA network of Doping Control Officers

In cooperation with the confederations and member associations, FIFA has established a worldwide network of specially trained physicians who act as FIFA Doping Control Officers (DCO). With regard to medical confidentiality and the necessity for specific knowledge in the field, FIFA exclusively appoints physicians (MDs) to perform this task. The FIFA doping control procedure is straightforward and transparent leaving no place for cheating or wrongdoing when all steps are performed in the presence of representatives from both teams. FIFA DCOs have all attended instructional seminars conducted by F-MARC and the FIFA Anti-Doping Unit in order to secure “unity of doctrine”. The DCOs, as members of the FIFA network, are located around the world. A new education and training scheme was developed and presented to the FIFA Medical Committee at the beginning of 2009 and has been implemented since that time.
WADA considered all these concerns and introduced changes in the final version of the 2009 Code. The 2009 WADA Code demonstrated that harmonisation was preferable to uniformity in the interest of the athletes. Flexibility was granted when sanctioning a player, so that all relevant criteria could be taken into account.

On 29 February 2008, FIFA and WADA signed a letter of intent and declared that the fight against doping must be continued through all possible means in order to safeguard the objectives of FIFA and WADA. On 30 May 2008, FIFA President Joseph S. Blatter and WADA President John Fahey ratified Version 3.0 of the Code at the ordinary FIFA Congress in Sydney.

The new World Anti-Doping Code

The revision process for the 2015 Code began at the end of 2011 and, following three phases of consultation over a two-year period, and with 2,000 changes submitted, the revised Code was unanimously approved on 15 November 2013 at the World Conference on Doping in Sport in Johannesburg, South Africa.

One of the key changes was the implementation of a new period of ineligibility of four years for presence, use or attempted use, or possession of a prohibited substance or prohibited method. Further, associating with a banned person or a person convicted or found in a criminal, disciplinary or professional proceeding to have engaged in conduct which would have constituted a violation of anti-doping rules if Code-compliant rules had been applicable to such person is sanctionable.

FIFA adopted these changes in its new Anti-Doping Regulations 2015.

**Duration:** ongoing

**Countries:** International

**Cooperation:** FIFA Medical Committee, FIFA Doping Control Sub-Committee, FIFA TUE advisory group, FIFA Legal Department, FIFA Anti-Doping Unit Laboratoire suisse d’Analyse du Dopage, University of Lausanne, Switzerland

**References:**
“Make the game doping free” is the aim of the anti-doping strategy of FIFA. Not only is the integrity of the game at stake, but so too is the need to protect the players’ health and keep them from the harm that can result from doping. Football players who compete in FIFA World Cups™ are ambitious professionals and FIFA wants to ensure their support in the fight against doping whilst demonstrating respect for the privacy and dignity of each player.

FIFA first conducted doping tests in 1970. The importance of the fight against doping is however not confined to just the doping control room at the stadiums of major competitions or the no-advance-notice testing. It is the responsibility of everyone within the football family to stand up against those who would seek to upset the competitive integrity of the game through chemical means. In FIFA’s view, the key to keep the game doping free is education and knowledge. And this does not only apply to the physicians, everyone plays a position in this game. Coaches are highly influential and can have enormous authority over their players. The role of a player’s parents cannot be discounted as they are the player’s primary role model and connect with their children on the most basic level every day. Finally, most players get information about many aspects of life from their peers – their teammates. The more players become aware of the dangers of cheating, both from a football perspective as well as the health perspective, the less doping we will see in our sport.

While it is important for physicians to further their understanding of the more technical aspects of doping and detection of doping, most members of the football family would find the reports in the F-MARC scientific supplement on doping hard to understand. To meet their needs, F-MARC decided to prepare a booklet that includes the pertinent information in easily understandable language.

### Recreational and social drugs

The vast majority of positive doping tests are for recreational and social drugs. Cannabis and cocaine account for more than 80% of all positive tests in football. Due to increasing the threshold limit of cannabis, it is no longer at the top of the list of prohibited compounds detected at WADA-accredited laboratories. Cannabis might be considered as having an indirect impact on performance by reducing anxiety before a match or increasing relaxation after a match. However, regular use can alter behaviour, concentration and motivation. Cocaine is the most powerful naturally occurring stimulant of the nervous system and is highly addictive. It has no performance enhancing effect on running times or endurance. The addictive nature of the drug can lead a player to redirect their energies away from sport and towards how to obtain their next dose. Both drugs are easily detected in urine.

#### Stimulants

Of concern in this category are amphetamines and ephedrine. Amphetamines are known enhancers of performance with established, and potentially dangerous, side effects. Ephedrine is perceived to be a performance enhancer, but any performance benefits are inconsistent and probably of little consequence. Some recent fatalities in athletes taking ephedrine have prompted associations to take a closer look at tightening restrictions on ephedrine.

#### Anabolic agents

Synthetic derivatives of testosterone are known performance enhancers that have been used in many sports and are generally banned in sports. Anabolic-androgenic steroids enhance protein synthesis, improve high intensity performance, speed up recovery, but can also affect the psychological and emotional state of the player. Dosing schedules and drugs of choice are largely empirical and well above what is used for therapeutic use in medicine. Complex analytical methods are required to detect the presence, amount, and relationships of compounds. There is concern about 19-norandrosterone that has been identified in some food supplements in amounts sufficient to trigger a positive doping test for nandrolo- 
ne. Uninformed players may unwittingly ingest this banned substance because the compound might not be listed on the label. Avoiding nutritional supplements is the best way to avoid innocent ingestion of such compounds.
Erythropoietin

Increasing the oxygen carrying capacity of the blood is a proven aid in endurance sports. Initially, blood doping involved removal and reinfusion of an athlete’s own blood. The introduction of recombinant erythropoietin (rhEPO) offered an alternative method of improving endurance. It can be expected that in future, each abuse of EPO will be detected. A long-term follow-up with repeated tests over time is probably the best way to target abusers.

Human growth hormone

Banned since the early 1990s, human growth hormone (HGH) is abused for its potential as an anabolic compound. While the abuse of HGH became more prevalent with the availability of recombinant HGH, there are few studies that show a significant effect on performance when used alone. Some athletes, however, use HGH as part of a drug cocktail combined with other anabolic agents. The basic physiology of HGH and the similarity with the recombinant version makes detection difficult.

Beta-2 agonists

Inhaled beta-2 agonists are used to treat exercise-induced asthma and are prohibited for use in non-asthmatic athletes because of a potential ergogenic effect. The published incidence of asthma in the population is about 5%, but the incidence in athletes has been reported to be between 10 and 20%. A review of 20 clinical trials on the use of beta-2 agonists failed to show a consistent enhancement of performance in athletes. Since WADA added thresholds for formoterol, salbutamol and salmeterol, positive test results for these substances decreased.

Glucocorticoids

This class of compounds has unchallenged therapeutic potential for treating numerous inflammatory and other diseases and is a first line therapy for the treatment of asthma. Sports medicine physicians have used glucocorticoids for numerous situations such as muscle injuries, tendon injuries, musculoskeletal inflammation and more. The World Anti-Doping Agency bans all oral, intravenous or intramuscular routes of administration and requires a formal use exemption for athletes treated with this class of medicine. The medical literature does not support the indiscriminate therapeutic use of glucocorticoids for most musculoskeletal injuries nor has it been proven that glucocorticoids are an effective performance enhancer.

What we have learnt from experience

The FIFA Medical Committee believes that doping controls and sanctions are an effective part of combating doping when applied over the long term in a comprehensive programme. The education and information of players is however just as important. Physicians, who must follow their own professional ethical codes, are integral components of the anti-doping strategy designed to create a drug-free environment through education that will improve the overall health of players. FIFA fully acknowledges its responsibility to reach out to the players and fans.

Duration: 2006
Countries: International
Cooperation: Martial Saugy, Laboratoire suisse d’Analyse du Dopage, University of Lausanne, Switzerland; Michel D’Hooghe, Bruges, Belgium; FIFA Medical Office, Zurich, Switzerland
Reference: Dvořák J, Grimm K (eds) (2006). The Fight against Doping in Football. A comprehensive introduction and overview. FIFA’s strategy, the relevant substances, their effects and detection. Official publication of the Fédération Internationale de Football Association, Zürich, Switzerland
7.3 Research Projects

7.3.1 Nandrolone Excretion after Exercise

Why we conducted this study

While there are numerous classes of agents that can enhance almost every aspect of sport, the use of anabolic steroids probably dominates the doping landscape. Anabolic steroids have legitimate clinical uses such as in the treatment of anaemia, osteoporosis, selected cancers and as hormone replacement therapy. Of all the anabolic steroids on the market, nandrolone (Deca-Durabolin®) is one of the most widely used because of its potent anabolic properties. In the body, nandrolone is broken down into two easily detectable metabolites: 19-norandrostenedione (NA) and 19-noretioccholanolone (NE) which are excreted in the urine. A test is positive if the urine level of NE is above 2ng/ml (males) or 5ng/ml (females). If the number of positive tests is an indication of use by sportsmen, one might conclude that its use is increasing. Shortly after 1997, when a number of sportsmen in France tested very close to the cut-off limit for nandrolone, a debate was raised about the capability of the human male body to produce these metabolites without any intake of nandrolone or related compounds. A number of specialists argued that exhaustive exercise could increase nandrolone production in the body or exercise-induced dehydration could lead to a greater concentration of nandrolone metabolites in urine, leading to a false-positive test. Of all the outcomes of testing for performance enhancing drugs, a false-positive is particularly troublesome and unfortunate. An athlete who has not taken something illegal could be punished for doing nothing wrong and suffer public censure for having tested positive. With the 1998 FIFA World Cup™ about to start in France, FIFA was very concerned and wanted to protect football players from such mishap by investigating the changes of nandrolone with exercise.

Aims of the study

- Determine the interindividual variability in nandrolone excretion patterns and kinetics after the administration of labelled nandrolone to healthy volunteers
- Find out if traces of nandrolone metabolites could be detected in the urine of football players after a match

How we collected the data

For the excretion part of the project, we recruited 22 volunteers who ingested two 25mg doses of [13C]nandrolone at 24 hour intervals that were followed up with urine specimens for five days. The “13C” means that specific carbons within the steroid structure were an isotope of carbon that can be measured and traced. The labelled metabolites were identified and measured by gas chromatography–mass spectrometry at an IOC-certified laboratory.

