# Sports Injuries in the EU countries in view of the 2004 Olympics:

# Harvesting the information from existing databases

## (PHASE I)

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## FINAL REPORT

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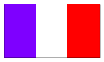

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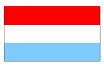

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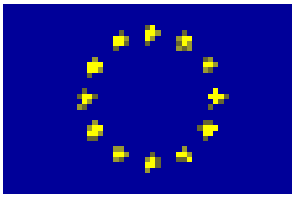

**Athens, January 2001**

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## Contents

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## EXECUTIVE SUMMARY


Sports activities reduce cardiovascular morbidity and mortality, increase fitness, improve quality of life and provide a welcomed shift of attention away from competing but far less beneficial activities. Sports activities, however, also have unwanted side effects, which may be classified in four sections:

1. Sports injuries of variable severity.
2. Adverse short-term health effects among individuals with compromised health.
3. Abuse of performance enhancing substances, including regular doping.
4. Over-concentration in sports activities leading to neglect of education and multidimensional social integration.

Sports injuries represent the most important and the most direct adverse consequence of sports activities. EU has recognized the need to develop indicators reflecting the magnitude and the pattern of sports injuries across the Union. In the context of this program a set of indicators was developed and approved by the participating EU member states and Israel. The development of these indicators followed the realization that:

- The frequency and severity of sports injuries is a function of the popularity as well as the inherent risk of each type of sport activity.
- Sports injuries are concentrated to specific segments of the population whose time weighted exposure is usually very difficult to calculate.
- Sports injuries can repeatedly affect the same individual making it necessary to count not only injured persons but also sport injury events.
- Sources of data for sports injuries vary considerably between and within countries.

In the light of these constraints, priority should be given to a subset that includes sports related indicators on:

1. deaths and mortality
2. number of hospitalizations and incidence rates of hospitalized injuries
3. hospital, including outpatient, contacts
4. cost estimates.

All these indicators, if at all possible, should be specified by gender, age and type of sport activity. Fatality (as contrasted to mortality) and disability indicators can be expressed as proportions among those hospitalized and then projected to the total population at risk on the basis of incidence rates.

Proportional indicators are simpler to calculate but more difficult to interpret, because an increase of such an indicator may either reflect an increase in the numerator or a decrease in the denominator. Thus, it would appear that the principal objectives of this project were to calculate incidence and mortality of sports injuries in EU member states.

Prominent scientists from six EU member states and Israel participated officially in this EU supported project (Austria, France, Germany, Greece, Italy and the Netherlands), whereas Denmark and the United Kingdom volunteered to provide valuable information based on the European Home and Leisure Accident Surveillance System (EHLASS) data collected in the respective countries. Results from the countries reports and overall conclusions are indicated below and summarized in a table.

## Country reports: Austria

The Austrian report is comprehensive and relies on EHLASS data as well as general data from the Austrian Sports Injuries Survey. The report provides estimates of persons injured in sports activities (227.400 or 29 per thousand person years) and the fraction among them admitted to hospital (24.000 or 3 per thousand person years). Sports are responsible for 11% of hospitalizations due to injuries and for 7% of total hospital bed days. The medical cost of sports injuries is estimated 66 million Euros but if the loss of production is accounted for, it reaches 302 million. Sports activities are responsible for 29% of all unintentional injuries. Most accidents are due to soccer

(71 per 1000 person exercising this sport per year), whereas as expected in this country alpine and winter sports in total cause 70.000 injuries per year (about 30% of the total sports injuries). Interestingly, however, the risk of injuries in this sport is lower than that in soccer. The HLA data provide detailed tabulations of injuries by type of sport and the data are generally compatible with those previously indicated from other sources. Hospital admission is lower for organized sports in comparison to unorganized sports (among adults 14% vs. 39%, whereas among children 5% vs. 15%). HLA data also provide tabulations indicating that the riskiest sport for head injuries is bicycle riding, followed by alpine skiing, snowboarding and in line skating, whereas the riskiest sports for fractures are inline skating, ice skating and snow boarding. The Austrian report also contains a valuable table of risk of injury by type of sporting activity together with person time of exposure. Rock climbing and combat sports are the riskiest activities but account for a small fraction of all injuries because relatively few individuals participate in these sports.

## Country reports: Denmark

Denmark was not an official participant at the first phase of the project and thus, did not produce a formal report. Nevertheless, the Danish colleagues provided data, which are particularly valuable, because of their country-wide coverage with representative EHLASS sample. Data shown in the tables of this report indicate that each year about 7600 sports injuries are registered by the former EHLASS among men and 4.700 among women leading to a total of 12.300 sports injuries. The estimated incidence of injuries is highest among those aged 10-19, followed by the age group 20-29 and 30-39. Among men the incidence per thousand person years is respectively about 65, 43 and 20, whereas among women the corresponding rates are 56, 18 and 9. Football causes about 50% of all injuries in men, whereas handball is the leading cause of sports injuries than any other sport among women. About 25% of all sports injuries are seeking medical care in the Accident and Emergency Departments of the hospitals.

## Country reports: France

The French report maximizes the information extracted from the former EHLASS and other sources to provide a picture of sports injuries in France. It is pointed out that every year about 700.000 are treated in the Emergency medical departments as victims of a sport injury. Indeed, for the population between 10-60 years sporting injuries are second only to domestic injuries. Although men sustain, in general more frequently sports injuries on account of their more frequent involvement in sports and their higher risk taking behavior, there is considerable variation of the gender ratio by type of sport. Thus, football and rugby are essentially male sports, whereas equitation and gymnastics are sports with high frequency of female injuries. In France among all sports injuries 29% are football related, whereas another 25% is associated with other team-played ball sports.

This report also provides information from an INSERM study indicating that sport active school children have almost twice the risk of a sport accident compared to those who practice sports only in the school setting. Exposure information is also given as concerns persons involved in various sports, showing that among the age group 14-17 years 87% are practicing some kind of sport activity, whereas 63% participate in organized sport activities. Among the older age groups this proportions range between 60-70% and 20-30%, respectively. Data from this report also indicate that at least in France, young people shift their preference from competitive sports to individualistic high-risk sports, a shift associated with a doubling of risk of death. Given the information from the report and the fact that CFES does not cover all sporting individuals one can estimate that close to 130 deaths due to sports are likely to have occurred.

### Country reports: Germany

The German report is extensive and sophisticated. According to this report, in Germany 2.0 million sports injuries, including school sports injuries, require medical attention and cost 4 billion Euros, of which 1.3 billion is contributed by the insurance system. 13 million pursue their sports in a club, whereas 10 million are not sports members and 13 million are school children. Injuries in each of the three categories correspond to 5-6 % of sports participants.

About 10% of club sports injuries are treated in a hospital for an average length of 11.5 days. The insurance cost of all club sports injuries both in hospital and ambulatory treated slightly exceeds 0.5 billion Euros. For non-club sports there can be no accurate information but inclusion of some serious injuries from alpine skiing implies that hospitalization rate approaches 15% with a total insurance cost of all non-club injuries exceeding that of club injuries. Among school sports injuries about 3.5% are treated in hospital and the remaining are accommodated in an ambulatory setting. The total insurance cost for school sport injuries exceeds 150 million Euros.

This report also includes valuable data on number of injuries by type of sport and context (club, non club, school). These estimates are a function of both the inherent risk of the sport and its popularity. In club sports almost half of the injuries are football related, whereas handball is responsible for about one in six or seven total club sports injuries. The remaining sports are responsible for far fewer injuries. In non-club sports football is responsible for more injuries, although it accounts for only one in six such injuries. Alpine skiing and in line skating, each account for about one in ten non club sports injuries, whereas other non club sports contribute fewer numbers of injuries in non club sports activities. Last, in the context of school sports, football, basketball, gymnastics and volleyball -in declining order- contribute close to 60% of all such injuries. The proportional contribution varies considerably by age and gender mostly as a function of the popularity of each sport in each demographic category.

The body parts injured in declining order are: ankle, knee, head and hand but there is considerable variation by gender, age and type of sport. The report also provides valuable estimates per person time of sport activity with specific estimates for most popular sports (football, basketball, volleyball and handball) varying between one and five per 1.000 person-hours or in a different perspective between 10-15 per 100 person-years.

The German report also allows a ranking of sports by relative risk of traumatic death. High risk sports are airial sports, bicycling, motor sports, canoeing and diving (relative risk estimates higher than 10), whereas football, basketball, handball,

swimming, gymnastics, athletics and most other popular sports have relative risks estimates less than one.

Some approximations had to be done in order to calculate the indices presented in the summary table. 59 deaths were reported in 1997 and 1998 (two years) among the 7.5 million active persons who in turn represent about one third of the members of the German Sports Federation. Thus, the 30 reported deaths per year would correspond to about 60 among all members, another 60 among those participating in non club sports, which generate also the same number of injuries with presumably the same fatality. The number of injuries among school children is approximately the same as among adults non club sports participants, but the fatality among these injuries is lower say, about half as is the proportion of hospitalized (serious injuries) among them. Thus, a total of 140 deaths from sports injuries can be estimated.

## Country reports: Greece

The Greek report relies on the EHLASS data, which has been shown to be a reasonably reliable source, allowing approximate extrapolations to the total country. The estimates from EHLASS were anchored to injury hospitalization data generated by the National Statistical Service of Greece (ESYE). Because there is a mixture of private care and public health care in Greece, the data were supplemented, whenever possible, by additional sources -for example, for professional athletes a systematic collection from the newspapers clips from the athletic press was undertaken, and information derived from the sports physicians' archives. It is of course recognized that systematic errors cannot be confidently excluded and random errors accumulate as we move from the EHLASS sentinel hospitals to the total country, from the latter to the proportion of injuries due to sports and subsequently, from sports injuries presenting at the A&E Departments to those hospitalized. Nevertheless, the estimates derived are compatible to the perceptions of clinical specialists and in line with the more reliable estimates derived from better organized and more developed countries. The general pattern emerging from the Greek data is that fewer people and for less time are involved; that the risk for a sport injury is apparently higher than the

corresponding risk in most other European countries, but the average severity and risk of hospitalization are generally lower.

### Country reports: Italy

The Italian report contains useful information, which is only limited by the fact that it relies on data provided for insured members of the Italian Olympic Committee (CONI). The report provides annual incidence and mortality rates among insured persons; also indicates the frequency of permanent disabilities and the secular decline over a period of ten years of overall sports injuries and disabilities by 24% and 15% respectively and overall deaths by 46%. SPORTASS, the CONI mutual insurance fund for athletes, has published the most recent report in 1996. This report contains information for the more severe injuries, their distribution by age and gender, proximal causes and conditions of injury, site and type of injury, type of sport and amount of compensation.

The annual number of sports injury deaths for a population of 8.5 M insured athletes is 56. Since 15 M Italians are regularly or occasionally sporting it can be estimated that the total annual number of deaths is about 100, to which another 20 should be added for the 20 M who are only reporting some physical activity. Moreover, since the annual number of severe injuries reported among insured persons is 25.833, the total number of severe sports injuries per year in the active population of 35M would be around 105.000. For this calculation the assumption was made that less active people would have the same incidence of severe injuries as more active; this is because lower fitness and sporting expertise implies higher risk, which balances their lower exposure. Additionally, we assume that these injuries, characterized in the report as more severe, could be roughly equated to those that have required hospitalization. We can further assume that hospital admissions represent 10-15% of those contacting the hospital, so that hospital contacts can be estimated as amounting 840.000. Medically attended injuries have been estimated as twenty times as many as those admitted to hospitals, because 20 is the mean of the respective ratios for Germany and the UK, so that they amount to 2.1M. The annual amount spent by

SPORTASS that covers about one quarter of hospitalized injuries in Italy is about 8.2 M Euros.

## Country reports: Israel

The Israel report provides useful information about school sports activities but overall there is little information because a system such as EHLASS is not functioning in this country. In 1998 16.530 cases of injuries were reported to the Israel national Trauma Registry and of those 901 that is 5.4% were sports related. This estimate is lower than those in northern European countries, but similar to that found in Greece. It should be pointed out that information concerning exposed individuals by type of sport is available in Israel as are basic data on the school population. Thus, an EHLASS like system could complement existing sources for the generation of useful and EU comparable data. Meanwhile, preliminary estimates for Israel could be anchored to those for Greece or Italy given geographical proximity and similarities in socio-cultural background.

## Country reports: Netherlands

The report from the Netherlands presents results from the Dutch Injury Surveillance System and also from the household survey “Injuries in the Netherlands”. The results indicate that about 1.5M people suffer sports related injuries per year, out of which 55% do not seek medical care. Specifically, in 1998 170.000 sports injuries presented and were treated at an Emergency Department throughout the country. The highest number of sports injuries is linked to outdoor football on account of the high popularity of that sport and injuries are concentrated in the age group from about 10 to about 45.

The Dutch report from the household survey provides useful information concerning the frequency of injuries from sports relative to injuries from any other type of activity (29%). This amounts to 690.000 injuries per year, half of which are non-medically treated. Among those treated, about 50% sought medical care at an

Emergency Department or by a specialist, generating a number very similar to the 170.000 indicated by the national injury surveillance system. About 4% of sports injuries victims are admitted to a hospital. The Dutch report also provides an insight on individuals still suffering from earlier injuries and on individuals suffering from gradually developing injuries as well as exposure data (annual hours) by individual sports practiced.

## Country reports: United Kingdom

Representatives from the United Kingdom in the Injury Prevention Program contributed thoroughly analyzed data for 1992 and processed data for 1998 from EHLASS. There are no striking differences between the two sets of data, when information for 1998 is crudely evaluated, so we have considered the 1992 data as presented in chapter 19 of the BMJ book "ABCs of sports medicine" [1] and the papers from the mini-symposium: "risks and benefits from sports and exercise" [2-4]. From this report information was abstracted and used to calculate the UK indices in the Table.

The chapter by Ball[1] provides realistic figures of fatal accidents per 100 million person-hours of exposure for selected sports. The results are not incompatible with those provided by Germany and Austria. They indicate that air sports and mountaineering are 30-100 times riskier than soccer and rugby. The material in the chapter is valuable because it also compares risk of death in sports with risk of death in general activities, including occupational activities. Specifically, injury death risk in aquatic sports and horse riding is lower than the corresponding risk of a cyclist. There is also information in this chapter about the risks of nonfatal injuries, where rugby and soccer appear to have the lead.

Further elaboration of risk of fatal and nonfatal injuries in sports activities as well as exposure estimates are provided in a more recent paper by Ball[5]. These papers also illustrate that sports injuries, though very common are rarely serious so that only 1:4000 injuries requiring attendance of an A&E Department and only 1:25000 requiring medical attention turns out to be fatal.

1. Ball DJ. Risks of injury – an overview. ABC of Sports Medicine. Mc Latchie G, Harries M, Williams G, King J. 2nd ed. BMJ Books
2. Ball DJ. MINI-SYMPOSIUM: Risks and benefits of sports and exercise. Part 1 of a 3 part series. Assessing the risks. Sports Exercise and Injury.1998;4:3-9
3. Ball DJ. MINI-SYMPOSIUM: Risks and benefits of sports and exercise. Part 2 of a 3 part series. Gauging the benefits. Sports Exercise and Injury.1998; 4: 74-79
4. Ball DJ. MINI-SYMPOSIUM: Risks and benefits of sports and exercise. Part 1 of a 3 part series. Looking ahead. Sports Exercise and Injury. 1998; 4: 174-82
5. Ball DJ. Ships in the night and the quest for safety. Injury Control & Safety Promotion 2000; 7:83-96

## Concluding remarks

The attached summary table does not allow detailed comparisons between countries or assessment of time trends, because there are substantial gaps in the data, differences could be due to sampling errors, there are variable registration patterns and one cannot exclude the operation of several types of biases. The priority at present, however, is to determine the overall dimensions of the problem, to convey to political leaders and health authorities the need to address the relevant issues.

Sports injuries are unique in that the objective cannot possibly be the reduction of person-time at risk, because sports activities are conducive to health at the individual and the social level. Targets of intervention should be carefully selected, and an obvious prerequisite is to ascertain the profile of sports injuries across EU.

From the existing data and taking into account the limitations of the data we can provide the following estimations:

- Mortality from sports injuries varies around 2 per million per year or slightly more than one per hundred injury deaths overall.
- Hospital admissions vary around two per thousand per year or about five per thousand sports participants per year.

- Admissions for sports injuries represent around 5% of hospitalizations for all injuries.
- About thirty per thousand of the total population or about sixty per thousand sports participants sustain per year a sports injury severe enough to require medical attention.
- About 12 per thousand of all population contact an A&E Department for a sport injury per year and around 10 percent of them are eventually hospitalized.
- There is considerable variation among the EU member states between genders and across age groups and these differences are due in part, to the sporting ethos (mostly among countries but also between genders), inherent factors (mostly between genders but also across age groups), sports preferences, athletic infrastructure (mostly among countries), balance between primary and secondary health care and hidden biases (reflecting tradition and affecting in variable degrees many of the contrasts).

On the basis of the previously indicated rates each year more than 700 individuals die in the EU from a sports injury, whereas about 700.000 are hospitalized. These estimates represent only the tip of the iceberg because each year more than ten million people have a sports injury requiring medical attention and more than five million contact the A&E Department of a hospital. The cost of dealing with sports injuries is considerable. It is estimated to exceed ten billion Euros throughout the Union.

EHLASS provides valuable information concerning the nature, body part, mechanism and severity of injury and thus, allows the rationalization of preventive measures and the calculation of the respective health care needs related to sports injuries. The information generated from EHLASS addresses questions like the following:

- What is the relative risk for a sport injury between genders and among age groups?
- What is the contribution of organized and non organized sports activities to the burden of sports injuries
- Are there differences between sports in school, organized sports outside the school and unorganized sports activities with respect to the type and the severity of the associated injuries?

- Which sports are responsible for most sports injuries in the EU populations?
- How best should the health care system be organized in each country in order to effectively and efficiently address the needs of those injured during sports activities.

EHLASS has already provided important leads but improvements are required, particularly with respect to estimation of person time at risk for sports injuries. Exposure to sports activities is likely to increase with the recognition of the beneficial role that sports play in personal and social life. In this perspective, prevention and control of sports injuries acquire a priority that should be addressed with several complementary activities.

| *Country (Population in million)* | *AU (8)* | *FR (58)* | *GER (82)* | *GR (10)* | *IT (57)* | *NL (15)* | *UK (59)* | *DK (5)* | *ISR (5)* |
|---|---|---|---|---|---|---|---|---|---|
| **Deaths (n)** | NA | 130 | 140 | NA | 120 | 10 | 160 | | |
| **Mortality*$10^{-6}$ person yr** | NA | 2.3 | 1.7 | NA | 2.1 | 0.06 | 2.7 | | |
| **Hospital admissions (n)** | 24. 000 | 100.000 | 180 000 | 3.500 | 105. 000 | 11.000 | 150. 000* | | |
| **Hospital admission incidence*$10^{-3}$** | 3.0 | 1.7 | 2.2 | 0.4 | 1.8 | 0.7 | 2.6 | | |
| **Hospital admission incidence*$10^{-3}$ sports participants/yr** | 3.3 | 7.1 | 5.5 | 3.5 | 3.0 | NA | NA | | |
| **A&E Dept sports injury visits** | NA | 700.000 | NA | 130. 000 | 840. 000 | 170.000 | 575.000 | | |
| **A&E Dept sports injury visits*$10^{-3}$ person-yr** | NA | 12.1 | NA | 13.0 | 14.7 | 11.3 | 9.8 | | |
| **Hospitalized/ A&E visits (%)** | NA | 12 | NA | 3 | 12 | 6 | 26 | | |
| **Medically attended (n)** | 227.400 | 1.000.000 | 1.94 M | 200.000 | 2.1 M | 688.000 | 4.5 M | | |
| **Medically attended incidence*$10^{-3}$ person years** | 29 | 17 | 24 | 20 | 37 | 44 | 77 | | |
| **Medically attended incidence*$10^{-3}$ Sports participants/yr** | 32 | 71 | 53.9 | 200 | 60 | NA | NA | | |
| **Hospitalized/ medically attended (%)** | 10 | 10 | 9 | 2 | 5 | 2 | NA | | |
| **Sport deaths as % of injury deaths** | NA | NA | NA | NA | NA | 0.2 | 1.3 | | |
| **Hospitalized sports injuries as % of hospitalized injuries** | 11 | NA | NA | 3 | NA | 6 | NA | | 5.4 |
| **Medically attended sports injuries as % of medically attended injuries** | 29 | NA | NA | NA | NA | 29 | NA | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Total cost (Euros)** | 302M | NA | 4B | NA | 8.2M | 94M | 1.7 B |
| **Cost per medically attended sport injury (Euros)** | 1.330 | NA | 2.000 | NA | NA | NA | 400 |
| **Cost per person (Euros)** | 38 | NA | 50 | NA | NA | 500 | 29 |

*UK: assuming that 50% of over 3 day sport injuries are hospitalized (derived by from adding all major injuries +1/2 with over 3 day (and the triangle ratio)

## INTRODUCTION

*"Sports for all: injuries and their prevention"*. This is the motto of a resolution passed by the European Union Sports Ministers in 1986, within the framework of which, there was a call to analyse sports accidents throughout Europe and develop preventive strategies.

Physical activity should be sought for every individual as an integral part of everyday life if we are to promote a healthy life style and to successfully combat the contemporary nosological spectrum. As such, it should be encouraged for providing desirable leisure activities both adults and the youth. Sports injuries, on the other hand, are a *sine qua non* of practising strenuous physical exercise. Occurrence of a sport injury is a function of many interacting factors, which can be categorised in three axes:

1. *personal characteristics* of permanent or transitional type such as age, gender, body type, personality, health status and mood
2. *type and duration of sporting activity* and
3. *environmental features*, such as climatic conditions, safe sporting facilities and availability of safety devices.

The size and magnitude of sports injuries is expected to greatly vary in the EU member states, but there has been no systematic effort in any EU country to ascertain comprehensively the health, social and financial burden and to critically analyse the underlying causal factors. Therefore, there is an emerging need to systematically review and analyse sports injuries in relation to severity, frequency, duration, and population(s) at risk. This information will be useful in developing EU policy and in

designing injury prevention programs. More specifically, comparison of EU sports injuries data and exchange of experiences in this field could facilitate the formulation and subsequent implementation of cost efficient preventive strategies at the EU-level.

The project "Sports Injuries in the EU Countries in View of the 2004 Olympics: Harvesting the Information from Existing Databases (Phase I)" proposed by the Centre for Research and Prevention of Injuries among the Young (CE.RE.PR.I.) and approved for funding by DG SANCO is aiming to addresses these issues.

## PROJECT AIMS

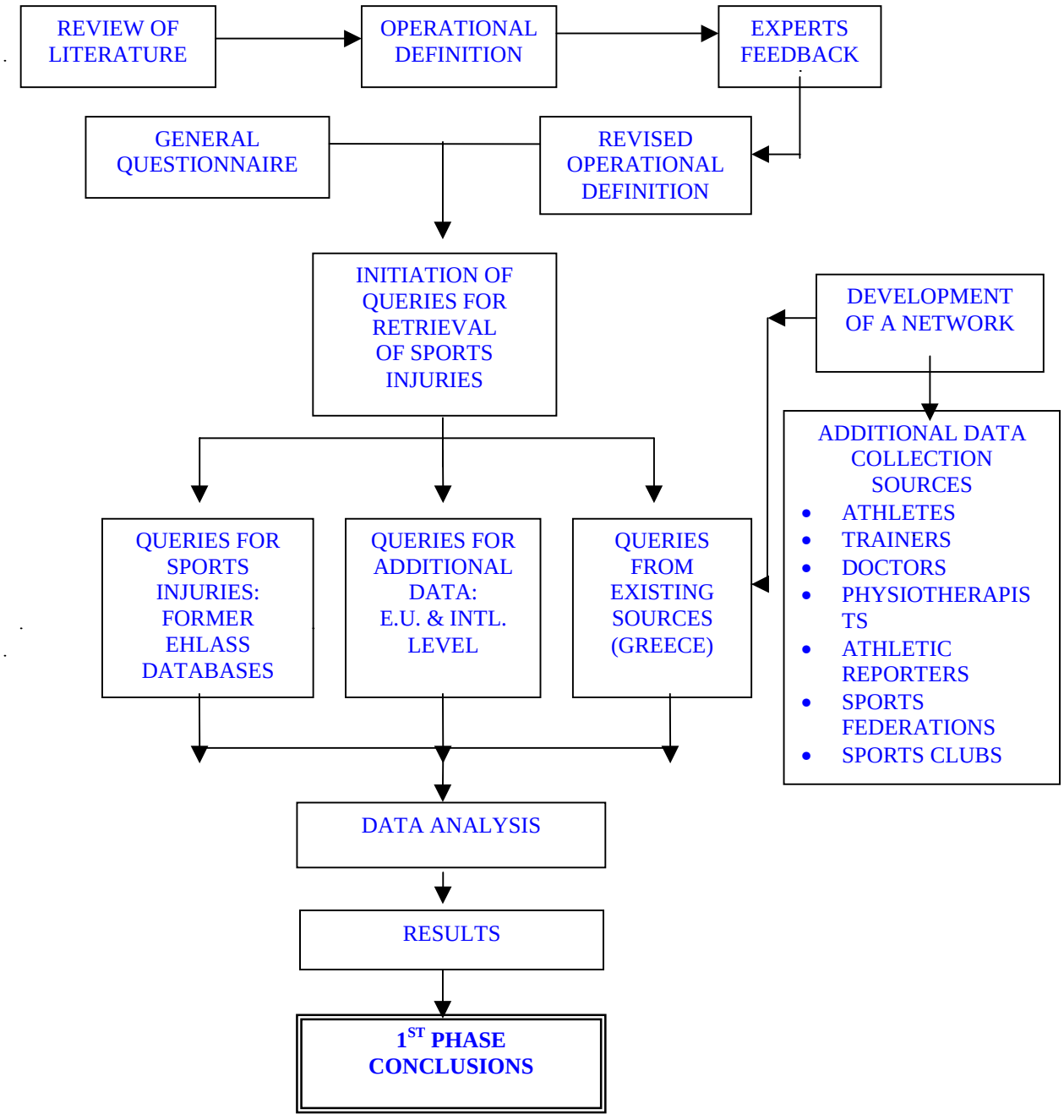
Specific aims of the project are to:

1. explore the ability of the former EHLASS database to capture sports injuries, analyse currently available information that is isolated or under-utilised at the National level and identify deficiencies, inadequacies or limitations.
2. ascertain the burden of sports injuries in EU Member States by type of injury, using complementary sources of information and ad hoc approaches,
3. develop a set a public health indicators for sports injuries and
4. promote the exchange of information about the use of sports injuries data

## APPROACHES AND METHODS

The schematic framework of Phase I of the Sports Injuries Project shown below depicts the progressive milestones of the collaborative effort of the participating EU member states and Israel, followed by detailed description of the undertaken tasks.

**SCHEMATIC INVESTIGATIVE FRAMEWORK**



*Operational definition*

In order to assure comparability of data among the participating countries the development of an operational definition of sports injury was deemed necessary. To accomplish this task process several national and international experts in the field of injury control and prevention were contacted and specific sources of information were used, including: 1) international literature (medline search results) 2) in-house consultation with experts 3) correspondence with external experts and partners and 4) WHO publications.

The following computerized databases were used for search

Medline using PubMed- http://www.ncbi.nlm.nih.gov/PubMed/

American Academy of Pediatrics ( AAP )- www.aap.org

American Academy of Orthopedics www.aaos.org

CDC- www.cdc.gov

National Athletic Trainers Association ( NATA )- www.nata.org

National Safe Kids Campaign www.sefekids.org

National Youth Sports Safety Foundation www.nyssf.org

Word Health Organization ( WHO )- www.who.org

The following terms were used for the Medline searching a) sports injury (ies) and definition and b) sports injury(ies) and epidemiology. The latter combination was considered as the most appropriate in order to find which terminology was used for the description of sports injury in epidemiological studies. Only a few articles directly address the issues of different methodological approaches that are used by the sports injury surveillance systems and the need for a standardized definition for the description of sports injuries. The majority of articles were mainly descriptive studies presenting injuries which a) were caused while participating in a certain sport or b) were resulted from sport or recreational involvement irrespective of the type of sport or c) were limited to a specific part of the body eg knee injury or head injury irrespective of the type of sport activity that led to the injury. A limited number of articles described the general pattern of injury impact on the studied population and included sports injuries as simply a subcategory of the unintentionally inflicted injuries.

Study titles and abstracts were evaluated and the more relevant articles to our question were reviewed. The main criteria for inclusion of studies in the current review was

that they either related directly to the search question or they related directly to sport injuries providing a definition of the term sports injury as this was applied to the study. It is of importance to note that there were review articles referring to sports injuries in general or in a specific age group avoiding to tackle the issue of the terminology at least directly, simply mentioning that different approaches have been used for the description of sports related injuries. This observation highlights the variance and inconsistency that exist in this field, resulting to the description of the problem without having defined it properly.

### *Review of literature*

Critical review of literature related to the role of:

- risk factors for sports injuries and
- assessment of prevention methods was undertaken.

An overview of the literature is presented in the respective chapters of the report, which can be used by practitioners, trainers, injury prevention specialists, academics and those responsible for policy development at local and national levels. The review can also be of interest for lay people in local authorities and community groups who are minded with sports injury prevention.

*Identifying the literature*

Relevant studies were identified by a variety of methods:

- A research of literature through international medical websites was performed using textwords for English- language articles. The consistency and reliability of the existing information is discussed

*Data Sources*: PubMed- http://www.ncbi.nlm.nih.gov/PubMed/
Word Health Organization (WHO )- www.who.org
American Academy of Pediatrics (AAP)- www.aap.org
CDC- www.cdc.gov
National Athletic Trainers Association ( NATA )- www.nata.org

*Key words:* Sports injury(ies) AND risk factors
Sports injury(ies) AND epidemiology
Sports injury(ies) AND prevention
Sports injury(ies) AND educational program(me)

Sports injury (-ies) AND safety

*Limits*: 10 latest years, human, review, clinical trials

- Scanning the reference list of other literature reviews and of important books and articles in the field.
- Hand searching of journals.

*Combining the results of publications*

The heterogeneity of sports injury types, study designs and statistical methodologies makes a numerical synthesis of results impossible. Instead we have combined the results in narrative review.

*Consultation of experts in field of sports and injury prevention.*

Experts on sports injuries and injury prevention were consulted. The draft form of this review was sent out for comments.

*Collection of data*

Sports injuries surveillance questionnaires **(Appendix A)** were developed to satisfy the needs of the project for uniform collection of data; information was solicited from investigators within the EU and external to the EU. The purpose of this exchange was to develop a definition of sports injury that would permit some degree of standardisation for purposes of data comparison between and among EU Member states and other interested groups.

The EHLASS database was queried and sports injury data retrieved and analysed. Constraints on data base variables were identified and applied in data retrieval **(Appendix B).** Model statistical tables were prepared on types of sports injuries, severity, and populations at risk as captured in the EHLASS injury database **(Appendix C).** Selected experts in the field of injury prevention were contacted and asked to comment on the quality and adequacy of existing data sources. Additionally, experts were contacted and asked to submit sports injury data as collected and reported in their respective countries. Model sports injury statistical tables were provided to participating experts and/or consultants to facilitate the comparison of

data between and among specific partners. EU partners involved in this information exchange included Austria, France, Germany, Greece, Italy, Netherlands and Israel (official partners) as well as Denmark, and United Kingdom (unofficial collaboration).

### *Sports Injury Network*

Outreach efforts for the development of a Sports Injury Network were made and contacts were identified including athletes, trainers, doctors, physiotherapists, athletic reporters and federations. Sports Injuries Questionnaires were developed to facilitate data collection **(Appendix D).**

### *Collaborative meetings*

Regular meetings with our partners took place during the course of this project, where the deliverables of the project were approved and progress was reported to the Injury Epidemiology Network.

## RESULTS

## OPERATIONAL DEFINITION OF SPORTS INJURIES

The main aim of this project was mainly to explore the ability of the former EHLASS database to capture sports injuries and to ascertain the burden of sports injuries in EU Member States by type of injury, using complementary sources of information and ad hoc approaches. However, it is not feasible to compare data from different countries if the respective surveillance systems use inconsistent terminology for the data collection and analysis. Therefore, following the literature search, the development of a unanimously agreed operational definition of sports injury was necessary. To this end, we compiled a first draft of a literature-based definition that was submitted for comments to a network of national and international experts in the field of injury control and prevention. After the first round of comments was completed, the proposed operational definition was modified and an effort was made to incorporate all suggestions and mingle the interesting points raised by the partners and other experts on subjects, such as the age range and inclusion or exclusion of bicycling injuries. The revised second version was submitted to all partners for final approval.

More specifically the questions that were firstly attempted to be addressed though the review of the literature were: a) is there any definition currently used and broadly accepted for the description of sport injuries? b) which are the discrepancies, if any, of currently used definitions in different studies focusing on the epidemiology of sports injuries in different communities c)do existing studies provide data that allow valid and reliable comparisons?

As it was pointed out in the papers that addressed the issue of methodological and definitional problems for sports injury surveillance systems, and sports injury research, a standardized definition should answer the following questions

- *What is a sport, what is recreational activity and what is exercise?*
- *What is a sports injury and how its severity can be assessed?*
- *Should the severity of the sports injury be taken into consideration for the definition and therefore for the inclusion of a sport injury in a surveillance system?*

Before attempting to answer the above questions we tried to identify the pitfalls of the currently used terminology in the literature.

There is no consensus for the definition of sport related injuries and various descriptions have been used in different studies. Population or Emergency Departments (ED) based studies seem to adopt a rather broad definition of sports injury. An ED based study conducted in Sweden characterized as sports injury any injury due to an accident during leisure physical activity and including competitions and games. No specific list with sports activities included in the study was provided. Injury severity was not considered of interest for the registration of the injury. However given that it was a ED surveillance system, the need for medical attention was apparently a prerequisite for the inclusion of a sports injury in the study. A similar but not identical approach was used by American investigators in a recent descriptive study characterizing as sports injury any injury that occurred while the patient participating in sport activity. However, none of these studies clarified the meaning of the term leisure physical activity or sport activity respectively and they did not provide an initial list with the activities that were considered under this term. The former excluded the overuse injuries whereas the same can be speculated for the latter without however being clearly stated in the text.

A question that raises when a population based study is to be conducted for the evaluation of sports injury rate is whether a certain age cut off would be necessary for assuring that the activity which was characterized as sports or recreational activity is not simply playing during leisure time. The Swedish study did not require such a limit. However, the youngest injured players were 7 years old, with the exception of downhill skiing with the youngest male skier being 5 years. These findings are in line with the guidelines of American Academy of Pediatrics, which advise free play until the age of six and participation in team sports after that age.