For the exercise project, all football players from the first and second divisions of the Swiss Football National League (n=358) submitted urine samples after a match as a part of normal doping controls. A group of amateur players (n=137) submitted urine samples before and after match play. We used a cut-off of 0.2ng/ml for presence of nandrolone metabolites, a value much more sensitive that the official cut-off for a positive test.

Results

The pattern of excretion (called kinetics) of the metabolites varied a great deal from person to person (interindividually) leading to considerable variation in the ratio of NE:NA. For example, norandrosterone varied between 1180 and 38,661ng/ml and noretiocholanolone varied from 576 to 12,328ng/ml. At the end of the five-day excretion period, the NE:NA ratio was sometimes >1 and followed no consistent pattern over the excretion period (Fig. 7.3.1.1). While most of the nandrolone was excreted within 20 hours, some subjects still had levels consistent with a positive test for nandrolone for 100 hours. There were concerns regarding urinary concentration from exercise also being a factor in the results. None of the amateurs examined had evidence of any nandrolone metabolites before exercise. After match play, just over 6% of the professionals and a similar percentage of amateurs showed presence of nandrolone metabolites (Tab. 7.3.1.1).

<table>
<thead>
<tr>
<th></th>
<th>Professional players</th>
<th>Amateur players</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence of NA</td>
<td>336</td>
<td>129</td>
</tr>
<tr>
<td>Presence of NA</td>
<td>22</td>
<td>8</td>
</tr>
</tbody>
</table>

Tab. 7.3.1.1 Level of player and presence or absence of NA (cut-off for presence or absence of urinary NA = 0.2 ng/ml)
After match play, a small percentage of the players showed presence of nandrolone metabolites. The origin of these metabolites in the urine after activity is unknown, however three hypotheses might be considered. First, an endogenous production of nandrolone metabolites might actually have taken place. Second, nandrolone metabolites could have been released from the fatty tissues after intake of nandrolone, some related compounds or some contaminated nutritive supplements. Finally, the sportsmen could have taken something just before or during the football game.

Doping control regarding steroids continues to be an evolving process as more is learned about excretion and the factors that can influence results. The value of using a single cut-off as the criteria for a positive test would need to be further to be investigated.

Fig. 7.3.1.1 NE:NA ratios (top) for two volunteers after the oral administration of two doses of nandrolone and corresponding chromatograms (bottom) obtained by GC-MS from spot urines collected at 50.5 h (A) and 54 h (B) after the first nandrolone dose (10).

What we learned from the study

Duration: 2002 - 2004
Country: Switzerland
Cooperation: Laboratoire suisse d’Analyse du Dopage,
             University of Lausanne, Switzerland
References:
7.3.2 Testosterone Variability – the Influence of Ethnicity on Steroid Profiles of Football Players

**Why we conducted this study**

When looking at the statistics of adverse analytic findings (AAF)s reported by the WADA-accredited laboratories during the last years, it becomes obvious that testosterone accounts for a high proportion of these cases. This does not reflect the actual use of endogenous steroids in sport, in particular not in football, but rather indicates that currently used parameters for the detection of steroids are leading to false positive results. This represents one of the most important problems international sport federations face nowadays. Previous studies with volunteers receiving testosterone had shown considerable variability between individuals regarding the diagnostic results of testosterone abuse.

Recently, the World Anti-doping Agency Code 2009 was adopted establishing the need of submitting a sample to isotopic ratio mass spectrometry (IRMS), if the urinary T/E ratio value is equal to or greater than four (previously at six). If such IRMS does not readily indicate exogenous steroid intake, the result is reported as inconclusive and further longitudinal studies can be performed. While longitudinal studies to investigate elevated T/E ratios are very costly, there is no strong scientific evidence supporting the following decisions of disciplinary committees. F-MARC therefore sees a clear need to conduct further investigations in individuals showing different metabolism speed in order to identify more valid biomarkers of steroid abuse.

**Aims of this study**

- Avoid false positive results when currently used parameters are measured including consequences with regard to costs, time etc.
- Provide sport authorities with efficient tools to take their decisions based on scientific data in case of an altered steroid profile

**Results**

No sample showed an absolute steroid concentration higher than the respective threshold defined by WADA. Three samples (1.7%) showed a T/E-ratio >4, but the above-mentioned IRMS did not reveal evidence for exogenous steroid use. Significant differences of the T/E-ratio were observed between all ethnic groups. Based on the results, ethnic-specific T/E-ratio thresholds were developed (Africans 5.6; Asian 3.8; Caucasian 5.7; Hispanic 5.8).

Defining a unique and non-specific threshold to indicate anabolic steroid abuse is not fit for purpose in doping control. Individual steroid profiling in players would allow individual reference values (endocrinological passport) to be identified. It was also shown that the threshold value of four lies considerably below the ethnic-specific threshold values in all but the Asian players.

**How we collected the data**

About 117 urine samples were provided by senior male players from different ethnic populations specifically for the study. More specifically, samples from 57 African players (Uganda, South Africa), 32 Hispanic players (Argentina), 32 Asian players (Japan) and 50 Caucasian players (Switzerland, Italy) were taken. All samples were analysed to determine the T/E ratio and analyse the steroid profile and isotopic ratio of testosterone metabolites. A new method for detection and quantification of steroid conjugates in urine samples was used in addition to already established methods.
**Duration:** 2007 - 2008

**Countries:** Switzerland, Italy, Uganda, South Africa, Argentina, Japan

**Cooperation:** Martial Saugy, Laboratoire suisse d'Analyse du Dopage, University of Lausanne, Switzerland, team physicians of the respective teams

7.3.3 Quantification of Clenbuterol at Trace Level in Human Urine

Why we conducted this study

Clenbuterol is part of the β2 agonists family, a class of compounds firstly designed for the antiasthmatic properties and tocolytic effect in human and animals. The administration of clenbuterol-like drugs has other physiological effects such as increase of aerobic capacity, blood pressure and oxygen transportation, stimulation of the central nervous system and has an impact on the body fat metabolism rate. The anabolic properties given by the marked increase of skeletal muscles in parallel to the decrease of the body fat mass has forced the World Anti-Doping Agency (WADA) to put clenbuterol in the class S1.2 (other anabolic agents) of the Prohibited List. Because there is no threshold level for clenbuterol in the anti-doping regulations, any of the concentration found in urines of athletes would lead to an adverse analytical finding, leading theoretically to a sanction of the athlete. Nowadays, clenbuterol has been banned for therapeutic use in humans but is sometimes employed as a growth-promoting agent in food-producing animals. The use of this compound for cattle and bovine breeding is well regulated in the United States of America by the FDA and in Europe. Despite these rules, there are still some countries where, after used of clenbuterol for the promotion of animal growth, residues of this compound can be found in the meat. Consumption of such contaminated meat could therefore lead to the presence of traces of this forbidden substance in human urine and then to an anti-doping rule violation for an athlete. Moreover, WADA has introduced since 2004 the strict liability rule in the World Anti-Doping Code meaning that athletes are responsible for themselves and should be cautious about any substances entering their body, which could cause a doping offence. In 2011, FIFA faced several adverse analytical cases containing traces of clenbuterol. The method developed herein is simple and rapid and was validated in compliance with authority guidelines and showed a limit of quantification at 5pg/mL and a linearity range from 5pg/mL to 300pg/mL.

Aims of the study

- Develop and validate a UHPLC–ESI-MS/MS method for the quantification of clenbuterol in urine samples at the low pg/mL range
- Apply to real urine samples from 18 healthy male volunteers collecting urines over six days after a single intake of clenbuterol-enriched yogurts at three dose levels 1, 5 and 10μg

How we collected the data

During the method-development part of the study, clenbuterol was extracted from urine samples by liquid–liquid extraction (LLE) using tertbutyl-methyl ether (TBME), allowing a 66 times concentration factor for the target analyte. Samples were then analysed by UHPLC–MS/MS with a linear gradient of acetonitrile in nine minutes only. This simple and rapid method was validated in compliance with authority guidelines and showed a limit of quantification at 5pg/mL and a linearity range from 5pg/mL to 300pg/mL. During the clinical study part conducted in 2011 in Cyprus after approval by the Cyprus National Bioethics Committee, the method was applied to real samples from 18 volunteers. Spiropent® syrup containing clenbuterol hydrochloride was used to enrich yogurts at 1, 5 or 10μg/yogurt. After ingestion, the volunteers were asked to collect urines over six days. Urine samples were analysed with the UHPLC–MS/MS method and the amount of clenbuterol excreted was plotted versus collection time with the aim of investigating the elimination profile in urine.

Results

The WADA recommendations in terms of Minimum Required Performance Limits (MRPL) for clenbuterol were adjusted down to 200pg/mL on the 1 January 2013. The development of the method was therefore focused on sensitivity issue in order to detect and quantify clenbuterol in urine samples in the low pg/mL range. The method developed herein is simple and rapid and was validated in compliance with authority guidelines with a LOQ at 5pg/mL. Satisfactory trueness, repeatability and intermediate precision results were obtained. No sample carry-over was observed in the analytical system. Clenbuterol showed acceptable stability in urine samples.
Urine samples from the 18 volunteers collected over six days after clenbuterol were analysed with the developed method. The urinary pharmacokinetic profiles are illustrated in Fig. 7.3.3.1. These profiles showed that maximum levels of clenbuterol in urine appeared approximately four hours after administration (Tmax).

Maximum excretion values (Cmax) during this time period were approximately 1.2 ± 0.3ng clenbuterol/mg creatinine (1.2 ± 0.4ng/mL) after a single dose of 10μg, while trace levels (approx. 5pg/mL) of this compound can still be found in urine samples up to six days after administration. Cmax for 5μg and 1μg administered doses were 0.5 ± 0.1ng clenbuterol/mg creatinine (0.6 ± 0.2ng/mL) and 0.1 ± 0.05ng clenbuterol/mg creatinine (0.2 ± 0.1ng/mL), respectively. As depicted in Fig. 7.3.3.1, a high inter-individual variability was observed in the pharmacokinetic profiles due to the urine matrix (diuresis, flow, and pH). However, the urinary elimination half-life was quite long for clenbuterol leading to concentrations above LOQ (5pg/mL) until 140 hours (six days) after oral intake. This was first valuable information to deter clenbuterol misuse in sports. The dose–response relationship was nevertheless difficult to evaluate in urine matrix and therefore blood samples analyses would be important complementary information for this topic in the future of the fight against doping.