In contrast to population-based studies, the studies which assess the impact of injuries on professional sports players pay attention to the period of time that an injury prevented the athlete from playing or training. Abstinence of the player from the practice or the game from one day to one week was considered as a prerequisite for the characterization of an injury as sports injury depending on the study. This criterion has been used at least in some studies as an alternative to the requirement of professional medical examination or treatment in an attempt to define objectively

sports injuries and not simply register as such any physical ailment of the affected athlete or player.

However, a diversity of the applied definition was evident even among studies focusing on the same type of sports. Performing a simple comparison of the epidemiological studies regarding soccer injuries, it was easy to see the extent of discrepancy of the currently used definitions as well as its consequences on the comparability of data from theoretically similar studies. Certain authors defined injury as every recorded injury during a specific time period, which was either limited to the competition period or was also extended to the practice time. Other investigators preferred to chose more functional terminology evaluating the time away from play. As one should have expected quite variable injury exposure rates derived from these different approaches ranging from 0.5-14/1000hours for boys and 1.1-32/1000hours for girls.

It is evident from the literature review that a broad but exact definition of what constitutes a reportable sports injury is necessary in order to advance our understanding for sports injury epidemiology. Ideally the definition should satisfy the needs of population based epidemiological studies as well as those targeted to specific professional groups. For this purpose we believe that injuries occurring during physical activity both competitive or recreational should be included as there is a considerable overlapping of sports and recreational activities at least for the amateur participants and a distinction may not be feasible. Furthermore, the promotion of a healthy life style with emphasis in the importance of the participation in sports activities increased not only the public involvement in the traditional sports but also in those that are considered, at least until now, more as recreational activities rather than sports. An operational definition should therefore include a broad spectrum of sports activities so that it could be effectively applied in population based studies while at the same time it will not act as a limitation for studies restricted to specific type of sports. Place of occurrence could not be considered as a restriction for the characterization of a sport injury as sports and exercise can be practiced in different type of places depending on the area (rural or town) as well as on the country. Therefore, using place as a criterion of inclusion or exclusion in the definition of sports injury, may lead to the underestimation of injuries incidence in certain areas and not allow reliable comparability of data across the countries. A cut off limit for the age of participants will minimize the possibility of adopting a very loose approach

of the sports activity definition. A balanced evaluation for the characterization of a physical ailment as injury should also be followed, allowing at the same time an objective definition but not an unnecessarily strict one. The abstinence from sports activities for a certain period of time (we suggest one day) should be required only for the characterization of injuries sustained by professional athletes, identifying as professional those who participate in supervised organized sports activities on a daily basis.

Taking into consideration all the aforementioned issues the following operational definition of sports injuries is suggested.

Operational Definition of Sports Injuries

*A series of undesired events occurring in the interplay between individual and environment during physical activity, competitive or recreational, resulting in physical impairment or ailment, because the human body or part of it was subjected to force(s) exceeding the threshold of physiological tolerance.*

*The result of an injury is the alteration, limitation or termination of participation of an athlete in the respective activity, for at least one-day.*

*Notable severity of an injury is considered one that shall have a physical effect lasting at least one week.*

*Incidence is measured as the number of injured persons in the time period of exposure.*

Inclusion and Exclusion Criteria

Inclusion criteria:

The operational definition of sports injuries refers to injuries occurring during the defined event(s), or having (meeting) one or more of the following

characteristics:

Competitive: activities undertaken during official games (authorised by governmental or non governmental organisation, a sports federation, a club or similar organisation) and unofficial games win intended.

Non-competitive sport: similar activities with competitive but not win intended. Referred on sports activities during individualised or a team training, persons exercised for improvement of personal physical condition (i.e jogging, swimming, aerobic exercise)

Professional and non-professional sport.

Organised: activities under taken under auspices of sports federation, club or similar organisation.

Non-organised sport: similar activities but not undertaken under auspices of sports federation, club or similar organisation.

Supervised: activities undertaken under supervision of a trainer, physical education teacher.

Unsupervised athletic activity: similar activities with supervised but not under supervision of a trainer or a physical education teacher.

Minimum age of individual for injury registration: 5 years of age: death is included as the ultimate injury;

Sports-related injuries at school: sports injuries occurring at school, during physical education lessons, intermissions, or school games.

Overuse injuries: repeated microscopic injuries leading to a macro-trauma

Injuries or fatalities secondary to an internal cause (e.g. heart attack) that was induced by physical activity.

There is no distinction between sport and athletic exercise or activity. - Olympic sports are defined according to the current list of registered sports (**Appendix F**) - Traffic accidents involving bicycles and skates are registered, according to a presumed intention; - A physician or another health

professional must be consulted at least once for each case.

Exclusion criteria:

Sports injuries in the Military.

People with special needs practising sports.

Local – traditional sports, which are not widely practised, even within a specific EU member state. (Referred on sports that are not recognised by a sport federation, a club or similar organisation)

Injuries concerning non-contending participants.

Injuries deriving from not strictly athletic causes.

Injuries deriving from natural disasters during sports.

Psychological effects, traumatic or post-traumatic.

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# REVIEW OF LITERATURE

## 1. RISK FACTORS FOR SPORTS INJURIES

### INTRODUCTION

There is sufficient scientific evidence supporting that sports and exercise are important for both physical and psychological well being. A large proportion of population undertakes either recreational or competitive sport and exercise. However, these benefits come at a cost as participation in sporting activity includes a variety of risks. The risks include occasionally fatalities and musculosceletal injuries. Injuries in sports may occur as a result of an acute event such as fall, collision etc. or they may be the ultimate consequence of repeated episodes of microtrauma that individually are insufficient to give rise to macroscopic injury. This latter category is known in literature as overuse injuries.

Although abstinence from sports would effectively prevent from sports injuries, such an approach would be unacceptable as the short and long-term health benefits of physical activity are well recognized. Therefore the implementation of other reasonable preventive measures is necessary in order to minimize the risk for injury while participating in a sport activity. The identification of risk factors for sports related injuries is the prerequisite for the design and establishment of appropriate prevention programs, which can then be specifically targeted.

Numerous studies in literature examined the risk of injuries by different methodological approaches. Definition is not uniform and research design is different. This report is trying to identify the most consistent factors associated with risk of sports related injuries. Sports injuries are not generally the effect of a single causative variable. A variety of factors that interact at time of accident are associated with [1,2,3,4]. General agreement exists on the classification of the risk factors for sports related injuries into 2 categories:

- *Intrinsic* (personal, host) risk factors, which are biological and psychological characteristics predisposing a person to injury.
- *Extrinsic* (environmental) risk factors, which are related to the type of sport activity, the manner in which sport is practiced, the environmental conditions and the equipment used [5,6,7,8,9].

## INTRINSIC

### Age

*Children - Adolescents*

Epidemiological studies suggest that has been a significant increase of sports injuries impact in recent years. It seems that this trend is associated with a parallel rapid growth of organized and unorganized sports activities for children and adolescents [10,11,12,13]. In a Massachusetts study by Galagher and colleagues in 1980s, sports injuries were found to be the most common cause of injury and overall, the second leading cause of emergency departments visits and hospital admissions in the 13- to 19- years old age group [14].

It seems that children are at increased risk to injuries compared with their adult counterparts [15,16]. There are several issues that distinguish children and adolescents athletes from their adult counterparts, which may predispose young athletes to acute and overuse sports related injuries. Study of exercise physiology over the last 10 years, however has made it clear that the young athlete is not a miniature of an adult [17]. Children' physiologic response in exercise is different. Children have lower anaerobic capabilities, than adults even when adjusted for body weight [18]. During exercise, children use more O2 / per kilogram of body weight, have increased heart rate, lower stroke volumes, and higher respiratory rates than adults [19].

In addition to functional differentiation, children's skeletal system is unique in that much of it is composed of cartilage. Growth cartilage in the immature skeleton is found at the epiphysis growth plate, the articular surface and the apophyseal insertions. Biomechanical and clinical evidence suggests that growth cartilage is less resistance to repetitive micro-injury than the mature adult counterpart. Skeletal immaturity and inappropriate pressure to perform, along with an aggressive training program can be a major cause of overuse injury in young athletes [20,21]. Children are at risk for an epiphyseal injury until the complete the growth bone is completed at 18 years for boys and 2 years after beginning of puberty for girls [22].

The process of growth itself constitutes a central factor in athletic injury. The soft tissues elongate passively in response to the longitudinal growth of the bones and thus become progressively tighter, especially during periods of rapid growth [23].
This is more pronounced in adolescents growth spurt. The decreased flexibility predisposes the young athlete to injury and should be addressed by a program of prophylactic stretching during growth spurt. Moreover differences on growing among young participant's leads to size mismatch and so increased risk of injury [24].

It must be emphasized that a child is not only developing physically but also mentally. Children and adolescents express a different pattern of sport behavior and this may also predispose these young athletes to increase risk. The participation of children in unsupervised competitive games creates an environment where their need to win make them forget the appropriate technique and develop occasionally aggressive behavior increasing the likelihood of both acute and overuse injuries [21]. Adolescents often feel invulnerable, like to experiment and take risks, shifting from desiring parental approval to focusing on peer acceptance. Adolescents, particularly the younger ones, often are unable to envision remote possibilities of injury [14].

As the risk of injuries sustained by young athletes can be significant, it is essential that training programs take into account the physical and psychological immaturity, so that the young athlete can adjust to their own body changes and benefit from sports participation [25].

*Adults*

In adults evidence that associates age with the risk of injury has been inconsistent. Some evidence exists that risks do vary with age. D. Souza for instance found increased injury rates in older athletes [26]. Studies in athletes show that older athletes maybe able to avoid overuse injuries and this could be attributed to their greater experience of sport activity; they may also exhibit musculoskeletal adaptation of the activity [27]. As far as stress fractures is concerned Matheson at al shows that femoral and tarsal fractures occur more frequently in the oldest athletes where as there is a preponderance of fibular and tibial among youngest athletes [28].

*Elderly*

It is generally agreed that older people could benefit from sporting participation physiologically and psychologically. The main parameter that distinguishes elderly people is aging as causes many structural and functional alterations in the human body. As a result elderly people liable to overloading of the musculoskeletal and cardiovascular systems. In addition, many older people have further problems because of chronic diseases.

Kallimen and Markku [29] have noted the lack of epidemiological studies of sports injuries among elderly athletes. However they conclude on the existing evidence that elderly athletes are more prone to both acute and overuse injuries. In elderly exertions injuries are common and are connected mostly with degenerating aging processes. Acute injuries are common in those elderly people participating in sports, which demand high coordination, reaction time, and balance capabilities such as ball games, down- hill skiing, and gymnastics. Muscle has been reported to be the most commonly acutely injures tissue among active elderly athletes. As far as injured body part is concerned, lower extremities are the most susceptible to injury.

Important for injury prevention among elderly is adequate warm up before exercise, the selection of safe exercises and movements pattern, and regular monitoring of body alignment and exercise intensity. Good agility, technical skills, and cardiovascular and musculoskeletal fitness are also of importance [30].

**Gender**

In civilian populations it has not been clarified whether gender is significant factor for injury [31]. However it seems that female are more vulnerable to injury as it is indicated by several studies demonstrating an overall male-female ratio of injuries from 1:2 to 1:3 [32,33]. This difference might be not to specific gender reason but can be attributed to difference on exposure. Studies using military data on new recruits also indicated that women were more prone to injuries than men, but recent research has shown this to be product of the poor initial fitness of women in these programs [34].

It is also suggested that female athletes be at increased risk for specific types of injury and the anatomic site that is affected. An excessive risk for stress fracture among female athletes being 1.5 to 3.5 times higher to that among males, has been

reported [35,36]. This discrepancy is not attributed to gender inherently but to sex-related factors, such as diet, menstrual history and bone density. The site of distribution of stress fractures also appears to differ between male and female athletes. Although tibia is the most common site of stress fractures in both men and women, women developed significantly more femoral, metatarsal and pelvic, stress fractures and fewer fibular stress fractures than men [37]. This difference is more likely to be multifactorial and not dependent exclusively on gender, but controlled studies are presently lacking.

Many studies have also documented an increased incidence of Anterior Crucate Ligament (ACL) injuries in female athletes compared with their male counterparts [38,39,40,41,42,43,44]. Theories that are proposed for this discrepancy include extrinsic factors such as physical conditioning, body movement and muscular strength and intrinsic factors that are primary anatomical differences [45].

**Nutritional status**

Nutrition seems to be an important factor in pattern risk of sports related injuries, as it's directly affect bones health. Bone mineral status of children, aged 2-16 years old has been found to be positively associated with dietary calcium intake [37]. Disordered eating patterns and energy deficit states not uncommon in the athletic setting, can lead to profound bone loss and place youth athletes at risk for osseous stress injury. Recent studies have detected deficiencies of calcium and vitamins in the diet of amenorrhoeic ballet dancers, gymnasts, and distance runners. Disordered eating, amonorrhea and osteoporosis are often interrelated in the young female athlete, referred as female athletic triad [46,47].

**Somatotype**

The majority of studies that include measurements of height, bodyweight, percentage body fat and BMI have been undertaken in military recruits during basic training. Most of these studies have shown an association between lower limbs musculoskeletal injuries and somatotype, some for all musculoskeletal injuries and a few for specific injuries, particularly knee pain and stress fractures.

Concerning height as a risk factor for injuries, the results are controversial. Most of studies did not find a correlation between height and the risk of injury while others show this correlation [48,49,50]. Neither studies of physical education [5] students nor studies in military recruits were able to predict an increased risk of injury associated with increased or decreased bodyweight [51]. There is dispute as to whether the percentage body fat is an important factor in contributing to risk of injury during training. Several studies did not find a relationship between percentage body fat and risk of injury, but an equivalent number of studies have reported a relationship between the two [48,51,52].

The ratio of bodyweight/height$^2$ (BMI) seems to be the most consistent of the somatotype predictors for the risk of injury in military studies.Most of these studies suggest that there is an increased risk of lower limb injury for trainees with a high BMI and low BMI for females. However, this evidence is inconsistent in civilian populations [50,51].

**Commorbidity**

Certain medical conditions increase risk for sports related injuries or affect the safety in sports participation. The conditions that are more commonly create an increase risk of injury are the following

*Epilepsy*

There is growing evidence that most patients with epilepsy benefit from regular exercise. There is little evidence to show that contact and collision sports place epileptics at increased risk for injury compared with athletes without epilepsy [53].

However these athletes need individual assessment for contact/collision or limited contact sports, especially if convulsive disorder is poorly controlled. Seizure frequency and type of seizure are important considerations. Individual assessment is necessary in the following non-contact sports: archery, swimming, weight or power lifting, strength training, or sports involving height and motor sports. In these sports the occurrence of a convulsion may be a risk to self or others [54].

The overall risk for death does not appear higher in athletes with epilepsy who compete in organized sports. One exception is unsupervised swimming in open water. Recreational swimming does carry a fourfold increased risk for drowning for epileptics compared with general population; however, the general risk is still low [55]. Provided there is close supervision, preferably by a trainee who has been informed of the swimmer's condition swimming is acceptable for people with epilepsy [54].

*Heart associated diseases*

Since the majority of non-traumatic deaths in young athletes are the result of occult cardiovascular disease, examination of the heart is an essential. By far the most common condition leading to sudden death during exercise, usually in those aged over 40, is coronary artery disease including congenital abnormalities of the coronary artery tree. Sudden death in younger athletes is rare. However, the leading cause of sudden death in young athletes is hypertrophic cardiomyopathy [56].

Other conditions that are responsible for sudden death during exercise are right ventricular dysphasia, Marfan's syndrome, aortic stenosis, mitral valve prolapse, dysrhytmias, dilated cardiomyopathy, premature atherosclerosis, and carditis [54].

*Hormonal associated diseases*

Hormonal associated diseases and their effect to bone health seems a factor related with increase risk in sports injuries. Hypoestrogenic primary amenorrhea of varying origin has been associated with significant osteopenia in studies of nonathletic women [57] In the mid of 1980s, that scientists linked a decrease in BMD of the lumbar vertebrae in premenopausal athletes with amenorrhea [58,59,60,61].The combination of excessive training and decreased body weight may all predispose an athlete to amenorrhoea.

Primary amenorrhoea is commonly seen in young athletes who participate in rigorous training schedules at very early age, for example gymnastics and ballet dancers [62,63,64] while secondary amenorrhoea is seen more often in collegiate and high school athletes especially distance runners in addition to the sports such as gymnastics, figure skating, ballet dancing [65,66]. Athletic amenorrhoea has been shown to be associated with serious consequences of lower bone density, stress fractures and an increased susceptibility to injury and premature osteoporosis [65].

Studies in male endurance athletes have found that excessive exercise may result in negative effects on bone [67] however no correlation was noted with testosterone levels or other hormones. Other studies have shown that reduced serum testosterone and prolactin levels have been noted in male distance runners, but BMD was not assessed [68]. These findings in male athlete may parallel those in the female athlete, and may involve similar, as yet unknown, mechanisms.