What we learned from the study

The rationale of this study was to better understand the pharmacokinetic of elimination from the human body of doses of clenbuterol similar to the ones, which can be ingested through contaminated food. The analytical results showed an important inter-individual variability in the excretion profiles as already observed for many pharmaceutical compounds. Thus, the determination of a possible urinary threshold level for clenbuterol based only on urinary excretion profiles must be carefully set to avoid any false positive cases. In addition, collection and use of alternative matrices such as serum could represent complementary information to urine matrix. Therefore, a multi-parameters approach using more sophisticated data treatment (e.g. correlation between blood and urine concentrations) as well as the deep insight of phase I and II metabolism of clenbuterol would be of high interest to document appropriately and interpret each case of clenbuterol misuse in anti-doping testing in the future.
7.3.4 Profiling of Steroid Metabolites after Transdermal and Oral Administration of Testosterone

Why we conducted this study

The screening of endogenous anabolic androgenic steroids (AAS) for doping control purpose is routinely implemented by assessing the steroid profile in urine. Monitoring ratios between precursors or biosynthetic metabolites of testosterone (T) helps to distinguish an exogenous intake from physiological levels. The most sensitive biomarker is the T glucuronide (TG) to epitestosterone glucuronide (EG) TG/EG ratio, which cut-off is set at 4 for suspicion of T or precursor administration. Despite the high specificity of this parameter, the sensitivity of this test suffers from the short detection window and the high inter-individual variability due to natural elevated TG/EG ratios or genetic polymorphisms [2–5]. The majority of steroids are biotransformed into phase I and II metabolites (glucuro- and sulfo-conjugates) to facilitate their excretion in urine. Among the UDP-glucuronyl transferases (UGT), the UGT2B17 is the most important isoform involved in T glucuronidation and is highly subjected to polymorphism. Moreover, today’s doping habits consist in low-doses and topical route of administration, according to testimony of top-level athletes, to avoid peak concentration excretion. Then, the current TG/EG ratio threshold and other steroid profile parameters might not be sufficiently sensitive to detect low doses and transdermal T route of administration. To avoid this limitation, subject-based monitoring approach was proposed by setting individual basal threshold levels instead of population reference limit as suitable tool for steroid profiling, as proposed for the future Athlete Steroidal Passport (ASP). With the perspective of using multiparametric indicators to reinforce the steroid profile detection ability, the research of novel biomarkers or minor metabolites is expanding to improve current detection windows of AAS doping.

In this study, a new generation quadrupole time-of-flight mass spectrometer coupled to ultra-high pressure liquid chromatography (UHPLC–QTOF-MS) was evaluated for its ability to assess the steroid metabolism after T administration. For that purpose, urine samples from a clinical trial protocol, collected after T transdermal and T undecanoate (TU) administration to 19 healthy male volunteers, having different UGT2B17 genotypes (del/del, ins/del and ins/ins), were analysed. The variation of 12 targeted steroid metabolites quantified in this study in more than 500 urine samples was evaluated with respect to both route of T administration based on individual threshold levels.

Aims of the study

- Develop and validate a UHPLC–QTOF-MS method for the quantification of 12 steroid metabolites in urine samples
- Apply to real urine samples collected after T transdermal and T undecanoate (TU) administration from 19 healthy male volunteers having different UGT2B17 genotypes (del/del, ins/del and ins/ins). Evaluation of the variation of the 12 targeted steroid metabolites in the 500 plus urine samples collected during the study

How we collected the data

During the method development part of the study, the target analytes were extracted from urine samples by solid-phase extraction (SPE) on Oasis HLB cartridges 30 mg in the 96-well plate format to extract selectively glucuro- and sulfo-conjugated AAS from urine samples (TG, EG, testosterone sulfate (TS), epitestosterone sulfate (ES), androsterone glucuronide (AG), androsterone sulfate (AS), etiocholanolone glucuronide (EtioG), etiocholanolone sulfate (EtioS), dehydroepiandrosterone glucuronide (DHEAG), dehydroepiandrosterone sulfate (DHEAS), dihydrotestosterone glucuronide (DHTG) and α-diol-3-glucuronide (5αββ-AdiolG). Samples were then analysed by UHPLC–QTOF-MS with a linear gradient of acetonitrile in 25 minutes. This method was validated in compliance with authority guidelines and showed limits of quantification and linearity ranges from 1 to 200ng/mL for TS and ES, 2 to 100 and 500ng/mL for 5αββ-AdiolG and DHTG, respectively, 5 to 500ng/mL for TG, EG and DHEAG, 50 to 3,000ng/mL for AS, DHEASand EtioS, and 500 to 8,000ng/mL for AG and EtioG.

During the clinical study part conducted in 2012 in Switzerland after approval by the Human Research Ethics Committee Vaud, the method was applied to real samples from a cohort of 19 volunteers. Control samples (C) were gathered during the first week. Kinetics urine and blood spots were collected at time C-t00 = 0 h, C-t01 = 2 h, C-t02 = 4 h, C-t03 = 8 h, C-t04 = 12 h and C-t05 = 24 h. During the second week, volunteers received twice 2 T transdermal systems of 2.4mg/24 h
As samples collected at different time points constituted homogeneous clusters, no chronological trend could be highlighted on the PCA biplot for control and transdermal data. Therefore, T patch administration could not reveal a detectable influence on the steroid profile suggesting that the induction of the phenomenon was too small. The effect of the treatment was confounded with the biological variability and could certainly be attributed to the low dose and bioavailability as well as the slow kinetic release of topical system. Nevertheless, three clusters could be clearly distinguished, corresponding to the three UGT2B17 genotypes and indicating the basal level of the steroid profile is closely related to the UGT2B17 genotype and correlates with the TG/EG level in urine. The PCA biplot of samples from volunteers exposed to oral TU and controls revealed a different picture. While no effect of this high dose could be highlighted for the del/del UGT2B17 genotype, a clear trajectory was revealed for the inserted heterozygotous and homozygotous individuals by linking the time points. Del/del individuals remained apparently unaffected by the treatment, as the samples were clustered with controls, but time points 2, 4, 8 and 12 h post-dose of ins/del and ins/ins genotypes were clearly separated from the control samples following a chronological trajectory. By these means, an acute excretion state, starting from 2 h to 12 h after TU pill intake could be distinguished from a basal level, and the analysis of the variables’ contributions indicated TG/EG, TG, DHTG and 5αββ-AdiolG as compounds driving the trend highlighted after TU pill administration.

Results

Two principal component analysis (PCA) models were calculated to assess the trends related to both T administration routes compared to control urines (Fig 7.3.4.1).
ROC curve analysis was performed to evaluate the overall accuracy of the measured parameters for the discrimination between control and T administered subjects. For that purpose, true positive rate (sensitivity) and false positive rate (1-specificity) were assessed at different thresholds. Transdermal testosterone administration ROC curves were built for each targeted steroid from the control and the patch group. The most relevant markers of the steroid profile were TG and the TG/EG ratio. Regarding topical T application, TG and TG/EG were poorly predictive. ROC curves of all the other compounds had very low discrimination power. The poor sensitivity could be attributed to the low dose and bioavailability of the topical route, as well as the genotypic UGT2B17 diversity included in the study. Oral testosterone administration ROC curves of 5 biomarkers from the steroid profile, including the TG/EG, presented good accuracy indices after TU administration. As expected, TG and TG/EG provided the best discrimination power but parameters such as AG as well as DHTG showed also satisfactory performance indices. From the sulfo-conjugated steroids, EtioS revealed also appropriate accuracy. To assess the pertinence of each biomarker, individual thresholds were set up, to avoid the influence of ethnicity and genotyping on the reference limit, as proposed for the forthcoming ASP approach. The usefulness of each marker after transdermal and oral administration of T was evaluated by setting subject-based thresholds. Detection time was defined as the time after T administration when the measured concentration was higher than the individual threshold, assuming that the administration of T will increase the levels of the metabolites (Fig. 7.3.4.2).

Only a few markers revealed detection ability based on individual threshold after transdermal testosterone administration. While the concentration of EG, DHEAG and ES never rose beyond the individual threshold, the best markers were TG, the TG/EG ratio and the AG/EG ratio. Individual thresholds were reached for 13 volunteers out of the 19, and the effect was less pronounced for the del/del genotype, as expected. The elevation of those markers after T patch administration followed the slow-kinetic release of the topical route with detection time mostly between eight hours and 24 hours after T patch administration. The
other targeted steroids quantified in the urinary samples were not notably modified after T patch administration. While the classic biomarkers used to screen for T misuse were not able to detect low T transdermal dose administration, the longitudinal follow-up of these markers based on subject-based thresholds presented higher detection ability predominantly at time 24 hours after patch application. However, most of the parameters remain below the individual threshold for the individuals bearing the del/del genotype. Regarding subject-based detectability after TU pill administration, the most relevant biomarkers were glucuro-conjugated analytes including TG, AG, EtioG, 5αββ-AdiolG, DHTG, as well as the ratios TG/EG and AG/EG. However, TG, 5αββ-AdiolG, DHTG, TG/EG and AG/EtioG ratios could not detect exogenous intake of TU by individuals bearing the del/del genotype. For all of the elevated markers and in accordance with several studies, the detection window ranged from two hours to 12 hours, with an excretion peak between four hours and 12 hours and returned to the baseline level 24 hours after pill intake. Based on individual threshold strategy, the integration of multiple parameters in a longitudinal follow-up could enhance the detection ability and discrimination power between confounding factors, individual biological variability and oral TU intake doping.

What we learned from the study

While UGT2B17 polymorphism was highly linked to TG excretion in this study, the UGT2B15 polymorphism could not be highlighted to influence specific metabolites excretion. Therefore, due to the complexity to integrate those data, longitudinal follow-up of individuals was the strategy of choice. This is particularly important because classical criteria based on the urinary steroid profile are not adequate to reveal T misuse via topical route and the detection of administration of high oral dose is limited to short time post dose. Based on this approach, transdermal T application consisting in low dose and slow-releasing kinetic could be detected at several time points by following TG or the ratios TG/EG and AG/EG. After 80mg oral TU ingestion, the sulfo-conjugated analyte EtioS was revealed as a promising biomarker, especially for individuals having a deleted UGT2B17 genotype. Additionally, hydroxy metabolites were highlighted as potential long-term detection markers of TU. The results confirmed this hypothesis, with an increase of this marker after TU intake even for individuals bearing the del/del genotype. Subject-based references, as found in the ASP, implemented with novel biomarkers (hydroxy-, sulfo-conjugated) would thus be the most adequate tool to screen for T misuse. Eventually, the blood matrix collected during this clinical trial will constitute invaluable complementary information to reveal T doping as a future perspective. In addition, as an untargeted acquisition over the entire selected mass range was possible with the QTOF mass spectrometer, unknown markers could be extracted. In the future, the predictive ability of these markers will be investigated with respect to T transdermal and oral administration, without necessity to re-analyse the samples. The selection of untargeted metabolites is promising for a broader steroid profiling on fresh and well-structured clinical study samples.

Duration: 2012 - 2013
Country: Switzerland
Cooperation: Swiss Laboratory for Doping Analyses (LAD), University of Lausanne, Switzerland
References:
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THE FIGHT AGAINST DOPING IN FOOTBALL | F-MARC PROJECTS

7.3.5 Influence of Multiple Injections of
Human Chorionic Gonadotropin (hCG)
on Urine and Serum Endogenous
Steroids Concentrations

Why we conducted this study

The attractive characteristic of testosterone as a doping
agent is its endogenous production by the human body
making the identification of an exogenous intake much
more complex. The urinary steroid profile, including
absolute concentrations of testosterone related compounds as well as ratio between testosterone and its
epimere epitestosterone (T/E ratio) and other ratios of
various androgens, is of central importance in doping
controls. However evaluation and quantification of steroids in urine are subjected to variations. In particular,
treatment with hormones such as luteinising hormone
(LH) and human Chorionic Gonadotropin (hCG) are
forbidden by WADA due to their physiological roles
linked to testosterone metabolism in the body. There is
unequivocal evidence that hCG in males causes testosterone to be produced and released. Hence, sportsmen
could use hCG to boost endogenous testosterone production but also to compensate a prolonged use of anabolic steroids disrupting the regulation of steroids production in the human body.
A mixture of hCG forms are found in the urine matrix,
which has a significant impact on the recognition of
samples by the multiple hCG immunoassays tests available on the market. Hence, an immunoassay sensitive to
the whole pool of hCG forms seems to be fit for purpose in the fight against doping. Another concern about
the quantification of urinary hCG is the setting of the
decision limit above which an atypical finding could be
considered. Indeed, as direct hCG quantification is now
considered as the only value to deter doping with hCG,
a cut-off value should be evaluated for each immunoassay as no standard tests are imposed by the WADA.
Commercially available assay has been validated for
quantitative serum hCG measurement whereas only
qualitative estimation of urine hCG concentration was
possible. As urine is currently the mostly used biological matrix for anti-doping tests, the lack of immunological tests allowing an exact measure of urinary hCG is the
first difficulty to detect hCG doping. Secondly, and even
if the Minimum Required Performance Limit (MRPL)
imposed by WADA is fixed at 5mIU/mL, this does not
mean that an adverse analytical finding should be report-

ed at a concentration above this value, considering that
over production of hCG could become from tumor cells.
It is therefore complex to put forth doping with hCG in
male athletes using only the urinary matrix.
In 1979, the urinary ratio between testosterone and LH
to detect doping with testosterone was first presented.
The value of this urinary T/LH ratio was confirmed by
additional studies either as a more reliable marker for
testosterone abuse or for additional information to the
more generally used T/E ratio in urine. As hCG misuse has an impact on endogenous testosterone and LH
production, this T/LH ratio should also be a marker of
hCG abuse.
In this study, we aimed to evaluate the effect of three
intramuscular injections of rhCG on urine and serum
concentrations of LH, hCG and androgens to put forward additional markers to direct urinary hCG detection
and serum T/LH ratio for gonadotropin abuse in sports.

Aims of the study

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UÊ««ÞÊÌÊL}V>ÊÃ>«iÃÊViVÌi`Ê>vÌiÀÊÌ ÀiiÊ Ê
injections at days 0, 2 and 4 from ten healthy male
volunteers. Evaluation of serum LH, hCG and T and
urinary LH, hCG and steroid proﬁle variations

How we collected the data

During the method development part of the study, T, E,
androsterone (A), etiocholanolone (Etio), 5α-androstan3α,17β-diol (5α-diol), 5β-androstan-3α,17β-diol
(5β-diol), dehydroepiandrosterone (DHEA) and dihydrotestosterone (DHT) were extracted from urine samples by liquid-liquid extraction (LLE) using tertbutylmethyl ether (TBME) and derivatised prior to injection,
resulting in a 20 times concentration factor for the
analytes. Samples were then analysed by GC-MS with
a suitable temperature programme to selectively separate the target compounds in 14 min. This simple and
rapid method was validated in compliance with authority guidelines and showed a limit of quantification and
linearity ranges from 0.5 to 450ng/mL for T and E, 100
to 8,000 for A and Etio, 2 to 450 ng/mL for 5α-diol and
5β-diol, 2 to 180ng/mL for DHEA, and 1 to 180ng/mL
for DHT.


the successive injections while the rest of the individuals presented stabilisation. It is known that when hCG is intra-muscularly administered, the maximum plasmatic level is reached between two and six hours. Furthermore, hCG is eliminated in two phases with a first of 8–12 hours and a second of 23–37 hours, principally in the kidney. As a consequence, the inter-individual variability observed in the excretion through urine is more important than in serum. The concentrations observed in the spot urines were comparable to serum levels for eight individuals, but two other subjects presented very low levels of urinary hCG.

The mean level in all subjects of serum T increased 12 hours after the first injection and increased some more after 24 hours. Likewise, the mean value increased 24 hours after the second injection. Twelve hours after the last injection, the mean serum concentration was slightly decreased. Interestingly, the mean testosterone level in serum was significantly decreased twelve days after the last injection dose compared to the basal level. It is important to note that at the basal level, the circadian influence on T production was significant with a higher value on morning blood samples than evening. The same difference was observed on the two last samples collected in the morning and the evening 12 days after the last injection.

The serum LH level decreased along the study due to the negative feedback on the hypothalamopituitary axis (HPA) performed by T up regulation. The average LH basal level remained stable 12 hours after the first injection and decreased after 24 hours and further on after 48 hours. The average LH concentration remained low 24 hours after the second injection and 12 hours after the last injection. Twelve days after the last injection, the
LH level among volunteers was not significantly different from the basal concentrations measured before the first treatment.

As a consequence, the T/LH ratio in serum was subjected to a major increase due to hCG administration (Fig. 7.3.5.1). The average basal ratio value was 4.6 and increased to 6.3 after 12 hours and 13.3 after 24 hours. At the second injection time, the T/LH ratio was of 24.9 and increased to 44.3 after 24 hours. A large inter-individual variation was observed on the T/LH ratio mainly due to the T response to hCG injections. Three individuals presented a decrease of the T/LH ratio between the second injection and 24 hours later essentially due to a rapid tendency to recover basal LH levels. Twelve hours after the last injection, the influence on the T/LH ratio was still important. And as a consequence of the low T level 12 days after the last hCG injection, the T/LH ratio was significantly below the basal value.

Urinary T excreted under its glucuro-conjugated form adjusted to specific gravity presented essentially similar pattern to serum except that the inter-individual variability was much higher. Two subjects presented a steroid profile typical of individuals devoid in UGT2B17 with an average basal T glucuronide level in urine significantly inferior. Only for individuals with inserted UGT2B17, the T increase in urine was significantly delayed compared to serum 24 hours after the first injection, at the second injection time and 24 hours after the second injection. The excretion patterns of the steroid profile were similar to T with differences in the accumulation after the successive injections of hCG. This explains for instance the non-significant variation for the T/E. It is important to note that a significant difference in basal values of the A/Etio ratio was observed between samples collected on mornings and evenings. In order to compare A/Etio levels along the study, morning values were compared to morning basal values and evening values to evening basal values. This ratio was significantly increased from 12 to 24 hours after the first injection, at 12 hours and 24 hours after the second injection and 12 hours after the last injection with a maximal value observed 12 hours after the last injection. If the elimination kinetic is similar to T for the other steroids, the recovery of basal values 12 days after the study was different regarding the steroid. While E followed the same significant tendency as T, i.e. to be below the basal level, A, Etio, DHT, 5α-diol, 5β-diol and DHEA were not significantly different from basal values 12 days after the last hCG injection.

Regarding urinary LH, the profiles were not significantly influenced by the hCG treatment during the whole protocol, however unpredictable fluctuations were observed. Nevertheless, the T/LH ratio in urine was studied as an alternative to the T/E ratio to deter hCG administration, particularly in UGT2B17 deleted individuals. The hCG injections affected the T/LH ratio by an increase of up to 110 times when the maximum T/E increase in UGT2B17 del/del subjects is of 1.9 times.

Relative serum T/LH (absolute values corrected by the individual basal values) as biomarker of hCG administration presented the highest discriminating power, followed by T in serum and T in urine. Due to the difficulty to measure low concentration of LH in urine, the T/LH ratio in urine was prone to outliers’ events in some cases. In order to satisfy anti-doping requirements, the cut-offs were defined for a maximal specificity.
What we learned from the study

The hCG pharmacokinetic observed in all subjects was, as expected, prone to important inter-individual variations. Using ROC plots, level of T and T/LH ratio in both blood and urine were found to be the most relevant biomarker of hCG abuse, regardless of inter-individual variations. This study showed the crucial importance of reliable quantification methods to assess low differences in hormonal patterns. In regard to these results and to anti-doping requirements and constraints, blood together with urine matrix should be included in the anti-doping testing programme. Together with a longitudinal follow-up approach it could constitute a new strategy to detect hCG abuse, applicable to further forms of steroid or other forbidden drug manipulation.

Duration: 2010 - 2011
Country: Switzerland
Cooperation: Swiss Laboratory for Doping Analyses (LAD), University of Lausanne, Switzerland
8. Football for Health

8.1 Prevention of Non-Communicable Diseases

8.1.1 Prevention of Risk Factors for Non-Communicable Diseases

**Why we conducted these studies**

Football’s worldwide governing body (FIFA) attaches particular importance to health. In 1994, an independent research unit was established, the FIFA Medical Assessment and Research Centre (F-MARC), with the objective of developing the scientific basis to protect the health of all players and promote football as a health-enhancing leisure activity. The focus of “Football for Health” is not only on players’ health, but also on the health of society as a whole. Football’s popularity gives it the potential to play a unique role in awareness and prevention of diseases – and at very low costs. FIFA/F-MARC has clear goals: to protect the health of the 265 million active participants worldwide and to promote football as a safe and healthy leisure activity contributing to an improvement in health of the general population.