*Other conditions*

There are also conditions that are may not put athlete in increase risk for athletic injury but may not compromise safe participation, in specific sports. Physical health of the athlete should be evaluated by the physician before participation. More specifically, the following conditions could be assessed[14]:

- Atlantoaxial instability
- Bleeding disorder
- Hypertension
- Diabetes melitus
- Diarrhea
- Eyes (functionally one-eyed athlete, loss of an eye, detached retina, previous eye surgery, or serious eye injury)
- Fever
- Heat illness history
- Human immunodeficiency virus infection
- Kidney, absence of one
- Liver, enlarged
- Malignancy
- Musculoskeletal disorders
- Neurologic (History of serious head or spine trauma, severe or repeated concussions, or craniotomy)
- Obesity
- Organ transplant recipient
- Ovary, absence of one

- Respiratory (Pulmonary compromise including cystic fibrosis, asthma, acute upper respiratory infection
- Sickle cell disease, sickle cell trait
- Skin: bolis, herpes simplex, impetigo, scabies, molluscum contagiosum
- Spleen, enlarged
- Testicle: absent or undescended

The pre-participation physical evaluation (PPE) is a sine qua non as it offers the opportunity to assess the athlete readiness to compete safely and effectively. Pre-participation athletic examination can identify those athletes at risk of injury or sudden death or those with an underlying medical condition that may affect participation. The abnormalities that are usually detected during PPE are musculoskeletal and visual disorders [69,70,71].

In general athlete's medical status may preclude participation in certain sports (i.e. those involving contact) while participation of the same athlete in other sports may be permitted. Several classifications of sports have been proposed. The ones that are most widely used for PPE are of American Academy of Pediatric and American Heart Association. The American Academy of Pediatrics has classified sports by amount of contact and strenuousness [72]. The American Heart Association (AHA) 26$^{th}$ Bethesda Conference provided a classification scheme in relation to cardiac effects, classifying sports into relative amounts of static and dynamic demands on the heart [73].

**Previous Injury**

There is almost a consensus of opinion that a past history of injury predisposes to further training- related injuries [74,75]. In some studies, re-injuries are reported, so it is reasonable that new injury correlates to the previous injury if it is of the same type and location.

Most studies in civilian populations have involved runners and have also documented that past injuries were associated with higher risk for current running injuries. Macera et al found that habitual runners with past history of injury were 3 times the risk of suffering a lower limb injury than runners without previous injury

[76]. A detailed prospective study investigated the incidence and mechanisms of soccer injuries in a group of 180 players over a period of 1 year. Knee and ankle injuries were by far the most common injuries. Of those with knee injuries, 74% had persistent instability on clinical examination resulting from past injury and 47% of sprained ankles had been previously sprained. Minor injuries were frequently followed by moderate or major injury [77].

Lysens et al. followed a group of physical education students through past their course. Those with past history of injury were at higher risk of injury recurrence; this particularly applied to sprains, dislocations and stress fractures. 18% of repeat injuries during the study period were at the same site and of the same type as the original injury and 82% were of a different type but at the same body segment.

An injury can end up with one or more of the following problems:

- Persistent pathologic ligamentous laxity (=mechanical instability).
- Persistent proprioceprive deficit, which can show as functional instability.
- Decreased muscle strength, which may cause muscle imbalance.
- Decreased muscle flexibility or decrease joint movement
- Localized scar tissue causing persistent discomfort [78]

Macera feels that is not clear whether the increased risk of injury with respect to a past history of injury is because of incomplete healing of the original injury, a personal propensity or susceptibility to re-injury or an uncorrected biomechanical problem that is distinct from the original injury [79].

However, prevention strategies for decreasing the risk of re-injury and permanent sequel after an injury occurred are treatment, early physical therapy and a structured progressive rehabilitation programs individualized to the needs of the athlete [80,81,82,83]. Athletes returning to sport after injury would benefit from informed examination. If there is persistent pain with use, stiffness or weakness suggestive of poor condition of incomplete recovery, they should urged to delay their return to serious activity, as they are otherwise at considerable risk of re-injury.

**Psychological factors**

Although sports behavior seems to be the key to the risk of injury, most of epidemiological studies of sports injuries have concentrated on risk factors from the

physical point of view [84,85].Information, therefore, concerning behavior at risk are rare. In the Ekstrand and Gillquist one third of the traumatic soccer injuries were caused by foul play, according to the judgment of the referee [86]. Jorgensen and Nielsen and Yde found that soccer players stated that fouls were in some way responsible for 25% of injuries [87,88]. The above studies show that aggressive behavior as this is expressed by violation of game rules may play a role in injury pattern risk and this finding is more prominent in team sports. There is clearly a need for further studies on the relationship between psychosocial factors and skills and the risk of sports related injury.

## EXTRINSIC

### Type of Sport

While all sports activities carry a risk of injury, that risk itself, the type of injury and the anatomic site varies widely depending on sport practiced. Certain types of injury characterize each sport. This seems to be closely associated with the movements that are performed. It is therefore expected that sports involve a similar pattern of exercise may also share a common descriptive profile of injury characteristics.

The risk for fatal and non-fatal injuries is not the same among sports. D.J. Ball [89] provides the average risk of fatality per 100million participations for various categories of sports. Among sports with the higher fatality rates are included air sports, mountaineering and motor sports. Turning attention to non-fatal events during sports activities contact sports such as soccer and rugby are included in the higher risk group. Several recent studies have found wrestling and gymnastics to rank second and third in overall injury rates. The difference in ranking may vary with methodology of injuries surveyed, such as injury in organized teams versus in non-organized [14].

As far as injured body part is concerned upper extremities are at particular risk in field throwing events, racquet games, archery and canoeing, lower extremities suffer most frequently in contact and high speed sports such as all types of football and downhill skiing [90]. Major eye injuries usually occur in baseball, basketball,

racket sports, ice hockey and soccer while head and neck injuries occur more frequently in contact sports such as football or boxing [14].

It is reported in literature that appropriate technique in every single sport may prevent acute and overuse injuries. Systematically teaching of basic techniques offers significant protection in each separate sport [91,92].

**Type of sport activity**

Type of sport activity, organized, unorganized seems to play a role in injury risk and in the type of injury. Children who participate in non-organized and unsupervised competitive games are at higher for sports related injury [21]. Non organized sports may also be associated with higher injury rates because there are fewer protective game rules in those activities, and the varying playing conditions can create more risk [14]. However in spontaneous non-organized activity overuse injuries occur rarely. The incidence of these types of injuries increases in organized sports, as well as with intensive training and competition spirit [14].

**Level of play**

Another risk factor for sports injuries has been reported to be the level of play. Difference in injury rate, with a higher incidence in games compared with practice, has been noticed [78]. In a retrospective study for spinal cord injuries in rugby players it was found that the most obvious risk was match play. It seems that competitiveness and aggression unleashed in a high-level match play must be an important factor contributing to the occurrence of injury [93].

**Training**

The same parameters of exercise (intensity, duration and frequency) that determine the positive fitness and health effects of physical training also appear to influence the risk of injuries. Studies in runners and other physically active groups have consistently demonstrated that greater duration and frequency of exercise are associated with higher risk of acute and overuse injury [94]. In a study of competitive runners reported by Coplan et al [95], a significant trend of greater risk of any running

injury with higher average weekly-running mileage for both men and women was documented.

The strongest and most consistent association exists between greater total amounts of exercise and higher injury risk. The total amount of exercise is the product of the intensity, duration and frequency of exercise. The literature suggests that each specific parameter of exercise influences the risk of injury in proportion that affects the total amount of exercise performed [96].

**Environmental**

*Running surface/Terrain*

Hardness of playing surface is suggested as an environmental risk factor because subtle changes of hard surfaces seem to predispose young athletes to overuse injury [97]. The hardness of the playing surface could be a factor for injury because harder surfaces, such as concrete pavement return more force to the extremity than asphalt or grass [98]. Running on hard surfaces may be associated with an increased risk of stress fractures because of the increased mechanical shock introduced to the bone. Alternatively, running on soft surfaces may hasten muscle fatigue, therefore predisposing athletes' stress fractures. Uneven running terrain (up or down hills) has empirically been thought to produce injury to bone; however after controlling for wheel distance, no difference in stress fracture rates were reported because the different types of running terrain [76].

*Climatologic conditions*

Outdoor sports are exposed to alternating weather. It is has not been proven, however, that bad condition as single factor is responsible for changes in sports-related injury rate. It is proposed that climatological conditions may influence the risk of injury mostly through alterations of playing surface [86,99]. In a study referred in soccer injuries, both in elite male and female athletes it has been reported that weather, temperature and playing surface did not influence injury rates [100].

Although, climatological conditions have not been proven to be a risk factor for sports injuries, it is generally admitted that environmental temperature may cause health problems through being either too cold or too hot. The effects may be general,

local or secondary and range from illness to possible death, either directly or indirectly [101,102].

## Equipment

Most athletic injuries are musculoskeletal and can be minimized by the use of proper equipment. Different kind of protective equipment is proposed by regulations of sports associations in different kind of sports and is used routinely by athletes. Perhaps the most striking example of this is American football, where padding covers many yards of taping, strapping, and bracing for added protection. Many studies demonstrate the need of proper equipment in different sport in order to reduce athletic injuries [14,103].

Correct use of such equipment is essential in avoiding injury. The design of helmets has altered and improved to prevent serious neck and face injuries in sports such as ice hockey and neck injury rates in horse riders [104]. The importance of correct use has also notices in footwear. Improper footwear with inadequate support of shock -absorbing capacity has been reported as a risk factor for stress fractures. Proper running shoe must provide support and impact absorption as well as protection from hyperpronation. Shock -absorbing insoles have been found to be effective in reducing the incidence of overuse injury [105]. The necessity of properly adjusted and maintained equipment is also noticed in sports literature.

## Conclusions

In conclusion the risk for injuries is multifactorial but still not well defined. Further research is also required to determine the effect of individual, host characteristics and extrinsic factors on the likelihood of exercise-related injuries.
The main points that found to be more consistent in literature are:

- Adolescents are more prone in overuse injury under extensive training load.
- Specific types of injury have higher incidence in females compared with their male counterparts. Female athletes have higher stress fractures injury rates and different distribution of injury anatomic site compared with the males counterparts.

- Nutrition status plays a role in injury pattern risk as it directly affects bone mineral status.
- Body mass index seems to be the more consistent of somatotype parameters that predispose in injury risk, in military studies.
- Athlete's medical status and chronic diseases need individual assessment in order to perform safe participation.
- Past injury and their residual effects predispose to further exercise related injuries.
- Type of sport activity (organized, non-organized) may increase the risk of specific types of injury.
- Intensity, duration and frequency of exercise influence the risk of injury in a proportion affecting the overall performance.
- No use, incorrect use, improper or not properly adjusted equipment is not promise safe participation and may predispose to injury.

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## 2. PREVENTION OF SPORTS INJURIES

### *The Concept of Injury Prevention*

Injuries occurring during sporting activities can often be prevented by taking preventative measures. There are several risk factors involved in the occurrence of sports injuries, including: the level of training, the type of sport (contact or non-contact), level of competition, playing conditions (environment), equipment used by the athletes. (1) All these factors have to be considered when developing an optimal strategy for the prevention of sports injuries.

The concept of injury prevention can be structured on three levels:

a. Primary prevention

The purpose of primary prevention is to avoid the possibility that an injury occur. It involves a continuum of passive, active and blended strategies. (2,3)

- *Passive strategies* are automatic and require no individual or repetitive action and are generally the most effective. (2) They encompass measures such as providing for optimal conditions for the game (scheduling of the game, the competition field, etc.). The examples include: break-away bases in baseball and softball, early morning starts in summer road races, and the banning of athletes who suffer from herpes dermatitis from participating in contact sports.(3, 4)

- *Active strategies* are voluntary and require repetitive, individual action to be taken. (2) They require an athlete to cooperate or make behavioral changes, and are generally less effective than passive strategies. Here are included educational efforts and safety advisories such as good health habits (nutrition and exercise), the avoiding of consumption of harmful substances (2), the recommendation that athletes drink more fluid during activity to maintain hydration, etc.

- *Blended strategies* require a certain degree of cooperation from the athlete. In this category we mention the rules of the game, which define standards of conduct for all players and allow them to expect certain responses (3,5)

while the strict enforcement of the rules is critical to ensure sports safety. The correct use of protective equipment is also a very important preventive measure.

b. Secondary Prevention

The secondary prevention means to treat a sports injury the best possible way in order to avoid the occurrence of permanent damage. (2)

c. Tertiary Prevention

Tertiary prevention requires taking safety measures in order to avoid the repetition of the injury. (2)

The spectrum of injury prevention measures (primary prevention) will be presented in more details.

**Table 1.** MEASURES IN PREVENTING SPORTS INJURIES

| |
|---|
| ◊ Preparticipation examination |
| ◊ Proper hydration and good nutritional status |
| ◊ Adequate methods for training and conditioning |
| ◊ Correct use of equipment |
| ◊ Proper playing conditions ( field/surfaces of play) |
| ◊ Paying attention to the environmental conditions |
| ◊ Playing within the rules of the game |
| ◊ Awareness of the overuse injuries |

## Pre-participation screening (Sports Examination) and Prevention of Sports Injuries

The pre-participation screening represents a very important test for the care and safety of the active and athletic individual. The practice of medical screening prior to participation in sports differs from one country to another. It encompasses a multitude of medical tests, as well as a detailed medical questionnaire to be filled by the athlete. These tests have improved considerably in the past few years (5)

Table 2. PRE-PARTICIPATION SCREENING- GENERAL FINDINGS

| |
|---|
| ◊ Performing a general health assessment and discovering life-threatening or disabling conditions (4,6,7) |
| ◊ The examination should be performed six to eight weeks prior to the beginning of the season and at the beginning of each new level of competition (4,8) |
| ◊ The station method with multiple examiners is a proper way for approaching the PPE (4,7,8) |
| ◊ Paying attention to the history during the examination (9,10) |
| ◊ Performing an assessment of additional areas (4) |

The objectives of the screening evaluation include to perform a general health assessment, and to discover the conditions that may be life threatening or disabling, that may limit participation or that predispose to injury or sudden death. (4,6,7) The pre-participation screenings are not designed to exclude individuals from participation, but rather to assist athletes in safe participation. (6)

It is recommended that the examination should be conducted six to eight weeks prior to the beginning of the season and at the beginning of each new level of competition. (4,8) Also, the examination should be conducted using the station method with multiple examiners, one of whom should have specialized training in musculoskeletal disorders. (4,7,8) The presence of expert providers may permit the assessment of additional areas, including nutritional status, fitness and body composition. (4)

During the examination process, the history is a very important component and uncovers at least 64 to 78% or more of potentially significant medical and orthopedic disorders (9,10)

Athletes returning to sport after an injury must be clinically examined. If there is persistent pain with use, stiffness or weakness suggestive of poor condition of incomplete recovery, they should urged to delay their return to strenuous activity, as they are otherwise at considerable risk of re-injury.

As for how pre-participation physical examination is viewed by the athletes, a study conducted by Carek and Futrell (11) focused on determining the value that student-athletes place on the pre-participation physical examination in ensuring safe participation and whether these athletes would accept a station-based pre-participation

screening that emphasizes health-related issues. The findings of this study indicate that athletes are receptive to most preventive health screenings and believe that the pre-participation screening prevents or helps to prevent injuries. However, the athletes participating in the study did not feel comfortable with certain issues being raised (i.e. questions related to sexual activity and health, eating disorders, smoking and personal and family use of alcohol). The authors suggest that specific modifications should be made in order to improve the comfort level of the athlete.

## Preparation and Prevention of Sports Injuries

Preparation is the key word when considering the prevention of sports injuries.(12) In order to contribute to a decrease of the risk of sports injuries, it is essential that the athletes follow a well-conceived training schedule. An insufficient warm-up can lead to the occurrence of "cold muscle" injuries. Over-training may cause generalized fatigue and poor competitive performance.

The training schedule has to be well balanced, and should include warm-up and cool-down exercises before and after practice, stretching exercises, strengthening exercises and flexibility training (5), fitness for sport - particularly aerobic – cardiovascular and respiratory fitness, muscle power and specific fitness. (12) There have to be avoided sudden changes in training methods, as well as in effort and intensity. (12)

*Warm-up exercises* are designed to increase muscle and tendon suppleness, stimulate blood flow to the periphery, increase body temperature and enhance free, coordinated movement. (13) Athletes perform better after a warm up and a good warm-up reduces the risk of injury. (14)

*The cooling down exercises* performed at the end of the training, are the opposite of the warm-up exercises, allowing the body to adjust slowly from a strained position to a rest position. (14) They increase lactate clearance during active recovery.

*Stretching exercises* also contribute to muscle warm-up and they counteract the adaptive shortening of muscle that occurs with strength training. (5) Stretching before exercises and after strength endurance is recommended as a way of warming-up and cooling down. (15) The warming-up and stretching procedures before exercise

is helpful in raising the muscle temperature and coordination. Cooling-down and stretching after exertion will minimize subsequent stiffness.

The efficacy of stretching exercises in prevention of sports related injuries is controversial. A number of studies evaluated this issue. Their results support the evidence that stretching before exercise does not reduce the overall risk of sports injuries. In spite of this, it remains a widely used technique in sports and physiotherapy. (15)

In a controlled clinical trial, Bixler and Jones (16) investigated what percentage of injuries occur during the third quarter of a football game and if completing a warm up and stretching routine after halftime reduces the risk of third quarter injuries. They examined a number of fifty-five games with 108 total injuries. The authors reported that the most common type of injuries were ligament sprains and strains (38%). In the intervention group (which participated in a prescribed three minute warm-up and stretching routine) there were significantly fewer third quarter sprains and strains per game comparing to the control group ($p < 0.05$). However, no significant difference in total third quarter injuries was noted. The results suggest an association between the post-halftime warm-up and stretching routine and reduced third-quarter risk of sprain and strain injuries.