**Physical demands during small-sided games**

Football practice organised as small-sided games for two to 14 players provides a marked physiological response even for youngsters, elderly and untrained individuals.

**Effect of regular participation in small-sided games on performance and muscle adaptations**

Football training for 12–16 weeks carried out as small-sided games two to three times (one hour) a week of untrained middle-aged male and female players without prior experience with football, led to e.g.:
-Enhanced lean body mass and leg muscle mass
-Enhanced maximal dynamic hamstring muscle strength
-Improved postural balance

Thus, 12–16 weeks of football training is sufficient to induce a variety of performance enhancements and muscular adaptation, which can be maintained, and some further elevated if training is continued even at a reduced frequency.

**Health benefits of regular participation in football practice**

Football training for 12–16 weeks carried out as small-sided games two to three times (one hour) a week for untrained middle-aged men and pre-menopausal women, without prior experience with football, led to e.g.:
-Reductions in resting heart rate as well as both systolic and diastolic blood pressure
-Lowering of fat mass
-Increased leg bone mineral content

Regular football practice has considerable positive effects on the health profile of middle-aged women and men, particularly for those exhibiting mild-to-moderate hypertension.

**Social and psychological effects**

The psychological effects of football training organised in small groups of 10–20 participants, most of whom...
were untrained and had no particular prior experiences or skills, were as follows e.g.:
• A rewarding psychological state, during football training
• Moderate ratings of perceived exertion and low scores for worry
• Football training is fun and a rewarding activity with the social capital and health promotion

Comparison of football training and endurance running
Regular recreational football training was compared with endurance running in a number of studies using physiological, psychological and sociological methods. Most of the results and adaptations were the same for football and running, but in a number of areas football training exceeded that of endurance running, e.g.:
• Greater variation in heart rate and anaerobic energy turnover
• Increase in muscle mass and elevation in VO$_2$\text{max}
• Motivated by the activity and fun and being together in the group

Effects of lifelong participation in football practice for the elderly
Elderly men (63-78 years) exposed to lifelong football had superior muscle force characteristics and better postural stability compared with untrained age-matched individuals, and the same levels as untrained young men. A higher rate of force development in the football-trained elderly could be attributed to qualitative neuromuscular and tendinous factors, such as motor unit firing rate and tendon stiffness, rather than quantitative factors such as muscle size.

Effects of regular participation in football practice for children and youngsters
Football training has been demonstrated to enhance intermittent exercise performance, coordination and maximum oxygen uptake of children and teenagers. In addition, for obese children, regular participation in football training is at least as efficient in improving the physical capacity, health-related fitness parameters and self-esteem as a standard exercise programme. Long-term studies of children and youngsters playing football at different ages with proper control groups are warranted to obtain evidence-based recommendations for using football in the early treatment of obesity and related co-morbidities in childhood.

What we learned from the study
The studies demonstrated that carrying out regular football training organised as small-sided games two to three times a week, causes significant cardiovascular and muscular adaptations, including muscle growth and elevated muscular strength independent on the level of training, lack of experience with football, gender and age. The effects can be maintained for a long period even with a reduced frequency of training to one to two times for one hour a week. Recreational football, therefore, appears to be an effective type of training leading to performance improvements and significant beneficial effects to health, including a reduction in the risk of cardiovascular diseases, falls and fractures. In a number of aspects, football training appears to be superior to running training. Football training can also be used to treat hypertension and it was clearly superior to a standard treatment strategy of physician-guided traditional recommendations.

The supplement papers reveal that football is a motivating activity that promotes social interactions and has the potential to facilitate adherence to an active lifestyle. The supplement offers scientific evidence that football can be promoted as a health-enhancing leisure activity.
8.1.2 Prevention and Treatment of Non-Communicable Diseases across the Lifespan

Why we conducted these studies

On the occasion of the FIFA World Cup™ in South Africa in 2010 and in the same journal, a special issue was dedicated to the prevention of risk factors for non-communicable diseases through playing football. The 13 original papers concluded that football, the most popular team sport in the world, is associated with positive motivational and social factors that may facilitate compliance and persistence with the sport and at the same time contributes to the maintenance of a physically active lifestyle (8.1.1).

The original studies demonstrated that carrying out football training on a regular basis, two to three times a week, caused significant cardiovascular and muscular adaptation, including muscle growth and elevated muscle strength, irrespective of the level of training, experience of the game, gender, and age.

The results of extensive scientific studies have been simplified in the slogan “Playing football for 45 minutes twice a week – best prevention of non-communicable diseases”, first presented at the 59th FIFA Congress in Nassau. In line with this, the editor-in-chief of the British Journal of Sports Medicine, Karim Khan, promoted the slogan “The exercise pill – time to prescribe it”. Given its popularity, football might be the appropriate exercise pill to prescribe and promote.

The research group from Copenhagen, under the leadership of Professors Peter Krustrup and Jens Bangsbo, joined forces with FIFA/F-MARC (FIFA Medical Assessment and Research Centre) as a number of questions remained unanswered following the research presented in 2010. During the past four years, these questions have been investigated in a large multi-national study covering Denmark, England, Portugal, and Brazil. Using the momentum of the 2014 FIFA World Cup Brazil™, this special issue of the journal presents 16 original papers with convincing data.

Aims of the studies

- Support the continued promotion of football as a health-enhancing leisure activity that improves social behaviour
- Justify the implementation of the “FIFA 11 for Health” programme, backed and approved by the 2013 FIFA Congress, as a global health initiative

Method

The team of international researchers has thoroughly investigated numerous groups of inactive subjects across the lifespan in a prospective controlled manner. These studies, which include groups of children aged 9-13, adult women and men up to the age of 80, have produced impressive results that cannot be ignored by public health policy-makers around the globe.

Results

Football conducted as small-sided games affects fitness and health of untrained individuals across a wide range of lifespan. The intermittent nature of football and high exercise intensity result in a broad range of effects. The heart changes its structure and improves its function. Blood pressure is markedly reduced with the mean arterial blood pressure being lowered by ~10mmHg for hypertensive men and women training two to three times/week for 12–26 weeks. Triglycerides and cholesterol are lowered and body fat declines, especially in middle-aged men and women with type 2 diabetes. Furthermore, muscle mass and bone mineral density increases in a number of participant groups, including 65–75-year-old men. The functional capacity is elevated with increases in VO2max of 10–15%, and 50–100% improvements in the capacity to perform intermittent work within 16 weeks. These effects apply irrespective of whether the participants are young, overweight, elderly or suffering from a disease.

The 16 original papers of the supplement describe in detail how fitness and health of each group was affected:
- Hypertension: Two articles describe football as an effective broad-spectrum treatment for hypertension in middle-aged Danish men (Andersen L.J. et al) and mature Faroese women (Mohr et al).
- Type 2 Diabetes: two articles describe the positive cardiovascular and metabolic effects of football for
type 2 diabetic men in Denmark (Andersen T.R. et al. 2014a) and Brazil (de Sousa et al).

- Untrained 65+ years population: Four articles present a brand-new insight into the effects of football for 65- to 80-year-old untrained men who have never played football before, describing marked improvements in heart function (Schmidt et al), physical capacity (Andersen T.R. et al) and bone strength (Helge et al) as well as elevated muscle mass for prostate cancer patients despite anti-androgen treatment (Uth et al).
- Self-esteem and physical competence of children: Three articles cover the effects of football for 9- to 12-year-old children, showing improved cardiac function after short-term school football in Denmark (Krustrup et al), enhanced self-esteem, perceived physical competence and attraction to physical activity for obese boys after short-term school football in Portugal (Seabra et al) and effective training through club football for recreational and elite U-10 and U-13 players in Denmark using 5v5 and 8v8 matches (Randers et al).
- Homeless population: Helge et al describes the positive effects on muscles, bones and postural balance for homeless men playing street football in Denmark.
- Untrained middle-aged population: Randers et al describes and explains the high intensity during football training for untrained men irrespective of the number of players.
- Motivation and social aspects: Three articles describe the positive psychosocial benefits of football for middle-aged men (Nielsen et al), elderly men (Bruun et al) and mature women (Bennike et al. 2014), covering the motivational and social aspects of football.

**What we learned from the study**

The supplement articles reveal that football has a great potential in the prevention and treatment of non-communicable diseases across the lifespan. Given that football is easy to organise as an intense and effective broad-spectrum type of training it shows a great promise in changing the habits of untrained people all over the world, creating adherence to a physically active and healthier lifestyle.
8.2 “FIFA 11 for Health”

8.2.1 Development and Evaluation in Different Settings

Why we conducted these studies

The World Health Organization (WHO) has identified the major worldwide mortality risk factors, and has estimated that, by 2020, preventable non-communicable diseases will be responsible for ~70% of deaths. Only 20% of chronic disease deaths occur in high-income countries, 80% occur in low and middle-income countries.

In 2006, FIFA recognised the unique role of football in the promotion of exercise and health behaviour. Given the strong evidence that exercise is suitable as a therapy for a wide range of diseases, and football being the most popular sport worldwide, FIFA decided to help to reduce the burden from communicable and non-communicable diseases to its best endeavours. This led to the development of a football-based health education programme, which was named “Football for Health”, and was first implemented in South Africa in 2009. In 2010, the programme was then implemented in Mauritius and Zimbabwe, and received its current name “FIFA 11 for Health”.

Aim of the studies

- Develop, implement and assess an interactive, football-based health education programme for children in South Africa, Mauritius and Zimbabwe

Method

In the initial stage, two focus groups comprising doctors, researchers and representatives of government and non-government organisations from Africa met in 2007 to discuss the build-up of the programme. It was decided that the implementation and evaluation of the programme should follow the ten-stage process already proposed by the WHO for AIDS health promotion programmes. Two additional health messages were added to the programme: “use of bed nets” to prevent the spread of malaria and dengue fever, and “respect for girls and women” to reduce the spread of sexually transmitted diseases. It was based on three factors: (1) the prevalence of communicable and non-communicable diseases in the area; (2) the availability of local organisations with sufficient experience to help deliver the football-based health education programme on site; (3) access to a suitable group of men/women who could be trained as instructors and coaches and who were fluent in the local language and familiar with local culture. To strengthen the appeal of the programme, each health message received the support of an international elite football player as a role model to encourage children to follow the programme.