A randomized controlled trial (17) has specifically examined the effects of pre-exercise stretching on injury risk in 1093 male recruits randomly allocated to either stretch of control group. Subjects in the intervention group stretched their calf-muscles during warm-ups. The control group did not stretch. The authors reported that the incidence of fife selected lower leg injuries in the stretch group (4.2%) did not differ significantly from that of the control group (4.6%).

Pope et al (18) investigated the effect of muscle stretching during warm-up and the risk of exercise-related injury, in a group of 1538 male army recruits, randomly allocated to the stretch or to the control group. For a 12 weeks period, both groups preformed active warm-up exercises before physical training sessions. The stretch group also performed one 20-s static stretch under supervision for each six major leg muscle groups during every warm-up. The control group did no stretch. The authors reported a number of 333 injuries, including 214 soft-tissue injuries (158 injuries in the stretch group and 175 in the control group). They did not find a significant effect of pre-exercise stretching on all injuries risk (the hazard ratio which is equal to the injury rate in the stretch group divided by the injury rate in the control

group (HR) was 0.95, 95% CI 0.77-1.18), soft-tissue injury risk (HR = 0.83, 93% CI 0.63-1.09), or bone injury risk (HR = 1.22, 95% CI 0.86-1.76).

Van Mechelen et al (19) evaluated the effect of health education intervention on running injuries in a study which included 421 male recreational runners randomly assigned to intervention or control group (167 control and 159 intervention subjects). The intervention consisted of offering information on, and the subsequent performance of, standardized warm-up, cool-down and stretching exercises. Both groups kept a diary on their running distance and time, and reported all injuries during the 16-week study,. The intervention group also noted compliance with standardized program. The number of injuries was 23 in the control group and 26 in the intervention group and the injury incidence for control and intervention subjects was 4.9 and 5.5 running injuries per 1000 hours, respectively. The authors reported that the intervention was not effective in reducing the number of running injuries. However, it proved significantly effective ($p<0.05$) in improving specific knowledge of warm-up and cool-down techniques in the intervention group. The authors suggest that this positive change can be the first step to a change of behavior, which may eventually lead to a reduction of running injuries.

*Strengthening exercises* have an important role in the prevention of sports injuries as they contribute to obtaining an appropriate agonist /antagonist muscle power, in addition to muscle power and endurance. The strength training contributes to the preservation of the shock- absorbing capacity of the muscles. (5)

## Protective Equipment and Prevention of Sports Injuries

The use of safety equipment is common in many sports. This equipment is meant to offer additional safety to the athletes by protecting them from eventual sports injuries or minimizing the effects of injuries. The occurrence of injury due to direct trauma is directly influenced by the design of the protective equipment and the obligation upon the wearer to comply with the regulations of the sports associations.(5)

1. Principles for selection and utilization of sports protective equipment

The process of selection and utilization of the sports equipment has to be conducted according to the *following principles* with the purpose of providing the athletes with the maximum of protection:

- *Safety* should be the first consideration when purchasing equipment, rather than cost or appearance. (1) There are numerous consumer organizations that establish standards for specification, testing methodology and recommend practices for sports equipment and methodology.

- In order to order to be protective, the equipment has to be *fitted properly*, according to the anthropometric measurements of the participants. (1)

- The equipment has to be *correctly utilized, maintained and adjusted.* (12, 20)
  It has to adapt to technological changes in the sport. (1)

- The equipment should be checked before and after each use to ensure that it is in proper condition, and replaced or repaired immediately if any problems are noted. (20)

- Appropriate protective equipment should be worn in all practices as well as during competitions. (20)

2. Protective equipment by type of sport

The risk of sports injury is associated with the type of sport. Most sports injuries are musculoskeletal, affecting limbs or trunk. Head injuries can also occur in many sports, and except for those in boxing, are accidental. (21) The first law in the management of head injuries is to prevent them, and all sport disciplines have to permanently revise their practice to define the current incidence rate and the risk of head injury and to develop their sports to either minimize or exclude these risks. (5) The second law is “if you can’t prevent, protect”. (5) This law refers to the utilization of *head protective equipment*.

There are numerous sports where the use of headgear is necessary, such as American football, skateboarding, cricket, cycling, climbing, winter sports, etc.

It is very well argued in the literature the efficacy of wearing *bicycle helmets* for the prevention of head injuries resulting from bicycle accidents. (22,23,24,25) The studies concluded that the risk of head injury is lower in bicycle accidents when the individual is wearing a helmet. Helmet has shown to reduce bicycle related head injuries for cyclists of all ages involved and in all types of crashes, including those with motor vehicle. (26)

Table 3. THE EFFICACY OF WEARING A HELMET FOR PREVENTION OF HEAD INJURIES RESULTING FROM BICYCLE ACCIDENTS

| Study (authors and year) | Main results |
|---|---|
| Thomas et al. 1994 | A reduced risk of head injury by 63% and of loss of consciousness by 86% among children wearing a helmet. |
| Maimaris et al. 1994 | An increased risk among non-wearers of sustaining head injury in a bicycle accident (head injury was sustained by 4% of helmet wearers compared with 11% of non-wearers |
| Finvers et al. 1996 | An increased risk of head injury when a helmet was no worn. |

Thomas et al. (22) have evaluated in a case-control study the risk of injury to the head and the effect of wearing helmets in bicycle accidents among children. They examined 445 subjects (children presenting with bicycle related injuries). The cases comprised 102 children who had sustained injury to the upper head including the skull, forehead and scalp or loss of consciousness. The controls were 278 cyclists presenting with injuries other than to the head and face and a further 65 children with injuries to the face were considered as an extra comparison group. The authors reported a reduced risk of head injury by 63% (95% confidence interval 34% to 80%) and of loss of consciousness by 86% (62% to 95%) among children wearing a helmet.

Maimaris et al. (23) compared injury patterns of cycle helmet wearers and non-wearers attending an accident and emergency department in the UK. The authors found an increased risk among non-wearers of sustaining head injury in a bicycle accident- head injury was sustained by (4%) of helmet wearers compared with (11%) of non-wearers (P=0.023). The incidence of head injuries sustained in accidents involving motor vehicles (18%) was significantly higher than in those not involving

motor vehicles (7%). These findings suggest an increased risk of sustaining head injury in a bicycle accident when a motor vehicle is involved and confirm protective effect of helmet wearing for any bicycle accident.

A prospective cohort of injured children with case-control design looking at serious head injuries and helmet use was conducted by Finvers et al. (24) The authors reported an increased risk of head injury when a helmet was not worn (chi 2 $0.01<p<0.05$), which represent an odds ratio of 3.12 (confidence interval CI=95%1.13-8.75). They concluded that helmets afford a protective effect with respect to serious head injuries.

Another factor of great importance in the prevention of head injuries among bicyclists is whether the *helmet is correctly fitted* according to the anthropometric measurements of the wearer.

Rivara et al (25) studied the relationship between helmet fit and the risk of head injuries in children. The authors found that individuals whose helmets were reported to fit poorly had a 1.96-fold increased risk of head injury compared with those whose helmets fit well. They concluded that poor fit of helmets may be associated with an increased risk of head injury in children, especially in males.

The results of the *bicycle safety helmet campaigns*, as well as of *mandatory laws* were encouraging by successfully increasing helmet use and decreasing the incidence of bicycle head injuries. (27, 28, 29, 30,31)

The Seattle's bicycle helmet campaign resulted in an increase in observed helmet wearing rates among the target population from 5% to 16% in the intervention group and from 1% to 3% in the control group. (27)

The Israeli bicycle helmet campaign (28) that began in 1993 was accompanied both by increases in sales of helmets and by increases in their use by children. Children’s exposure to the initial pilot campaign was associated with changes in normative perceptions of helmet wearing and with increased willingness to wear a helmet. The exposure to the subsequent comprehensive campaign was associated with changes in utilitarian beliefs but not with increased willingness to wear helmets.

The Australian state Victoria introduced the first law in the world requiring cyclists to wear helmets in 1990, which was preceded by a decade of helmet promotion. In the following year, deaths and head injuries among cyclists fell between 37% and 51%. The helmet wearing rates rose from 5% in 1982-1983 to 31% in 1989-1990 to 75% in 1991. (29)

Dannenberg et al. (30) made a comparison of bicycle helmet legislation, educational campaigns and no specific campaigns in three counties. The results of the study show that legislation combined with education is the most effective way to increase helmet use in child bicyclists. Self-reported helmet use in the legislation county rose from 11% to 38% after the law and educational campaign, compared with the county where educational efforts were undertaken (8% to 13%).

The results of Florida's bicycle helmet law and a bicycle safety educational program are also relevant with an increase in helmet use from 5.6% to 20.8% with children aged 10 to 12 years having the greatest increase in helmet use (27%). (31)

These results encourage the continual support of projects for the promotion of bicycle helmets because even though bicycle helmet use has increased, it still remains too low and non-helmeted bicyclists continue to have a higher risk of serious injuries.(31)

The design of helmets has changed and improved over time to include *visors* or *grill extensions* helping to prevent serious neck and face injuries in sports such as American football, ice hockey, cricket, motorcycling. (5) In order to reduce head, eye, face, and dental injuries, helmets that have *shatter-resistant face shields* made by polycarbonate must be used. (32)

*In ice hockey*, the players began to wear helmets and face masks 30 years ago. This sport has a high risk of cervical spine trauma. (33) For sports governing bodies and researchers, the search for improved player safety to prevent these injuries has been an ongoing process.

Ice hockey associations from Canada and the United States have introduced head and neck risk management strategies. The use of facemasks and helmets in hockey has become compulsory since 1976 and injuries to the eyes and teeth have been minimized since then. However, there are some speculations regarding the association of helmets and full-face shield use with an increased risk of cervical injuries by promoting a more aggressive play or due to biomechanical alterations.

Smith et al. (34) studied the consequences of wearing a hockey helmet and face shield on the head and neck during inertial loading. They found no difference between the helmeted and non-helmeted trials and concluded that the increase in angular displacement of the head by the addition of a helmet and face shield does not increase the risk of cervical spine trauma.

In a recent study, Benson et al (35) tried to determine the risk of sustaining a head or neck injury among intercollegiate ice hockey players wearing full-face shields compared to those wearing half-face shields. The study brings evidence that the use of full-face shields is associated with a significant drop in the risk of sustaining facial and dental injuries without bringing an increase in the risk of neck injuries, concussions, or other injuries.

*In boxing*, by the nature of the game, the athlete is permanently exposed to a high risk of head injury. It was suggested to better control the type of sparring and limiting the number of fights in a boxer's career, in order to reduce the risk of cumulative damage. (21)

The head protection is regularly worn in boxing training session. In the country where headgear is compulsory there has been a reduction in the number of facial cuts and knockouts. (21)

Matser et al (36) conducted a study whose objectives were to determine whether significant Acute Traumatic Brain Injury (ATBI) occurs in boxers who compete, the nature of cognitive impairment and if headgear could reduce the risk for ATBI in amateur boxing. The authors reported that despite the use of headgear, participation in amateur boxing could diminish neurocognitive functions.

Chronic Traumatic Brain Injury (CTBI) associated with boxing (also known as dementia pugilistica, chronic traumatic encephalopathy or the punch-drunk syndrome) occurs in approximately 20% of professional boxers. (37) CTBI related to boxing represents a major public health concern. In order to prevent the occurrence of CTBI measures that limit excessive exposure must be taken. (37)

Leclerc and Herrera suggested (38) that sports physicians and others expert in prevention and diagnosis of head injuries should take a public stand against boxing, to increase public awareness of the risks. The American Academy of Pediatrics (AAP) already has issued policy statements opposing boxing.

In *horse riding*, there is also recommended to wear helmets for reducing head injuries. A good body of epidemiology supports the proper use for approved helmets for preventing head injuries in this sport. (39) However, because of perceived poor design, many riders choose not to wear helmets. (39)

*Eye protection* is necessary in sports in which there is a high risk of eye injury such as: baseball, ice hockey, rackets sports. Baseball is the leading cause of sports-related eye injury in the United States (32).

Sports-related eye injuries have a high risk for ocular morbidity and subsequent vision loss. (40) Many eye injuries can be avoided by using several methods of prevention, including the supervision of the play, the enforcement of the game rules and the use of eye-protective devices.

To reduce risk of eye injury, it is recommended to wear goggles with polycarbonate plastic lenses and frames, which are sturdy and impact resistant and provide optimal protection. Lens-less goggles, street wear and spectacle correction glasses do not provide optimal protection. (41)

The use of *mouth guards* is recommended in sports, which have an increased risk of dental injuries. Dental injuries are the commonest type of orofacial injury sustained during participation in sports. (42) While all contact sports participants are at risk, the highest number of mouth and teeth injuries is in rugby football in the UK and American football in the USA. (5) The non-contact sports also carry the risk of orofacial injuries, but the risk is much smaller in the case of these sports.

Only five amateur sports and one professional sport have regulations requiring the use of mouth guards. Even in the sports that require their use, compliance is not universal. (43)

Different types of mouth guards are available. Their role is to protect against trauma of the teeth, fillings, bridges, and crowns. Additionally the likelihood of laceration of lips, mouth, and tongue from the teeth is drastically reduced. (5) There is evidence that mouth guards are effective in protecting against concussion and injuries to the cervical spine. (44) Of the mouth guards which are currently available, custom-made mouth guards fitted by a dentist have been demonstrated to provide the greatest protection from dental injuries. (42)

A wide range of protective equipment provides the *body-protection.* For example, in cricket the protective equipment is ranging from body padding to gloves and face protectors. (45) In American football, the body-protection is also very extensive. The incidence of head, neck, and shoulder injuries appears to be on the decline. (5)

Some sports, for example football and basketball, have a very high incidence of ankle injuries, mainly sprains. The ankle sprain is one of the most commonly treated injuries. (46) Many choices are available to athletes seeking an *ankle support*:

- *Ankle taping* with adhesive tape support does offer protection against ankle sprains during activity; (47) The mechanism by which taping works is not certain; the major effect of taping may be its proprioceptive effect on underlying muscle groups. (48)
- *Laced stabilizers* offer an equal or possibly greater amount of support than ankle taping; (47) *Air stirrup* may be indicated for patients with a history of ankle injury who are undergoing a graduated rehabilitation program. It reduces significantly the incidence of recurrent sprains in athletes with previous history of ankle sprains.(47, 49)
- The studies support *the use of high top shoes* for ankle sprain prevention because of their ability to limit extreme ranges of motion, provide additional propioceptive input and decrease external joint stress. (50)

Knee injuries are also a major problem facing the sports medicine community. The use of prophylactic knee braces in sport did not prove to be effective. (51)

Football players have a high risk of soft-tissue injuries to their legs. Fractures of the tibia and fibula represent a serious potential injury. (52)

*Shin guards* are the only protective devices that are require by the international and collegiate soccer associations. They contribute in reduction of injuries in the shin region by absorbing the shock. Shin guards are assumed to be most effective in reducing leg abrasions and contusions. (52)

Bir et al. (53) reported as results of an experimental study that load forces were reduced by 41% to 77% by using shin guards. The shin guards were found effective in lowering the amount of impact force transferred to the shin region even at varying temperatures.

Francisco et al (54) have evaluated the effectiveness of a number of shin guards in protecting against tibia fracture in soccer players, as well as the relationship between the material and structural differences in shin guards and the protection provided. The results indicated that all shin guards provide some measure of

protection against tibia fracture, although the level of protection may vary significantly among the different guards.

The *footwear* also has a very important role in preventing sports injuries. Proper running shoe must provide support and impact absorption as well as protection from hyperpronation. Shock -absorbing insoles have been found to be effective in reducing the incidence of overuse injury. (55)

There is a multitude of factors that can contribute to the occurrence of ski injuries: skier behavior, environment - especially the weather and slopes conditions, but the equipment is also very important- *skis, boots and bindings.* (56)

The design of ski boots helped reduce certain types of injury, such as tibia and ankle fractures, though these to some extent have been replaced by boot-top tibia fractures. (5, 56) The modern two-mode ski release bindings have allowed earlier release of the ski under excessive rotational stress, and thereby reduced the incidence of medial collateral ligament (MCL) injuries. However, they do not reduce the more severe knee-ligament disruption. (5, 57) There are no bindings that can protect both the knee and lower extremities from serious ligament sprains. (57) It appears that lower extremity equipment-related injury rates can be lowered substantially by promoting proper binding adjustment procedures. (58)

*Snowboarding* has become a very popular sport in the last years. Boldrino and Furian (59) found in a case-control study that the risk of injury of lower extremities increased with the use of ski boots by the snowboarders. The ski boots do not appear to be suitable for snowboarding (23% of injured snowboarders compared with 12% in the control group, $p<0.05$). The authors reported also that injured snowboarders were far more likely to have rented equipment than the non-injured (22% compared to 7%, $p<0.05$).

## Rules of the game and Referees

One of the impacts of sports medicine has been in changing the rules of some sports. (9) Selected rule changes in sports have been prompted by a desire to reduce

the risk of injury. (60) The decrease in cervical spine injuries in American football after the reduction in the use of helmet for blocking (the “spearing” rule) is a commonly used example. (32,60)

The recommendations for the referees are (61):

◊ to apply the rules more strictly

◊ to modify or change the rules in a more safe direction

◊ to make equipment compulsory.

Enforcement of safety measures by ensuring that athletes adhere to the rules of the game is very important because in many sports illegal play can be dangerous.(5) For example, Ekstrand and Gillquist found in a study that one third of the traumatic soccer injuries were caused by foul play, according to the judgment of the referee. (62) Two other studies revealed that soccer players stated that fouls were in some way responsible for 25% of injuries. (63,64)

Also, players and coaches must be aware about the importance of the use of protective equipment.

Positive pressure toward safe coaching can be encouraged through the media, local or community- based education programs or campaigns, and effective use of coalitions. (32)

## Sports arenas and playing surfaces

The design of the sports arenas is relevant when it comes to prevention of sports injury. Safety designs of arenas and training competition surfaces, including pole-vaulting, high jump, and gymnastic landing areas are important considerations.(5)

For instance, indoor arenas should be designed to exclude obstacles such as radiators. Spring-back flag-posts of non-breakable material should also be used. In sports such as rugby and football a suitable padding of existing props reduces the risk of sports injury (5).

The playing surfaces must be properly care in order to avoid the occurrence of sports injuries. For example, in wrestling, proper and frequent scrubbing of the mat can help minimize the spread of contagious skin disease. (32)

## Environmental conditions

Environmental conditions can play an important role in the occurrence of sports injuries. When conditions are improper they can impair athletic performance and even stress athletes beyond the limits of recovery. (3) For example, cold weather with inadequate warm-up leads to reduced elasticity and stiffness, hot and humid weather can cause heat stroke, competing in poor light can cause injury. (12)

The physicians must educate the athletes on basic preventive measures if they are going to participate in outdoor sporting activity in order to avoid hypothermia, heat-related illness and high-altitude illness. (65)

For example, physical activity should be modified in the face of *high ambient temperature and humidity*:

- *Clothing* should be should be white, light weight, and loose fitting. (66)
- *Acclimatization* typically requires 10 to 14 days of heat exposure, with the biggest changes in days 3-5) and is lost within a few weeks unless exposure to heat is repeated regularly at intervals of four days or less. (65,66) Initial exercise sessions should be shorter and less intense than normal training levels. (67)
- A *proper hydration* is also essential for exercising in warm climates.

  The American College of Sports Medicine suggests that the rate of fluid ingestion during prolonged exercise should attempt to match fluid losses from sweating or follow a more generic guideline of 150 to 300 mL (about 5 to 10 oz) every 15 minutes during running or similar vigorous activity. (68)

  It is also recommended the practice of hyperhydration before exercising, respectively rehydration before, during, and after exercise in the heat. (67) The night before an event, athletes should hydrate with electrolyte fluids to reduce the risk of dehydration. (20) Fluid breaks should be offered at least every 45 minutes, and athletes should be entitled to unrestricted amounts of fluids to help prevent dehydration. (20)

Regarding practicing in cold climate, hypothermia risk is increased with wind chill and temperatures T<50 F/ 10 C; frostbite risk increases with T< 31 F/ -1 C. (69) The recommendations are for skiing events to be stopped at T< -4F/ -20 C. (69).

## Proper hydration and good nutritional practices

Proper hydration and good nutritional practices are also very important for the athletes' health and safety. Dehydration and nutritional insufficiency from caloric restriction to "make weight" (used in sports such as wrestling and gymnastics) predispose to injury and should be discouraged. (20,32) The athlete should be advised to maintain a proper hydration and to ingest approximately 20 kcal/kg, plus the calories of training and activities daily, with the proportion of calories as follows: 60% to 70% carbohydrate, 25% to 30% fat, and 10% to 15 % protein. (69)

## Prevention of overuse injuries

The prevention of overuse injuries presumes the identification of the etiological factors responsible for overload, for example: poor sports technique, anatomical malalignment, wearing inadequate equipment and sports shoes, excessive training, etc. Victims of overuse injuries have failed to manage correctly their training schedules or have paid inadequate attention to correct use of equipment. (5,12) An appropriate training program and conditioning, the correct use of properly fitted equipment and footwear plus well kept playing surfaces can minimize the risk of overuse injury. (70,71) It is also very important to have educational programs for the instruction of coaches and parents to the hazard of overuse injuries and inappropriate sports participation. (32)

## Prevention of sports injuries in children

The sports injuries are the number one reason for emergency department visits among children (72). Knowledge, not only regarding the diagnosis and treatment of sports injuries particular to the pediatric athlete, but also of methods of preventing them is essential in helping maintain the long-term health of these individuals. (73)

An understanding of the pattern of musculskeletal injury in children is required prior to a consideration of injury-prevention. The different patterns of injury are dependent on the difference in the relative strength of the various components in the child compared to the adult. (5)

The relevant contact groups should take the responsibility for the prevention of sports injuries in children: parents, teachers, coaches, trainers, sports clubs, and sport associations. (5) Parents should be involved and to make sure that the child wears protective gear, follows the rules of play and is physically and emotionally prepared to play sport.

The American Academy of Pediatrics does not recommend team sports for children under the age of six. (72)

A child is not a scaled-down version of an adult so the training program must be adapted considering the fact that the child athlete responds differently to training. (73)

Until the onset of puberty, boys and girls can complete together, being almost the same size and weight. (72) After puberty, because the fact that boys gain an advantage in both strength and size, it is not recommended for boys and girls to compete against each other anymore. (72)

## *Conclusions*

The medical professionals and particularly sports physicians have the mission to advise athletes and sports organizations on the latest prevention strategies and to supervise their implementation. The ***general guidelines*** for any type of sports activity have to underline the importance of the following measures in preventing sports injuries:

- Good nutritional status and proper hydration;
- The preseason physical examination;
- Proper methods of training and conditioning;
- Correct use of equipment;
- Proper playing conditions ( field/ surfaces of play );
- Playing within the rules of the game;
- Paying attention to the environmental conditions;
- Awareness of the overuse injuries.

Depending on the type of sport, are recommended some *specific measures*.

Presently, the important role of prevention of sports injury is very well argued in the sports medicine literature. Despite advances in injury prevention in sports, sports injuries continue to affect a significant proportion of the population. This situation indicates the necessity for comprehensive, collaborative and continuous campaigns, which should be conceived, to specific groups of risk (for instance children and adolescents participating in high-risk sports). For most sports, there seems to be a need for further studies on the etiology and determinants of behavior, before effective prevention can be realized.

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## EHLASS (CODING MANUAL 86) AND SPORTS INJURIES

In contrast to the ICD coding, EHLASS manuals include rubrics for the description of sports injuries. Unfortunately, no injury deaths due to sports injuries can be solicited from the widely available and reliable WHO mortality data, whereas because of its features EHLASS is a surveillance system, which offers unique opportunities for sports injury prevention. More specifically:

- The pre-coded questionnaire that is systematically completed in the EHLASS databases covers information on sociodemographic features, accidents characteristics and nature of injuries. Based on information collected for the activity of the injured person during the time of accident, the general profile of sports injuries can be described.
- In member states with population based EHLASS databases the extent of magnitude of problem on sports injuries can be calculated and time-trend analyses can be performed. Moreover, proportional indicators useful for policy development strategies can be assessed, using figures about patients treated at Accident and Emergency departments, those hospitalised, the hospitalisation time etc.
- The incorporation of EHLASS into European Monitoring System (European Union Public Health Information Network, EUPHIN/ Health Indicator Exchange Monitoring System HIEMS, set up by DG SANGO) with its potential to provide linkage with other data sources opens a new era for those working in the field of sports injuries prevention.

We have tried to identify the ability of previous EHLASS (coding version 86 was used by most of the participating member states) to sufficiently capture sports based on experience obtained using this coding system and by comparing the results of EHLASS with ad hoc studies.

The analysis of the sports injury data provided by participating member states was restricted due to the following limitations:

1. Coding issues

2. Ability for comparisons among participating countries
3. Limitations of EHLASS data

## 1. Coding issues

Although a uniform operational definition was used in data analysis, it was not possible certain cases to be characterized as sports injuries. The following considerations concerning sports injuries were raised:

*Coding of intent*

By definition, sports injuries to be included in the EHLASS surveillance system should be of unintentional nature. However, there may be few cases that are intentional but due to lack of clarity and no specific questions to address the issue in the EHLASS database, there may be characterized as unintentional.

*Coding of place*

EHLASS coding system (version 86) provides a relatively analytic list of places where sports injuries occur. Nevertheless, it would better serve prevention strategies if injuries in sports areas such as swimming pool, skiing resort or sports hall (indoor, outdoor) separated in the coding manual.

*Coding activity*

EHLASS coding system (version 86) has several rubrics describing the type of activity. In some cases, however, it is difficult to classify a given activity in one of the existing categories. For instance, bicycle or walking could be considered as unspecified training or as a leisure activity. On the other hand many different codes might apply to the same activity. For example, a football match which takes place at school can be coded either as a sport or as an educational activity. There is also considerable difficulty to discriminate between sports or recreational activities.

Version 96 of the EHLASS coding manual has been improved and is more analytical compared with the 1986 coding manual. The 1996 EHLASS coding version describes in detail the majority of variables involved in sports injuries. Especially for sports injuries a new coding set on category “athleticism, gymnastics, exercise” has been

introduced. Describing each type of sport in an exact way offers a clear view of the activity, which was practiced during the given time of accident.

## 2. Ability for comparisons among participating countries

In order to make valid comparisons among the participating countries, it was necessary to use the same coding system or to transform the data in the same coding manual. To this end, a questionnaire concerning the availability of sports injuries data as well as different codes used by various countries participating in this project was mailed to the participants. Results from this survey are presented on Table 1.

Table 1. Type of coding system used by partners

| *Type of coding system* | ***AU*** | ***DK*** | ***FR*** | ***GB*** | ***GER*** | ***GR*** | ***IT*** | ***NL*** | ***ISR*** |
|---|---|---|---|---|---|---|---|---|---|
| **EHLASS 86** | ✓ | | ✓ | | | ✓ | | ✓ | |
| **EHLASS 96** | | ✓ | | ✓ | | | | | |
| **UK coding manual** | | | | ✓ | | | | | |
| **ICD-9 E-CODE** | | | | | | ✓ | | | ✓ |
| **NOMESCO** | | ✓ | | | | ✓ | | | |
| **AIS** | | | | | | | ✓ | | |
| **Other** | | ✓ | | | ✓ | | | | |

Most of the officially participating countries (Austria, France, Greece and Netherlands) made use of the same EHLASS coding system (version 86) for the year 1998 or they were able to transform their data to this version of the manual. EHLASS data for Italy were not made available and for the purpose of this study data from CONI and other sources were used, some of which were coded with the Abbreviated Injury Scale (AIS). Germany provided detailed sports injuries data derived from other than EHLASS sources. No EHLASS database currently exists in Israel, where ICD-9 E-code is used for hospital data. Lastly, the United Kingdom, an unofficial partner, offered data that where coded with a UK coding manual converted to the EHLASS coding system version 96.

Given these constraints comparisons of EHLASS data among participating countries were not easy. National estimates for sports injuries could be generated only for three member states, which claim to rely on representative home and leisure injury data collection systems, whereas these figures can be extrapolated by EHLASS in Greece.

Another point that should be stressed is that of the diversity of sports practiced in the participating countries. According to the literature each type of sport has its own injury profile. Therefore, overall comparisons concerning injuries from all types of sports could not be reliable, unless this variability was taken into account.

Moreover, differences in the health delivery systems and referral practises could be responsible for the observed variability in the frequency of sports injuries. For instance, in some countries injured persons are to be referred to a hospital by a primary care physician, whereas in others free access to the hospital may be allowed, even for injuries of minor severity.

## 3. Limitations of EHLASS Data

Although EHLASS was the main system used for the identification of sports injuries, it was felt from the conception of this project that there may severe underreporting of sports injuries, especially those suffered by elite athletes. Elite athletes may sustain

injuries of high severity but they have their own system of mostly confidential referrals to specialized private care services. Therefore, the following considerations should be taken into account:

- EHLASS database does not capture sufficiently sports injuries as a) the majority of elite athletes seek medical care privately and b) a significant proportion of sports injuries are of minor severity and therefore the injured persons are usually self-treated.
- As the study population consisted of persons with acute sports injuries who visited the Accident and Emergency Departments of the participating hospitals, the registered cases are eventually representative of acute injury events rather than recurrent injuries.
- The pre-coded questionnaire that are routinely obtained for the completion of EHLASS database does not include important parameters which are specific for sports injuries, such as history of previous injuries, exposure time to sports activities, personal safety equipment and field conditions.

## PRACTISED SPORTS IN THE PARTICIPATING COUNTRIES

In the context of this project an inventory of most frequent practiced sports in each of the participating member states was assembled. It has been stressed that this inventory should be based on data derived from non injury based sources and that a short description of the sports that are rather locally practiced and are not well known among other EU MS would be very helpful. Sports were divided in Olympic and non-Olympic. As it was expected different ranking on most frequent types of sports were noticed among participating member states. The rank of 10 most frequently practiced sports in each member state is presented on Table 1 and Table 2. The popularity of sports in each separate participating country are presented on (**APPENDIX F).**

Data describing the most popular sports in each participating country were derived either from already existing sources in some of the countries or relied on ad hoc telephone surveys as shown below:

AUSTRIA: Official Survey on "Sports, Leisure and Home Accidents" (Statistics Austria) 1997
FRANCE: Investigate BVA/L' Equipe (1997) with a representative sample of 1010 persons 15+ years old.
GREECE: Phone Inquiry to sports federations and associations
ITALY: CONI-ISTAT (Italian Institute of Statistics)
NETHERLANDS: Household Survey "Injuries in Netherlands"
UK: Ball D.J. Mini-Symposium: Risk and benefits of sports and exercise. Part 1 of a 3 part series. Assessing the risks. Sports Exercise and Injury (1998) 4; 3-9
ISRAEL: Phone Inquiry to sports federations and associations

Table 1. Ten most popular sports in EU member states and Israel*

| AUSTRIA | FRANCE | GREECE | ITALY | NETHERLANDS | UNITED KINGDOM | ISRAEL |
|---|---|---|---|---|---|---|
| 1. Cycling | 1. Swimming | 1. Football | 1. Football | 1. Football | 1. Swimming | 1. Fitness |
| 2. Swimming | 2. Cycling | 2. Basketball | 2. Gymnastic | 2. Tennis | 2. Billiards | 2. Tennis |
| 3. Hiking Mountain | 3. Football | 3. Volleyball | 3. Swimming | 3. Fitness | 3. Running/Jogging | 3. Football |
| 4. Alpine Skiing | 4. Athletics | 4. Swimming | 4. Winter sports | 4. Swimming | 4. Football | 4. Basketball |
| 5. Gymnastics | 5. Tennis | 5. Handball | 5. Tennis | 5. Gymnastics | 5. Golf | 5. Sailing |
| 6. Ice Skating | 6. Gymnastics | 6. Cycling | 6. Athletics | 6. Equestrian | 6. Bowls (law &carpet) | 6. Martial arts |
| 7. Other winter sports | 7. Walking/Ramble | 7. Water polo | 7. Cycling | 7. Volleyball | 7. Badminton | 7. Judo |
| 8. Athletics | 8. VTT | 8. Gymnastics | 8. Volleyball | 8. Hockey field | 8. Tennis | 8. Taek wondo |
| 9. Table tennis | 9. Basketball | 9. Tennis | 9. Hunting | 9. Running / Jogging | 9. Squash | 9. Volleyball |
| 10.Tennis | 10. Alpine skiing | 10. Diving | 10. Basketball | 10.Athletics | 10.Equestrian | 10. Handball |