The intervention consisted of 11 90-minute sessions, divided into two 45-minute halves of Play Football (football skills) and Play Fair (health issues). Each session focused on one specific health issue or health risk factor. Main outcome measures for the implementation were: (1) health knowledge using a 20-item (South Africa), and 30-item questionnaire (Mauritius; Zimbabwe), implemented pre- and post-intervention; (2) coaches’ attitudes towards their training using a ten-item questionnaire (South Africa); and (3) children’s attitude towards the health education programme using a six-item questionnaire designed with the Likert scale.

Based on the results from a pilot study, it was suggested that a sample size of ~110 children would be needed to identify with 95% confidence and 90% power an increase in the proportion of correct responses to 80% after the intervention. It was assumed that an overall loss of ~25% would occur in the follow-up so that the minimum initial sample size required in each group should be ~150 children.

The implementation took place in 2009 in South Africa in two schools, and in 2010 as in-school intervention at 11 secondary schools on Mauritius and as an out-of-school intervention using local coaches in Zimbabwe. Overall, three groups of 370-395 school children aged 12-15 participated in the implementation.

Results

South Africa: Average attendance levels were 89.5% for the intervention group, grade 7; 93.9% for the control group, grade 7; 93.4% for the intervention, grade 6. There were no significant differences between the number of boys and girls included in each group, and no statistically significant differences in the demographic data for the children. Responses to the health-related statements were measured at an overall accuracy of 99.7.
Compared with pre-intervention levels, the intervention grade 7 group showed significant increases in knowledge for nine of the 20 health statements at the post-intervention assessment and for 11 of the 20 statements at the three-month follow-up assessment. In the health issues, knowledge of coaches was a significant gain in the intervention group but no change was observed in the control group after their “Play Football” training programme.

In Mauritius and Zimbabwe, average attendance levels were 92.3% and 86.6%, respectively. There were no significant differences between the number of boys and girls included in the cohorts in either country. At the post-intervention stage, responses to 21 statements were significantly higher in Mauritius. On average, knowledge enhancement from pre- to post intervention was similar in both countries. In Mauritius, there were two statements resulting in significantly different responses between boys and girls at the pre-intervention stage—both of these related to the health message “respect girls and women”.

**What we learned from the study**

Results from these studies demonstrated that it was possible to implement an education programme for children containing valuable health messages linked to football and to achieve significant improvements in knowledge regarding a number of health issues. Importantly, the knowledge gained was retained beyond the end of the programme. The positive outcome of these studies suggests a further development of the “FIFA 11 for Health” programme, and large-scale implementation in different countries and different settings.

The results from all three countries showed that the programme was effective for girls and boys, and equally well received by girls in the different countries. It could be demonstrated that new forms of partnerships for developing health promotion programmes can be developed successfully between non-governmental organisations and national Football Associations. The studies show that the “FIFA 11 for Health” programme can indeed be scaled up to accommodate large numbers of children.
8.2.2 Planning a Nationwide Implementation

Why we conducted this study

The social and economic burden associated with communicable diseases, such as HIV/AIDS, malaria and gastrointestinal diseases, is a major concern in the developing countries of Africa. According to WHO reports however, non-communicable diseases, such as coronary heart disease, hypertension, and diabetes will become an even greater problem by 2030, if no appropriate preventive actions are taken.

Since 1994, FIFA/F-MARC has been committed to research aimed at improving the health prospects of football players of all levels of skill in different environments around the world. In 2006, the centre moved its research focus from “Medicine for Football” to “Football for Health”: the main objectives being to use the popularity of football to encourage greater physical activity among all age groups and to deliver health education to children in developing countries.

“FIFA 11 for Health” is a football-based health education programme for children, developed by F-MARC, and consisting of 11 simple messages designed to address the most common risk factors for communicable and non-communicable diseases.

Aims of the study

- To address important health issues already identified by the Mauritius Ministry of Health among schoolchildren in Mauritius and to develop a long-term strategy for the direction and implementation of the “FIFA 11 for Health” programme within the country
- To set up and present a football-based health education programme, which is sustainable through capacity-building of local stakeholders and acceptable to government health and education departments
- To exercise all steps of organising, planning, implementing and monitoring requirements needed to deliver the “FIFA 11 for Health” programme nationally and to establish thereby, a case study for community-based educators who wish to implement this, or similar, sport-based health education programmes in their country
- To gain knowledge about the issues involved in transferring the ownership of the “FIFA 11 for Health” programme to national bodies

Method

Planning

Moving from a regional pilot study completed successfully in South Africa, Mauritius and Zimbabwe to a nationwide project in Mauritius meant that additional concepts, such as the individual, organisational and social dimensions of the health promotion, as well as additional implementation issues had to be considered. Furthermore, given the large scale of the project, it was necessary to distribute lead responsibilities for various aspects of the project.

Implementation

a) Pilot study

An implementation protocol for the delivery of the “FIFA 11 for Health” programme was developed by F-MARC which included: (1) preparation of a manual; (2) arrangements for teachers’ training courses and (3) a time schedule for delivering the teachers’ training courses, the interventions and the pre- and post-course programme evaluation questionnaires. Schools were recruited with the help of the local coordinator and upon assessment visits by F-MARC. Teachers from the participating schools together with football coaches from the Mauritian Football Association (MFA) were taken through a five-day interactive training course by F-MARC.

b) Nationwide project

A local organisation was established that could oversee and ensure the delivery of a successful project to ~17,000 children studying in ~200 schools. Two “zone leaders” (North/South) were recruited to work with the local coordinator at the MFA.

Monitoring & Sustainability

The efficacy of the “FIFA 11 for Health” pilot and nationwide projects was assessed using questionnaires. Data analyses for the pilot and nationwide projects were completed by F-MARC. The sustainability of the project was safeguarded through a cost-effective approach using a tripartite agreement between F-MARC, the country’s football association and the appropriate government departments. To safeguard an ongoing support, F-MARC provided a reduced level of support in Mauritius for two years beyond the first nationwide implementation.
**Materials used to support the pilot and nationwide project**

The successful implementation of a football-based education programme requires the input of informative literature and other resources. F-MARC developed a manual for the training course and provided teachers with a summary of (1) the skills required to deliver the programme, (2) the content of each of the 11 sessions, (3) the timings for each aspect of each session, and (4) health information sheets that contained additional information to support the teachers when answering children’s questions during session discussion periods. Activity cards were used to highlight issues related to the session’s health topic, and the equipment needed for implementing the interactive games in each session was distributed. Health knowledge questionnaires and attendance records were applied to evaluate the project.

**Results**

The pilot study produced an 18% absolute increase in post-intervention health knowledge across the health messages, which was equivalent to a 26% relative increase against the children’s baseline knowledge level. The nationwide study produced a 14% absolute increase in the post-intervention health knowledge across the health messages, equivalent to a 22% relative increase against the baseline knowledge level.

An independent assessment of the development and implementation of FIFA’s “Football for Health” philosophy, which includes the “FIFA 11 for Health” programme, concluded that it fulfilled all eight components of Kotter’s model for strategic change. The implementation of the “FIFA11 for Health” programme in Mauritius was considered to have met the objectives set out at the beginning of the project and, importantly, was considered to be a success by F-MARC, the MFA and the Mauritius Government Departments of Health, Education and Sport.

**What we learned from the study**

This study demonstrated that it is possible to develop and implement a large-scale football-based health education programme, which is adaptable to different national and regional settings and sustainable through the integration and cooperation of local stakeholders and appropriate governmental bodies.

The study drew attention to issues involved in transferring the ownership of the “FIFA 11 for Health” programme to national bodies and showed that adapting or changing individual health messages from the programme may be necessary or even crucial as differing health issues may predominate in the various countries.

The positive results of the measured post-intervention health knowledge among children and the overall positive response from teachers and coaches, governmental and non-governmental bodies shows that a football-based health education programme such as the “FIFA 11 for Health” programme is capable of attracting the support and commitment of local and national stakeholders. It presents a promising tool in the fight against communicable and non-communicable diseases as defined by the WHO.
8.2.3 Implementation in Five African Countries

Why we conducted this study

In 2007, the FIFA Medical Assessment and Research Centre (F-MARC) recognised the important contribution that football could make to health in the community and began developing a football-based health education programme for the children of Africa, entitled “FIFA 11 for Health”. The programme was intended to be a medical legacy for Africa following the 2010 FIFA World Cup South Africa™. The programme was designed to address risk factors associated with the most common non-communicable diseases, such as cardiovascular disease, hypertension and diabetes, and communicable diseases, such as HIV, malaria and diarrhoeal diseases, encountered in sub-Saharan Africa. The rationale behind the development, content, implementation and evaluation of the “FIFA 11 for Health” programme has been described in detail previously. The programme was developed following input from 14 experts working in areas of health, education and physical activity: the contributing experts came from ten countries on three continents but all had intimate knowledge and experience of the specific problems and issues related to developing and delivering health-related programmes in Africa.

The FIFA programme was first implemented and evaluated in South Africa in an out-of-school project involving children (mean age of 13.3 years); later it was evaluated in Zimbabwe in an out-of-school project involving children (mean age of 11.5 years) and in Mauritius in an in-school project (mean age of 13.0 years). All three projects resulted in significant increases in the children’s health knowledge but it was concluded that the programme would be more likely to achieve nationwide acceptance and sustainability if it were delivered within the school curriculum in collaboration with the country’s Ministry of Education and Football Federation.

Aim of the study

• To assess the effectiveness of the “FIFA 11 for Health” programme in increasing children’s knowledge about communicable and non-communicable diseases in five countries of Sub-Saharan Africa

Method

A prospective five-cohort study was implemented in schools in Ghana (17), Malawi (12), Namibia (11), Tanzania (18) and Zambia (11). The programme consisted of eleven 90-minute sessions consisting of two 45-minute halves of Play Football (football skills) and Play Fair (health issues). Participants were boys and girls aged 10–14 years: Ghana (906), Malawi (1098), Namibia (439), Tanzania (720), Zambia (651). The main outcome measures recorded were children’s attendances at each session, their health knowledge (30-item questionnaire) before and after the interventions and the children’s evaluation of the programme itself by means of a six-item questionnaire.