*Data from Germany are missing

Table 2 Ranking of Sports practised in EU member states and Israel*

| | AU | | FR | | GR | | IT | | NL | | UK | | ISR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | % | R | % | R | % | R | % | R | % | R | | R | % |
| **OLYMPIC SPORTS** | | | | | | | | | | | | | | |
| Archery | | | | | | | | | | | | | 25 | 0.1 |
| Athletics | 8 | 4.6 | 4 | 15.0 | | | 6 | 8.4 | 10 | 2.7 | 17 | 0.8 | 20 | 0.1 |
| Marathon | | | | | | | | | | | | | | |
| Badminton | | | | | | | | | 16 | 1.9 | 7 | 3.3 | 20 | 0.1 |
| Baseball | | | | | | | | | 31 | 0.5 | | | 25 | 0.1 |
| Basketball | | | 9 | 8.0 | 2 | 34.4 | 10 | 3.4 | 21 | 1.2 | 14.5 | 1.1 | 4 | 8.8 |
| Boxing | | | | | | | | | 28 | 0.6 | | | 20 | 0.1 |
| Canoeing | | | | | | | | | | | | | 19 | 0.2 |
| Flat water | | | | | | | | | | | | | | |
| Slalom | | | | | | | | | | | | | | |
| Cycling | 1 | | 2 | 18.0 | 6 | 2.3 | 7 | 7.9 | 12 | 2.2 | | | 15 | 0.6 |
| Track | | | | | | | | | | | | | | |
| Road | | 16.0 | | | | | | | | | | | | |
| Mountain bike | 14 | 2.1 | | | | | | | | | | | | |
| Equestrian | 16 | 1.1 | 13 | 3.0 | | | | | 6 | 4.9 | 9.5 | 2.5 | 15 | 0.6 |
| Jumping | | | | | | | | | | | | | | |
| Dressage | | | | | | | | | | | | | | |
| Three-day event | | | | | | | | | | | | | | |
| Fencing | | | | | | 0.4 | | | | | | | 18 | 0.2 |
| Football | 10 | 3.2 | 3 | 16.0 | 1 | 36.2 | 1 | 20.8 | 1 | 18.1 | 4 | 7.8 | 3 | 10.3 |
| Gymnastics | 5 | 7.9 | 6 | 14.0 | 8 | 0.6 | 2 | 16.8 | 5 | 5.2 | | | 17 | 0.5 |
| Artistic | | | | | | | | | | | | | | |
| Rhythmic | | | | | | | | | | | | | | |
| Trampoline | | | | | | | | | | | | | | |

| | AU | | FR | | GR | | IT | | NL | | UK | | ISR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | % | R | % | R | % | R | % | R | % | R | | R | % |
| OLYMPIC SPORTS | | | | | | | | | | | | | | |
| Handball | | | | | 5 | 3.4 | | | 13 | 2.1 | | | 11 | 1.1 |
| Hockey | | | | | | | | | 8 | 3.0 | 20.5 | 0.5 | 25 | 0.1 |
| Judo | | | | | | | | | 18 | 1.9 | | | 7 | 2.2 |
| Modern Pentathlon | | | | | | | | | | | | | | |
| Rowing | | | | | | | | | 23 | 1.0 | | | | |
| Sailing | | | | | | | | | 24 | 0.9 | 12.5 | 1.9 | 5 | 8.8 |
| Windsurfing | | | | | | | | | 38 | 0.2 | | | | |
| Shooting | | | | | | | | | 35 | 0.3 | | | 10 | 1.2 |
| Softball | | | | | | | | | | | | | 25 | 0.1 |
| Aquatics | | | | | | | | | | | | | 12 | 1.0 |
| Swimming | 2 | 12.9 | 1 | 21.0 | 4 | 5.4 | 3 | 14.0 | 4 | 8.7 | 1 | 24.6 | | |
| Diving | | | | | 10 | 0.5 | | | | | | | | |
| Water polo | | | | | 7 | 0.9 | | | 34 | 0.4 | | | | |
| Synchronized | | | | | | 0.5 | | | | | | | | |
| Table tennis | | | | | | | | | 27 | 0.7 | 12.5 | 1.9 | 13 | 0.9 |
| Tae kwon do | | | | | | | | | | | | | 8 | 1.5 |
| Tennis | 9 | 3.8 | 6 | 14.0 | 9 | 0.6 | 5 | 9.0 | 2 | 14.4 | 8 | 2.8 | 2 | 15.4 |
| Triathlon | | | | | | | | | | | | | | |
| Volleyball | | | 11 | 6.0 | 3 | 14.5 | 8 | 5.6 | 7 | 3.5 | | | 9 | 1.4 |
| Beach Volley | | | | | | | | | | | | | | |
| Weightlifting | | | | | | | | | 37 | 0.2 | | | 25 | 0.1 |
| Wrestling | 20 | 0.4 | | | | | | | 40 | | | | 15 | 0.6 |
| Freestyle | | | | | | | | | | | | | | |
| Greco-Roman | | | | | | | | | | | | | | |

| | AU | | FR | | GR | | IT | | NL | | UK | | ISR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | % | R | % | R | % | R | % | R | % | R | | R | % |
| **WINTER OLYMPIC SPORTS** | | | | | | | | | | | | | | |
| Alpine skiing | 4 | 12.5 | 10 | 7.0 | | | | | 32 | 0.5 | | | | |
| Biathlon | | | | | | | | | | | | | | |
| Bobsleigh | | | | | | | | | | | | | | |
| Cross Country Skiing | | | | | | | | | | | | | | |
| Curling | | | | | | | | | | | | | | |
| Ice skating (Figure Skating) | 6 | 7.1 | | | | | | | 17 | 1.9 | | | | |
| Freestyle Skiing | | | | | | | | | | | 20.5 | 0.5 | | |
| Ice Hockey | | | | | | | | | | | | | | |
| Luge | | | | | | | | | | | | | | |
| Nordic Combined | | | | | | | | | | | | | | |
| Short Track Speed Skating | | | | | | | | | | | | | | |
| Skeleton | | | | | | | | | | | | | | |
| Ski Jumping | | | | | | | | | | | | | | |
| Snowboarding | 15 | 1.5 | | | | | | | | | | | | |
| Inline skating (Speed Skating) | 11 | 2.6 | | | | | | | | | | | | |

| | AU | | FR | | GR | | IT | | NL | | UK | | ISR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R | % | R | % | R | % | R | % | R | % | R | | R | % |
| **NON OLYMPIC SPORTS** | | | | | | | | | | | | | | |
| Aerobics | | | | | | | | | 11 | 2.4 | | | 1 | 35.2 |
| Ballet/dance/jazz | | | | | | | | | 14 | | | | | |
| Billiards | | | | | | | | | 26 | 0.7 | 2 | 20.6 | | |
| Body building | | | | | | | | | 30 | 0.5 | | | | |
| Bowling | | | | | | | | | 33 | 0.5 | | | | |
| Bowls (law & carpet) | | | | | | | | | | | 6 | 4.5 | | |
| Cricket | | | | | | | | | 25 | 0.8 | 14.5 | 1.1 | | |
| Fitness training | | | | | | | | | 3 | 8.8 | | | | |
| Fishing | | | | | | | | | 29 | 0.5 | 2.2 | 2.2 | | |
| Golf | | | | | | | | | 19 | 1.5 | 5 | 7.5 | | |
| Hiking | 3 | 12.7 | | | | | | | | | 20.5 | 0.5 | | |
| Hunting | | | | | | | 9 | 3.4 | | | | | | |
| Indoor soccer | | | | | | | | | 22 | 1.0 | | | | |
| Korfball | | | | | | | | | 15 | 1.9 | | | | |
| Martial art | | | | | | | | | | | | | 6 | 8.8 |
| Motoring | | | | | | | | | 36 | 0.3 | 17 | 0.8 | | |
| Motor-boating | | | | | | | | | | | | | | |
| Netball | | | | | | | | | | | 20.5 | 0.5 | | |
| Running jogging | 8 | | | | | | | | 9 | 2.9 | 3 | 10.9 | | |
| Rock Climbing | 18 | 0.6 | | | | | | | | | | | | |
| Rugby | | | 12 | 4.0 | | | | | | | 17 | 0.8 | | |
| Skateboarding | 19 | 0.6 | | | | | | | | | | | | |
| Squash | 17 | 0.9 | | | | | | | 20 | 1.3 | 9.5 | 2.5 | | |
| VTT | | | 8 | | | | | | | | | | | |
| Walking/Ramble | | | 6 | | | | | | | | | | | |
| Other ball sports | 13 | 2.1 | | | | | | | | | | | | |
| Other winter sports (non specified) | 7 | 5.2 | | | | | 4 | 10.7 | | | | | | |
| Other sports | 12 | 2.2 | | | | | | | | | | | | |

*Data from Germany are missing

## PUBLIC HEALTH INDICATORS FOR SPORTS INJURIES

Sports injuries represent the most important and the most direct adverse consequence of sports activities. EU has recognized the need to develop indicators reflecting the magnitude and the pattern of sports injuries across the Union. In the context of this program a set of indicators was developed and approved by the participating EU member states and Israel. The development of these indicators followed the realization that:

- The frequency and severity of sports injuries is a function of the popularity as well as the inherent risk of each type of sport activity.
- Sports injuries are concentrated to specific segments of the population whose time weighted exposure is usually very difficult to calculate.
- Sports injuries can repeatedly affect the same individual making it necessary to count not only injured persons but also sport injury events.
- Sources of data for sports injuries vary considerably between and within countries.

In the light of these constraints, priority should be given to a subset that includes sports related indicators on:

1. deaths and mortality
2. number of hospitalizations and incidence rates of hospitalized injuries
3. hospital, including outpatient, contacts
4. cost estimates.

Data from national reports were used in order to provide estimates for these indicators in the participating countries and they are shown in detail below:

*Basic indicators for sports injuries in selected European Union member states and Israel*

| *Country (Population in million)* | *AU (8)* | *FR (58)* | *GER (82)* | *GR (10)* | *IT (57)* | *NL (15)* | *UK (59)* | *DK (5)* | *ISR (5)* |
|---|---|---|---|---|---|---|---|---|---|
| **Deaths (n)** | NA | 130 | 140 | NA | 120 | 10 | 160 | | |
| **Mortality*10$^{-6}$ person yr** | NA | 2.3 | 1.7 | NA | 2.1 | 0.06 | 2.7 | | |
| **Hospital admissions (n)** | 24. 000 | 100.000 | 180 000 | 3.500 | 105. 000 | 11.000 | 150. 000* | | |
| **Hospital admission incidence*10$^{-3}$** | 3.0 | 1.7 | 2.2 | 0.4 | 1.8 | 0.7 | 2.6 | | |
| **Hospital admission incidence*10$^{-3}$ sports participants/yr** | 3.3 | 7.1 | 5.5 | 3.5 | 3.0 | NA | NA | | |
| **A&E Dept sports injury visits** | NA | 700.000 | NA | 130. 000 | 840. 000 | 170.000 | 575.000 | | |
| **A&E Dept sports injury visits*10$^{-3}$ person-yr** | NA | 12.1 | NA | 13.0 | 14.7 | 11.3 | 9.8 | | |
| **Hospitalized/ A&E visits (%)** | NA | 12 | NA | 3 | 12 | 6 | 26 | | |
| **Medically attended (n)** | 227.400 | 1.000.000 | 1.94 M | 200.000 | 2.1 M | 688.000 | 4.5 M | | |
| **Medically attended incidence*10$^{-3}$ person years** | 29 | 17 | 24 | 20 | 37 | 44 | 77 | | |
| **Medically attended incidence*10$^{-3}$ Sports participants/yr** | 32 | 71 | 53.9 | 200 | 60 | NA | NA | | |
| **Hospitalized/ medically attended (%)** | 10 | 10 | 9 | 2 | 5 | 2 | NA | | |
| **Sport deaths as % of injury deaths** | NA | NA | NA | NA | NA | 0.2 | 1.3 | | |
| **Hospitalized sports injuries as % of hospitalized injuries** | 11 | NA | NA | 3 | NA | 6 | NA | | 5.4 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Medically attended sports injuries as % of medically attended injuries** | 29 | NA | NA | NA | NA | 29 | NA |
| **Total cost (Euros)** | 302M | NA | 4B | NA | 8.2M | 94M | 1.7 B |
| **Cost per medically attended sport injury (Euros)** | 1.330 | NA | 2.000 | NA | NA | NA | 400 |
| **Cost per person (Euros)** | 38 | NA | 50 | NA | NA | 500 | 29 |

*UK: assuming that 50% of over 3 day sport injuries are hospitalized (derived by from adding all major injuries +1/2 with over 3 day (and the triangle ratio)

## DOPING

The major national and international laboratories qualified in detecting performance-enhancing substances were contacted. Moreover, brainstorming sessions with athletes collaborating in this project were made in order to identify ways and formulate a research questionnaire to elicit this information

Issues related to doping will be examined in detail during the second phase of the project. Preliminary information was gathered, however, in collaboration with the director of Doping Control Laboratory of Olympic Games Center of Athens, (one of the twenty-five internationally authorized laboratories in doping testing) Costas Georgakopoulos. Data showing the increasing problem among competitive athletes were provided. Specifically, the proportion of positive samples examined in the athletes' urine specimens during two recent year period and sorted by type of sport and competition in Greece and worldwide provide objective evidence that the problem is there and more work is to be done in order to determine the underlying causes and ways to combat this epidemic. As an ethical and scientific prerequisite, absolute confidentiality is, by all means a sine qua non.

The extent of sport doping and it's potential risks for health is to be considered as a problem of public health. Elite, competitive athletes use many types of drugs in order to improve their performance. A great deal of misuse also may occur in private gymnasiums, among non -competitive recreational athletes.

Athletes may use drugs for therapeutic indications, as ergogenic aids or to mask the presence of other drugs during doping control.

These drugs can be divided into the following categories:

- those that enhance performance as stimulants (amphetamines, ephedrine and cocaine)
- those that are used to reduce tremor and heart rate (beta blockers)

- those involved in bodyweight gain or loss (anabolic-androgenic steroids, growth hormone, beta 2-agonists, and diuretics)
- other endogenous substances (erythropoietin)
- other nutritional supplements presented as a natural and safe method of improving athletic ability.

For some of the above there is no reliable method available for detection through urine test (growth hormone, erythopoietin).

As many of these drugs are supported by unethical and illegal distribution pattern, the estimation of prevalence of their use is difficult

The data provided by Athens doping control center are based on data of the International Olympic Committee (IOC).

# Athens Doping Control Statistics: Year 1999

| Sport event | Number of samples | Sort of competition | Positive samples | Negative samples |
|---|---|---|---|---|
| Athletics | 138 | Major International | 0 | 138 |
| Athletics | 48 | International | (1) methenolone | 47 |
| Athletics | 65 | National | (1) ephedrine<br>(1) salbutamol | 63 |
| Athletics | 27 | Out of competition | (1) salbutamol<br>(1) nor-androsterone, nor-etiocholanolone | 25 |
| Basketball | 202 | National | (2) nor-androsterone, nor-etiocholanolone<br>(1) pseudoephedrine<br>(2) ephedrine<br>(2) 11-nor-9-carboxy-$\Delta^9$-tetrahydrocannabinol<br>(1) danazol | 193 |
| Basketball | 102 | Out of competition | (3) danazol<br>(1) salbutamol | 100 |
| Boxing | 7 | Major International | 0 | 7 |
| Cycling | 60 | Major International | 0 | 60 |
| Cycling | 40 | National | 0 | 40 |
| Football | 316 | National | (1) nor-androsterone, nor-etiocholanolone<br>(4) salbutamol | 313 |
| Gymnastics | 6 | Major International | (1) salbutamol | 5 |

| | | | | |
|---|---|---|---|---|
| Handball | 54 | Major International | 0 | 54 |
| Handball | 4 | National | 0 | 4 |
| Jockeys (Horse racing) | 248 | National | (2) 11-nor-9-carboxy-$\Delta^9$-tetrahydrocannabinol<br>(1) cocaine | 245 |
| Jockeys (Horse racing) | 9 | Out of competition | 0 | 9 |
| Judo | 12 | National | (1) salbutamol | 11 |
| Judo | 9 | Out of competition | (1) stanozolol | 8 |
| Karate | 18 | Major International | 0 | 18 |
| Shooting | 12 | Major International | 0 | 12 |
| Squash | 7 | Major International | 0 | 7 |
| Swimming | 23 | Major International | 0 | 23 |
| Swimming | 17 | International | (1) bromantan | 16 |
| Swimming | 29 | National | 0 | 29 |
| Table tennis | 8 | International | 0 | 8 |
| Taek Won Do | 10 | National | 0 | 10 |
| Tennis | 8 | National | 0 | 8 |
| Underwater Activities | 10 | National | 0 | 10 |
| Unknown | 31 | Out of competition | (1) salbutamol | 30 |
| Volleyball | 16 | National | 0 | 16 |
| Water sky | 25 | Major International | 0 | 25 |
| Weightlifting | 49 | Major International | (5) epitestosterone<br>(2) nor-androsterone, nor-etiocholanolone | 45 |

| | | | | |
|---|---|---|---|---|
| Weightlifting | 37 | International | 0 | 37 |
| Weightlifting | 99 | National | (1) 11-nor-9-carboxy-$\Delta^9$-tetrahydrocannabinol<br>(1) salbutamol | 97 |
| Weightlifting | 58 | Out of competition | (2) stanozolol | 56 |
| Wrestling | 24 | Major International | (1) nor-androsterone, nor-etiocholanolone | 23 |
| Wrestling | 20 | National | 0 | 20 |
| Wrestling | 7 | Out of competition | 0 | 7 |

**Overview on the results reported by the IOC accredited laboratories**
**(n = 25 )**

| Classification Of Events | A Samples Analyzed | A Sample Positive | % |
|---|---|---|---|
| National Competitors | 34943 | 852 | 2,44 |
| International Competitors | 10440 | 216 | 2,07 |
| Major International Championship | 10659 | 273 | 2,56 |
| Out of Competition | 49208 | 585 | 1,19 |
| **Total** | **105250** | **1926** | **1,83** |

Differentiation between Olympic and Non-Olympic Sports

| | A samples Analyzed | A samples Positive | % |
|---|---|---|---|
| Olympic Sport | 69764 | 1222 | 1,75 |
| Non Olympic Sport | 35486 | 704 | 1,98 |
| **Total** | **105250** | **1926** | **1,83** |

| Classification Of Events in Non-Olympic sports | A Samples Analyzed | A Sample Positive | % |
|---|---|---|---|
| National Competitors | 6293 | 266 | 4,23 |
| International Competitors | 1112 | 52 | 4,68 |
| Major International Championship | 1381 | 74 | 5,36 |
| Out of Competition | 26700 | 312 | 1,17 |
| **Total** | **35486** | **704** | **1,98** |

| Classification Of Events in Olympic Sports | A Samples Analysed | A Sample Positive | % |
|---|---|---|---|
| National Competitors | 28650 | 586 | 2,05 |
| International Competitors | 9328 | 164 | 1,76 |
| Major International Championship | 9278 | 199 | 2,14 |
| Out of Competition | 22508 | 273 | 1,21 |
| **Total** | **69764** | **1222** | **1,75** |

* A samples having found to contain banned substances are summarized under the headline "A samples positive". This figure may not to be identical with the sanctioned cases, as the figures given in this report contain findings with salbutamol and terbutaline which, nevertheless, may be given as an aerosol form permitted by IOC regulations. Some positive samples also correspond to multiple measurements performed on the same athlete in the case of longitudinal studies on testosterone