Results

Mean attendance by children during the “FIFA11 for Health” programme ranged from 88% (Malawi) to 99% (Tanzania) of participants. The proportions of children responding correctly to each question in the pre- and post-intervention health-knowledge questionnaires are presented as percentage changes (absolute) in mean knowledge value for each health topic and each country Figure 8.2.3.1. Pre-intervention questionnaire responses in the five countries showed that the mean level of children’s health knowledge fell into two distinct groups, namely, a higher-knowledge group consisting of Malawi (74.7%) and Tanzania (71.3%) and a lower-knowledge group consisting of Ghana (61.3%), Namibia (57.9%) and Zambia (57.5%). The health topics showing the biggest differences in knowledge between the high- and low-knowledge groups related to HIV/AIDS, malaria, hygiene and vaccination. Post-intervention, the level of health knowledge increased significantly (p ≤ 0.001) in all countries for a large number of the 30 health-related questions (Ghana: 29; Malawi: 20; Namibia: 29; Tanzania: 24; Zambia: 25). Increases in the children’s overall level of health knowledge were recorded in all countries: range: 11% (Malawi) to 25% (Namibia). Children’s overall evaluation-rating of the programme was very positive in all countries, ranging from 93% (Zambia) to 98% (Namibia, Tanzania).
What we learned from the study

The “FIFA 11 for Health” programme produced significant increases in children’s health knowledge and their awareness of disease prevention using an in-school, football-based health education programme. This success was most likely linked to the very high satisfaction rating given to the programme by the children involved. The success of the interventions also demonstrated the benefit of collaborating with the Ministries of Education in each country.

This study demonstrated that the “FIFA 11 for Health” programme offers an effective way of engaging with children in order to increase levels of physical activity and to enhance health knowledge, improve understanding of health risk factors and provide guidance on prevention strategies for the major diseases in sub-Saharan Africa. When delivered through national education systems, the programme has the potential to reach a very high proportion of the target population. The results obtained are most likely linked to the very high satisfaction rating given to the programme by the children involved, which was reflected in the high attendance levels achieved during each session. The results obtained also demonstrate the contribution that international sports governing bodies can make in health education and helping to reduce the prevalence of communicable and non-communicable diseases in sub-Saharan Africa.

**Duration:** 2010 - 2014

**Countries:** Namibia, Tanzania, Malawi, Zambia, Ghana

**Cooperation:** Namibia Football Association, Tanzania Football Federation, Football Association of Malawi, Football Association of Zambia, Ghana Football Association


Fig. 8.2.3.1: Change in health topic knowledge (% absolute change from baseline value)
8.2.4 FIFA in the Fight against Ebola

Why we conducted this campaign

Just over a year has passed since the Ebola epidemic broke out in West Africa. The Ebola disease, which is transmitted through direct contact with bodily fluids, was first detected in Sudan and the Democratic Republic of Congo in 1976. The current epidemic is the most widespread outbreak of the disease ever recorded. In total, 21,689 cases have been detected, 8,626 of which have resulted in death (WHO, 18.01.2015). There is currently no cure – only the symptoms themselves can be treated. Due to the highly contagious nature of the Ebola virus, taking hygienic precautions is of utmost importance. Ebola will only be conquered if people learn how to protect themselves from infection.

The virus has even had an impact on football in West Africa. National championships had to be brought to a halt, qualification for the 2015 Africa Cup of Nations was an organisational nightmare and the tournament itself was in considerable doubt until Equatorial Guinea stepped into replace Morocco as hosts.

Aims of the campaign

- Raise global awareness through Football in the fight against Ebola
- Educate people about the disease and how to prevent it from spreading

How we conducted the campaign

On 22 September the concept “11 against Ebola” was presented to the FIFA Medical Committee where it was fully supported by the medical doctors and then approved by the FIFA Executive Committee on 24 September 2014.

With the support of the African doctors, experts from the World Bank Group and top football stars, the campaign was completed and presented on 17 November 2014.

International football stars are supporting world governing body FIFA, African confederation CAF and healthcare experts in a global information campaign promoting simple preventative measures to help combat the spread of Ebola. “11 against Ebola” is a campaign encompassing 11 simple messages and featuring Ronaldo, Neymar, Drogba, Lahm, Xavi, Piqué, Obi Mikel, Boateng, Bale, Varane and Guardiola.

Using the umbrella slogans “Together, we can beat Ebola” and #wecanbeatebola, the world stars convey the 11 messages in a multi-media campaign incorporating animated films, commentaries, banners, posters and images.

What we learned from the campaign

In the event of an emergency, we can count on the power of football in helping to lessen people’s misfortune. What we have also learnt is that we have to act faster, be prepared and click into gear should a similar situation occur.

Moreover, the Ebola situation underlines the fundamental philosophy of the FIFA Medical Assessment and Research Centre – prevention.

The football platform proved to be successful in disseminating simple educational messages about health among children through the voice of football stars.

Duration: 2014 - ongoing
Country: West Africa
Cooperation: African confederation, World Bank Group, Healthcare experts
Reference: www.fifa.com/aboutfifa/organisation/the-fifa-weekly/issues/newsid=2512893.html
TOGETHER, WE CAN BEAT EBOLA.

11 PLAYERS, 11 MESSAGES, ONE GOAL

The “11 against Ebola” campaign brings together football stars and doctors from around the world in the fight against Ebola. Share these 11 messages to help reduce the chances of Ebola spreading in your community. Together, we can beat Ebola.

This is a joint campaign from the world governing body of football FIFA, the World Bank Group, the national football associations of Sierra Leone, Liberia and Guinea and doctors from Africa.

REPORT UNUSUAL ILLNESSES

Please report any unusual illnesses or deaths in your community.

KNOW THE SYMPTOMS

Do you have a fever with a loss of appetite, headache, fatigue, pain, vomiting, bleeding or diarrhoea? Know the symptoms of Ebola.

SEEK IMMEDIATE MEDICAL HELP

Please seek urgent medical help if you have a fever with additional symptoms.

AVOID BODY CONTACT

Avoid direct, skin and body contact with anyone suffering from Ebola.

WASH YOUR HANDS AND DISINFECT

Wash your hands regularly and disinfect anything touched by suspected or confirmed Ebola sufferers.

WEAR PROPER PROTECTION

Wear gloves and proper protective clothing if you are caring for an Ebola sufferer, and get the right instruction for the use of protective clothing.

COOK MEAT PROPERLY

Cook all meat and animal products thoroughly before consumption.

ALWAYS PRACTISE SAFE SEX

Use protection if you are having sex with anyone recovering from Ebola.

AVOID CONTACT WITH WILD ANIMALS AND BATS

Wild animals and bats can carry the Ebola virus. Avoid them.

DO NOT TOUCH THE DEAD

Avoid direct contact with dead Ebola victims or anyone who has died from a strange disease.

SEEK HELP FOR SAFE BURIALS

Please seek help from local authorities to bury any victims of Ebola or strange diseases.

11 AGAINST EBOLA

FIFA
9 Citation & Bibliography

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2015


2014


Bizzini M, Silvers HJ.

Bjernerboe J, Bahr R, Andersen TE.

Casartelli NC, Bizzini M, Maffullielli NA, Lepers R, Leunig M.
Rehabilitation and return to sport after bilateral open surgery for femoroacetabular impingement in a professional ice hockey player: A case report. Phys Ther Sport. 2014 Aug 13. [Epub ahead of print]


Feddermann-Demont N, Straumann D, Dvořák J.


Kesti M, Müller M, Becher J, Schnabelrauch M, D’Este M, Eglin D, Zenobi-Wong M.
A versatile bioink for three-dimensional printing of cellular scaffolds based on thermally and photo-triggered tandem gelation. Acta Biomater. 2015 Jan 1;11:162-72

Statistical significance of hair analysis of clenbuterol to discriminate therapeutic use from contamination. Drug Test Anal. 2014 Nov;6(11-12):1108-16

Lislevand M, Andersen TE, Junge A, Dvořák J, Steffen K.

McCall A, Carling C, Nedelec M, Davison M, Le Gall F, Berthoin S, Dupont G.
Risk factors, testing and preventative strategies for non-contact injuries in professional football: current perceptions and practices of 44 teams from various premier leagues. Br J Sports Med 2014 Sep;48(18):1352-7

Melendez JA, Dvořák J, Villalobos JC, Lopez MJ, Torres JD, Palacios JC, Valdés-Olmedo J, Junge A, Fuller C.

Rössler R, Donath, L, Verhagen E, Junge A, Schweizer T, Faude O (2014)


Tschoßl PM.

Vieth V, Schulz R, Brinkmeier P, Dvořák J, Schmeling A.

Wittschieber D, Vieth V, Timme M, Dvořák J, Schmeling A.

Football for Health - Prevention and Treatment of Non-Communicable Diseases across the Lifespan through Football. Supplement of the Scandinavian Journal of Medicine & Science in Sports 2014; Vol. 24(S1)

Blatter JS, Dvořák J.


Randers MB, Andersen TB, Rasmussen LS, Larsen MN, Krstrup P.


Mohr M, Lindenskov A, Holm PM, Nielsen HP, Mortensen J, Weihe P, Krstrup P.


Nielsen G, Wikman JM, Jensen CJ, Schmidt JF, Gliemann L, Andersen TR.


Botré F, de la Torre X, Donati F, Mazzarino M. Narrowing the gap between the number of athletes who dope and the number of athletes who are caught: scientific advances that increase the efficacy of antidoping tests Br J Sports Med. 2014;48(10):833-6


Ljungqvist A. The fight against doping is a fight for the protection of the clean athlete, the health of the athlete and the integrity of sport. Br J Sports Med 2014;48(10):799


2013


Anti-Doping Supplement of the British Journal of Sports Medicine 2014; Vol. 48, No. 10


Ekstrand J, Dvořák J, D’Hooghe M. Sport medicine research needs funding: the international football federations are leading the way. Br J Sports Med 2013;47:726-728


### 2012

**Bizzini M, Hancock D, Impellizzeri F.**

**Bizzini M, Schmied C, Junge A, Dvořák J.**
Pre-Competition Medical Assessment (PCMA) of referees and assistant referees selected for the 2010 FIFA World Cup™. Br J Sports Med 2012;46(5):374-376

**Di Paolo FM, Schmied C, Zerguini AV, Junge A, Quattrini F, Culasso C, Bizzini M.**

**Dvořák J, Fuller CW, Junge A.**

**Dvořák J, Grimm K, Schmied C, Junge A.**

**Fuller CW, Junge A, Dvořák J.**

**Impellizzeri FM, Bizzini M.**

**Kirkendall DT, Zerguini Y, Dvořák J.**
Fasting and Sport: Sawn Ramadan as a model. Journal of the National Soccer Coaches Association of America 2012;48-50

**Kramer EB, Botha M, Drezen J, Abdelrahman Y, Dvořák J.**

**Mountjoy M, Alonso JM, Bergeron MF, Dvořák J, Miller S, Migliorini S, Singh DG.**

**Steffen R, Bouchama A, Johansson A, Dvořák J, Isla N, Singh DG.**

**Weston M, Castagna C, Impellizzeri FM, Bizzini M, Williams AM, Gregson W.**

### Ramadan and Football Supplement of the Journal of Sport Science 2012, Vol 3(51)

**Maughan RJ, Zerguini Y, Chalabi H, Dvořák J.**
Ramadan and football (Editorial) J Sport Sci 2012;30(1 Suppl):S1

**Zerguini Y, Ahmed QA, Dvořák J.**

**Alkandari JR, Maughan RJ, Roky R, Aziz AR, Karli U.**

**Burke LM, King C.**

**Maughan RJ, Shirreffs SM.**

**Drust B, Ahmed Q, Roky R.**

**Chaouachi A, Leiper JB, Chitourou H, Aziz AR, Chamari K.**

**Roky R, Herrera CP, Ahmed Q.**
Sleep in athletes and the effects of Ramadan. Journal of Sport Science 2012;Vol 30(1 Suppl):S57-S84

**Herrera CP.**

**Chamari K, Haddad M, Wong del P, Dellal A, Chaouachi A.**

**Kirkendall DT, Chaouachi A, Aziz AR, Chamari K.**

**Maughan RJ, Zerguini Y, Chalabi H, Dvořák J.**

### Cartilage Injury in the Football Player Supplement of Cartilage 2012, Vol 3(51)

**Mithoefer M, Peterson L, Saris D, Mandelbaum B, Dvořák J.**

**Mandelbaum B, Mithoefer K, Peterson L, Saris D, Dvořák J.**


2010


2011


Dvořák J, Junge A, Derman W, Schwennus M. Injuries and illnesses of football players during the 2010 FIFA World Cup. Br J Sport Med 2011;45:626-630


Schmied C, Dvorák J. Football is the most important unimportant thing in the world. Eur Heart J 2010;31(12):1425-1427


Football for Health - Prevention of Risk Factors for Non-communicable Diseases


2009


BIBLIOGRAPHY | F-MARC PROJECTS


Football and Ramadan


F-MARC Consensus Meeting: Football and Altitude

Supplement of the Scandinavian Journal of Medicine & Science in Sports 2008, Vol. 18(S1)


2006


Women’s Football Supplement of the British Journal of Sports Medicine 2007, Vol. 41(S1)


**Nutrition and Football**

Supplement of the Journal of Sports Sciences 2006; Vol. 24(S7)


**FIFA’s Fight Against Doping**

Supplement of the British Journal of Sports Medicine 2006; Vol. 40(S1)

Blatter JS. FIFA’s commitment to doping-free football. Br J Sports Med 2006;40(1 Suppl):i1


**2005**


Head injuries in Football Supplement of the British Journal of Sports Medicine 2005; Vol.39(S1)


Incidence and Causation of Football (Soccer) Injuries in FIFA Competitions Supplement of the American Journal of Sports Medicine 2004; Vol. 32(S1)


### 2000

**Fuller CW, Smith GL, Junge A, Dvořák J.**

**Fuller CW, Smith GL, Junge A, Dvořák J.**

**Junge A, Dvořák J, Graf-Baumann T, Peterson L.**

**Weston M, Helsen W, MacMahon C, Kirkendall D.**

### 2003

**Mussack T, Dvořák J, Graf-Baumann T, Jochum M.**

**Graf-Baumann T.**

**Giza E, Fuller C, Junge A, Dvořák J.**

### 2002


**Junge A, Rösch D, Peterson L, Graf-Baumann T, Dvořák J.**

### 2001

**Robinson N, Taroni F, Saugy M, Ayotte C, Mangin P, Dvořák J.**
Detection of nandrolone metabolites in urine after a football game in professional and amateur players: a Bayesian comparison. *Forensic Sci Int* 2001;122(2-3):130-135

### 2000 Risk Factors and Incidence of Injuries in Football Players

**Supplement of the American Journal of Sports Medicine 2000; Vol. 28(S5)**

**Dvořák J, Graf-Baumann T, Peterson L, Junge A.**
Football, or soccer, as it is called in North America, is the most popular sport worldwide. *Am J Sports Med* 2000;28(5 Suppl):S1-2

**Junge A.**

**Junge A.**

**Junge A, Chomiak J.**

**Peterson L, Junge A, Chomiak J, Graf-Baumann T, Dvořák J.**

**Chomiak J, Junge A, Peterson L, Dvořák J.**


**Fuller CW, Smith GL, Junge A, Dvořák J.**

**Fuller CW, Smith GL, Junge A, Dvořák J.**

**Junge A, Dvořák J, Graf-Baumann T, Peterson L.**

**Weston M, Helsen W, MacMahon C, Kirkendall D.**
10 Supplements
10.1 Twenty years of the FIFA Medical and Research Centre (F-MARC): From “Medicine for Football” to “Football for Health”

Medicine for Football

In 1994, epidemiological data on the incidence of injuries during major football competitions were scarce. Thus, F-MARC established an injury surveillance system at the 1998 FIFA World Cup France™, and has routinely implemented it in all subsequent FIFA competitions. This database now enables comparison of the incidence and characteristics of injury between competitions for different age, gender and skill-levels, and over time. From the 2002 to the 2014 FIFA World Cup™, the incidence of injuries decreased by 37% (Junge & Dvořák 2015). Reasons for the decrease might be the better preparation of the players for the competition, the strict application of the Laws of the Game by the referees, and also the improved approach of the players towards of fair play.

Since the large majority of the football players around the world are recreational players, F-MARC developed an injury prevention programme for these players based on scientific evidence and best practice. Bizzini and Dvořák (2015) summarised the scientific evidence of the effectiveness of “FIFA 11+” in reducing injuries by up to 50% if performed regularly. Since 2009, FIFA has been disseminating “FIFA 11+” through the network of its 209 member associations (MAs) and implementing the programme on a large scale.

Prevention is possible on the level of recreational football players by implementing the “FIFA 11+” programme. However, the survey on the perception and practice of the injury prevention strategies of physicians from the 32 participating national teams at the 2014 FIFA World Cup Brazil™ documents the need for improvement in developing preventive strategies at top level football (McCall et al, 2015).

The 2014 FIFA World Cup Brazil™ was played in five different regions from temperate to tropical environmental conditions. The web bulb globe temperature (WBGT) was obtained prior to, during and after the match while various physical and technical performance parameters were recorded during each match for both teams. Nassis at al (2015) reported that top-level players seemed to modulate their activity patterns during matches in hot and humid environments to preserve the global match characteristics.

For the first time, FIFA implemented a new anti-doping programme and biological monitoring before the 2014 FIFA World Cup Brazil™ (Baume et al, 2015). All players were tested unannounced prior to the competition, and results from the individual players were then compared with the samples provided after each match during the 2014 FIFA World Cup Brazil™ (two players randomly selected from each team). The steroid profiles of the urine of the players were stable and consistent with previously published publications. The blood parameters showed no significant differences in haemoglobin value between pre-competition and post-match samples. The experience from Brazil documented that the implementation of biological monitoring during the time of a footballers career is feasible, offering more information on the potential manipulation of the body by prohibited substances.

The use of medication has been analysed since the 2002 FIFA World Cup™. More than two thirds of adult male players used medication(s) during the tournament, and more than half were using non-steroidal anti-inflammatory drugs (NSAIDs). Up to one third of the players were using NSAIDs prior to every match. Despite of potential side effects especially of NSAIDs, No decrease in the use of medication was observed during 2014 FIFA World Cup Brazil™ (Tscholl et al, 2015).

Following the tragic death of Marc-Vivien Foé during the FIFA Confederations Cup 2003, FIFA has been fully committed to a programme of standard research education and practical implementation to prevent and manage emergency cardiac arrest on the football field (Kramer et al, 2015). In the meantime, this strategy has been routinely implemented with the aim of detecting football players with a medical risk during mandatory pre-competition medical assessment and by implementing the international accepted guidelines for the interpretation of an athlete’s ECG based upon the Seattle criteria. A clear protocol has been developed and applied for on the field of play for the recognition response, resuscitation and the removal of a player under sudden cardiac arrest. FIFA have introduced and distributed to all MAs the FIFA Medical Emergency Bag including an Automated External Defibrillator (AED). The FIFA Sudden Death Registry has been established at the FIFA Medical Centre of Excellence of the Saarland University to document and examine fatal events in football worldwide (Scharhag et al, 2015).
The effects of recreational football for prevention and treatment of non-communicable diseases from children to mature women and ageing men were summarised by Bangsbo et al, 2015. Regular football training in small-sided games for 45-60 minutes up to three times a week reduces blood pressure, lowers resting heart rate, makes favourable adaptations in cardiac structure and function, improves lipid profile, elevates muscle mass, re-uses fat mass and ultimately improves functional capacity.

The most recent nationwide implementation of the “FIFA 11 for Health” programme is presented by Fuller et al, 2015. The momentum of the 2014 FIFA World Cup Brazil™ was used to prepare the medical legacy of the World Cup in Brazil/South American continent. The programme was delivered to 128 schools in the 12 official Host Cities in five regions of Brazil, jointly with the Brazilian Football Association and the Brazilian Ministry of Health, Sport and Education. The mean increase in health knowledge was 18.4%, and almost 91% of the children gave a positive evaluation of the programme. The study showed that the “FIFA 11 for Health” programme was successfully delivered across the five regions of Brazil, and the results were equivalent to those previously obtained in sub-Saharan Africa.
11 Acknowledgement

The F-MARC-studies could and can only be conducted with the substantial support of a broad number of persons and institutions. F-MARC would like to thank all collaborating experts, team physicians, coaches, research assistants and people “behind the scene” who substantially contributed to the success of the studies and, especially, the players for their participation in the various projects. In particular, we are extremely grateful for the untiring support of the following people and organisations:

FIFA


FIFA Member Associations


Players, Coaches, Referees and Clubs


Collaborating experts

ACKNOWLEDGEMENT | FOOTBALL MEDICINE PROJECTS

Physicians


Research assistants


Players, coaches, team physicians, physiotherapists, managers and representatives of all the clubs and school teams that volunteered to participate in our studies.

Physiotherapists, coaches and instructors


Should we have forgotten to specifically name anyone of our numerous supporters, please accept our sincere apologies, and be reassured of our utmost gratefulness!
### FIFA Medical Committee

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