**IOC Statistics 1998**
**Laboratories broken down by events**

| Laboratory | With National Participants | | | With International Participants | | | Major International Championships | | | Out Of Competition | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N Total | N Pos | % | N Total | N Pos | % | N Total | N Pos | % | N Total | N Pos | % | N Total | N Pos | % |
| **Athens** | 934 | 18 | 1,93 | 120 | 3 | 2,5 | 132 | 2 | 1,52 | 214 | 7 | 3,27 | 1400 | 30 | 2,14 |
| **barcelona** | 727 | 17 | 2,34 | 204 | 10 | 4,9 | 33 | 3 | 9,09 | 1953 | 34 | 1,74 | 2917 | 64 | 2,19 |
| **Beijing** | 1162 | 4 | 0,34 | 217 | 12 | 5,53 | 139 | 1 | 0,72 | 2146 | 11 | 0,51 | 3664 | 28 | 0,76 |
| **bloemfontein** | 832 | 16 | 1,92 | 256 | 4 | 1,56 | 223 | 0 | 0 | 162 | 2 | 1,23 | 1473 | 22 | 1,49 |
| **cologne** | 1439 | 23 | 1,6 | 561 | 8 | 1,43 | 2712 | 65 | 2,4 | 2699 | 9 | 0,33 | 7411 | 105 | 1,42 |
| **copenhage** | 232 | 9 | 3,88 | 104 | 3 | 2,88 | 10 | 0 | 0 | 456 | 9 | 1,97 | 802 | 21 | 2,62 |
| **Gent** | 1809 | 77 | 4,26 | 301 | 9 | 2,99 | 0 | 0 | | 49 | 3 | 6,12 | 2159 | 89 | 4,12 |
| **helsinki** | 467 | 6 | 1,28 | 59 | 2 | 3,39 | 146 | 1 | 0,68 | 532 | 6 | 1,13 | 1204 | 15 | 1,25 |
| **huddinge** | 775 | 27 | 3,48 | 242 | 13 | 5,37 | 94 | 1 | 1,06 | 1578 | 69 | 4,37 | 2689 | 110 | 4,09 |
| **Indiana** | 2217 | 26 | 1,17 | 132 | 0 | 0 | 289 | 5 | 1,73 | 11292 | 96 | 0,85 | 13930 | 127 | 0,91 |
| **kreischa** | 831 | 9 | 1,08 | 427 | 1 | 0,23 | 70 | 1 | 1,43 | 2159 | 4 | 0,19 | 3487 | 15 | 0,43 |
| **lausanne** | 1763 | 13 | 0,74 | 155 | 0 | 0 | 404 | 9 | 2,23 | 411 | 0 | 0 | 2733 | 22 | 0,8 |
| **Lisbon** | 988 | 13 | 1,32 | 0 | 0 | 0 | 0 | | | 196 | 4 | 2,04 | 1184 | 17 | 1,44 |
| **London** | 2289 | 40 | 1,75 | 692 | 13 | 1,88 | 210 | 0 | 0 | 1725 | 14 | 0,81 | 4916 | 67 | 1,36 |
| **los angeles** | 3891 | 72 | 1,85 | 0 | 0 | 0 | 0 | | | 11973 | 116 | 0,97 | 15864 | 188 | 1,19 |
| **Madrid** | 4279 | 135 | 3,15 | 875 | 28 | 3,2 | 2724 | 122 | 4,48 | 562 | 6 | 1,07 | 8440 | 291 | 3,45 |
| **montreal** | 689 | 47 | 6,82 | 626 | 36 | 5,75 | 2 | 1 | 50 | 1980 | 88 | 4,44 | 3297 | 172 | 5,22 |
| **moscow** | 1295 | 56 | 4,32 | 70 | 4 | 5,71 | 42 | 1 | 2,38 | 111 | 0 | 0 | 1518 | 61 | 4,02 |
| **Oslo** | 695 | 9 | 1,29 | 129 | 1 | 0,78 | 112 | 3 | 2,68 | 1588 | 12 | 0,76 | 2524 | 25 | 0,99 |
| **Paris** | 4400 | 174 | 3,95 | 2101 | 53 | 2,52 | 824 | 12 | 1,46 | 1474 | 30 | 2,04 | 8799 | 269 | 3,06 |
| **Prague** | 864 | 17 | 1,97 | 423 | 6 | 1,42 | 280 | 6 | 2,14 | 148 | 7 | 4,73 | 1715 | 36 | 2,1 |
| **Rome** | 325 | 3 | 0,92 | 1968 | 4 | 0,2 | 750 | 21 | 2,8 | 620 | 16 | 2,58 | 3663 | 44 | 1,2 |
| **seoul** | 105 | 0 | 0 | 16 | 0 | 0 | 57 | 10 | 17,54 | 486 | 5 | 1,03 | 664 | 15 | 2,26 |
| **sydney** | 1418 | 31 | 2,19 | 344 | 3 | 0,87 | 728 | 4 | 0,55 | 3508 | 29 | 0,83 | 5998 | 67 | 1,12 |
| **Tokyo** | 517 | 10 | 1,93 | 418 | 3 | 0,72 | 678 | 5 | 0,74 | 1186 | 8 | 0,67 | 2799 | 26 | 0,93 |
| **Total** | **34943** | **852** | **2,44** | **10440** | **216** | **2,07** | **10659** | **273** | **2,56** | **49208** | **585** | **1,19** | **105250** | **1926** | **1,83** |

**IOC Statistics 1998**
**Number of Substances identified in the banned classes**

| | | N | % |
|---|---|---|---|
| **TOTAL** | | **2180** | **100,0** |
| A. | Stimulants | 412 | 18,9 |
| B. | Narcotics | 18 | 0,8 |
| C. | Anabolic Agents | 856 | 39,3 |
| A/C. | Beta Agonist | 479 | 22,0 |
| D. | Beta Blockers | 12 | 0,6 |
| E. | Diuretics | 80 | 3,7 |
| F. | Masking agents | 16 | 0,7 |
| G. | Peptide Hormones | 12 | 0,6 |
| H. | Others | 295 | 13,5 |

## DISCUSSION

Sports activities are welcome and recommended by all authorities and from the point of view of several professionals, including physicians, sociologists, psychologists and educators. In the long term these activities reduce cardiovascular morbidity and mortality, increase fitness, improve quality of life and provide a welcomed shift of attention away from competing but far less beneficial activities, which are either neutral or outrightly detrimental. Sports activities, however, also have unwanted side effects, which may be classified in four sections:

1. Sports injuries of variable severity, including occasional death or permanent disability.
2. Adverse short-term effects, including sudden death among individuals with compromised cardiovascular system.
3. Abuse of performance enhancing substances, including regular doping.
4. Over-concentration in sports activities leading to neglect of education and multidimensional social integration.

Sports injuries represent the most important and the most direct adverse consequence of sports activities and the EU has recognized the need to develop indicators reflecting the magnitude and the pattern of sports injuries across the Union. A set of indicators was developed and received provisional approval at the meeting of the participating EU member states and Israel in September 2000. The development of these indicators followed the realization that:

- The frequency and severity of sports injuries vary considerably by type of sport activity and the public health impact is a function of the popularity as well as the inherent risk of each type of sport activity.
- Unlike chronic diseases like cardiovascular or cancer, which affect the totality of the population, albeit with variable risk gradient, sports injuries are concentrated to specific segments of the population whose time weighted exposure is usually very difficult to calculate.
- Unlike most other causes of morbidity which are either inherently chronic or accompanied by post disease immunity, sports injuries can repeatedly affect the same individual the same individual making it necessary to count not only injured persons but also sport injury events.

- Sources of data for sports injuries vary between and within countries and there is not even a consensus even taxonomy and terminology.

In the light of these constraints and given the early stage of research into sports injuries the variability of data sources and for certain countries the limitation of resources, it was recognized that from the indicators priority should be given to a subset that includes sports related:

1. deaths and mortality
2. number of hospitalizations and incidence rates of hospitalized injuries
3. hospital contacts, including outpatient

Of these indicators (1) including deaths on arrival and out of hospital deaths, should be viewed as a subset of (2) and (2) should be viewed as a subset of (3). All three indicators should be specified by gender, age and type of sport activity. In most instances, however, lack of accurate data concerning person time of exposure, particularly for indices for gender, age and type of sport activity necessitate simplifications and approximations. A different group of indicators concerns the consequences of sports injuries in terms of fatality and disability rates that can be specified by type of sport as well as age and gender. Fatality and disability indicators can be expressed as proportions among those hospitalized and then projected to the total population at risk on the basis of incidence rates. The first of these tasks is usually simpler because it relies on available clinical data.

Proportional indicators are simpler to calculate but more difficult to interpret, because an increase of such an indicator may reflect may either reflect an increase in the numerator or a decrease in the denominator. Thus, it would appear that the principal objectives of this project were to calculate incidence and mortality of sports injuries, preferably by type of sport activity as well as by age and gender.

Prominent scientists from six EU member states and Israel participated officially in this EU supported project (Austria, France, Germany, Greece, Italy and the Netherlands), whereas Denmark and the United Kingdom volunteered to provide valuable information based on the European Home and Leisure Accident Surveillance System (EHLASS) data collected in the respective countries. Results from the countries reports and overall conclusions are indicated below:

## Country reports: Austria

The Austrian report is comprehensive and presents predefined Tables in the requested format as well as general data from the Austrian Sports injuries survey. The report provides estimates of persons injured in sports activities (227. 400 or 29 per thousand person years) and the fraction among them admitted to hospital (24 000 or 3 per thousand person years). Sports are responsible for 11% of hospitalizations due to injuries and for 7% of total hospital bed days. The medical cost of sports injuries is estimated 66 million Euros but if the loss of production is accounted for, it reaches 302 million. Sports activities are responsible for 29% of all unintentional injuries. Most accidents are due to soccer (71 per 1.000 person exercising this sport per year), whereas as expected in this country alpine and winter sports in total cause 70 000 injuries per year (about 30% of the total sports injuries). Interestingly, however, the risk of injuries in this sport is lower than that in soccer. The HLA data provide detailed tabulations of injuries by type of sport and the data are generally compatible with those previously indicated from other sources. Hospital admission rate is lower for organized sports in comparison to unorganized sports (among adults 14% vs. 39%, whereas among children 5% vs. 15%). HLA data also provide tabulations indicating that the riskiest sport for head injuries is bicycle riding, followed by alpine skiing, snowboarding and in line skating, whereas the riskiest sports for fractures are inline skating, ice skating and snow boarding. The Austrian report also contains a valuable table (see national report Table 5: Ranking of sports injuries in Austria) of risk of injury by type of sporting activity together with person time of exposure. This table shows that rock climbing and combat sports are the riskiest activities but account for a small fraction of all injuries because relatively few individuals participate in these sports.

## Country reports: Denmark

Denmark was not an official participant at the first phase of the project and thus, did not produce a formal report. Nevertheless, the Danish colleagues provided data, which are particularly valuable, because of their country wide coverage with

representative EHLASS sample. Data shown in the tables of this report indicate that each year about 7600 sports injuries are registered by the former EHLASS among men and 4.700 among women leading to a total of 12 300 sports injuries. The estimated incidence of injuries is highest among those aged 10-19, followed by the age group 20-29 and 30-39. Among men the incidence per thousand person years is respectively about 65, 43 and 20, whereas among women the corresponding rates are 56,18 and 9. Football causes about 50% of all injuries in men, whereas handball is the leading cause of sports injuries than any other sport among women,
about 25% of all sports injuries seeking medical care in the Accident and Emergency Departments of the hospitals.

## Country reports: France

The French report maximizes the information extracted from the former EHLASS and other sources to provide a picture of sports injuries in France. It is pointed out that every year about 700 000 are treated in the Emergency medical departments as victims of a sport injury. Indeed, for the population between 10-60 years sporting injuries are second only to domestic injuries. Although men sustain, in general more frequently sports injuries on account of their more frequent involvement in sports and their higher risk taking behavior, there is considerable variation of the gender ratio by type of sport. Thus, football and rugby are essentially male sports, whereas equitation and gymnastics are sports with high frequency of female injuries. In France among all sports injuries 29% are football related, whereas another 25% is associated with other team-played ball sports.

This report also provides information from an INSERM study indicating that sport active school children have almost twice the risk of a sport accident compared to those who practice sports only in the school setting. Exposure information is also given as concerns persons involved in various sports, showing that among the age group 14-17 years 87% are practicing some kind of sport activity, whereas 63% participate in organized sport activities. Among the older age groups this proportions range between 60-70% and 20-30%, respectively. Data from this report also indicate that at least in France, young people shift their preference from competitive sports to

individualistic high risk sports, a shift associated with a doubling of risk of death. Given the information from the report and the fact that CFES does not cover all sporting individuals one can estimate that close to 130 deaths due to sports are likely to have occurred.

## Country reports: Germany

The German report is extensive and sophisticated. According to this report, in Germany 2.0 million sports injuries, including school sports injuries, require medical attention and cost 8 billion deutsche marks (DM), of which 2.6 billion is contributed to by the insurance system. 13 million pursue their sports in a club, whereas 10 million are not sports members and 13 million are school children. Injuries in each of the three categories correspond to 5-6 % of sports participants.

About 10% of club sports injuries are treated in a hospital for an average length of 11.5 days. The insurance cost of all club sports injuries both in hospital and ambulatory treated slightly exceeds 1 billion DM. For non-club sports there can be no accurate information but inclusion of some serious injuries from alpine skiing implies that hospitalization rate approaches 15% with a total insurance cost of all non club injuries exceeding that of club injuries. Among school sports injuries about 3.5% are treated in hospital and the remaining are accommodated in an ambulatory setting. The total insurance cost exceeds 300 million DM.

This report also includes valuable data on number of injuries by type of sport and context (club, non club, school). These estimates are a function of both the inherent risk of the sport and its popularity. In club sports almost half of the injuries are football related, whereas handball is responsible for about one in six or seven total club sports injuries. The remaining sports are responsible for far fewer injuries. In non club sports football is responsible for more injuries, although it accounts for only one in six such injuries. Alpine skiing and in line skating, each account for about one in ten non club sports injuries, whereas other non club sports contribute fewer numbers of injuries in non club sports activities. Last, in the context of school sports,

football, basketball, gymnastics and volley ball -in declining order- contribute close to 60% of all such injuries. The proportional contribution varies considerably by age and gender mostly as a function of the popularity of each sport in each demographic category.

The body parts injured in declining order are: ankle, knee, head and hand but there is considerable variation by gender, age and type of sport. The report also provides valuable estimates per person time of sport activity with estimates for most popular sports (football, basketball, volleyball and handball) varying between one and five per 1 000 person-hours or in a different perspective between 10-15 per 100 person-years.

The German report also allows a ranking of sports by relative risk of traumatic death. High risk sports are airial sports, bicycling, motor sports, canoeing and diving (relative risk estimates higher than 10), whereas football, basketball, handball, swimming, gymnastics, athletics and most other popular sports have relative risks estimates less than one.

Some approximations had to be done in order to calculate the indices presented in the summary table, shown in the results section. 59 deaths were reported in 1997 and 1998 (two years) among the 7.5 million active persons who in turn represent about one third of the members of the German Sports Federation. Thus, the 30 reported deaths per year would correspond to about 60 among all members; another 60 among those participating in non club sports, which generate also the same number of injuries with presumably the same fatality. The number of injuries among school children is approximately the same as among adults non club sports participants, but the fatality among these injuries is lower say, about half as is the proportion of hospitalized (serious injuries) among them (German report: Tables 2-3). Thus, a total of 140 deaths from sports injuries can be estimated.

### Country reports: Greece

The Greek report relies on the EHLASS data, which has been shown to be a reasonably reliable source, allowing approximate extrapolations to the total country. The estimates from EHLASS were anchored to injury hospitalization data generated by the National Statistical Service of Greece (ESYE). Because there is a mixture of private care and public health care in Greece, the data were supplemented, whenever possible, by additional sources -for example, for professional athletes a systematic collection from the newspapers clips from the athletic press was undertaken, and information derived from the sports physicians' archives. It is of course recognized that systematic errors cannot be confidently excluded and random errors accumulate as we move from the EHLASS sentinel hospitals to the total country, from the latter to the proportion of injuries due to sports and subsequently, from sports injuries presenting at the A&E Departments to those hospitalized. Nevertheless, the estimates derived are compatible to the perceptions of clinical specialists and in line with the more reliable estimates derived from better organized and more developed countries. The general pattern emerging from the Greek data is that fewer people and for less time are involved; that the risk for a sport injury is apparently higher than the corresponding risk in most other European countries, but the average severity and risk of hospitalization are generally lower.

### Country reports: Italy

The Italian report contains useful information, which is only limited by the fact that it relies on data provided for insured members of the Italian Olympic Committee (CONI). The report provides annual incidence and mortality rates among insured persons; also indicates the frequency of permanent disabilities and the secular decline over a period of ten years of overall sports injuries and disabilities by 24% and 15% respectively and overall deaths by 46%. The SPORTASS, the CONI mutual insurance fund for athletes has published the most recent report in 1996. This report contains information for the more severe injuries, their distribution by age and gender, proximal causes and conditions of injury, site and type of injury, type of sport and amount of compensation.

The annual number of sports injuries deaths for a population of 8.5 M insured athletes is 56. Since 15 M Italians are regularly or occasionally sporting it can be estimated that the total annual number of deaths is about 100, to which another 20 should be added for the 20 M, who are only reporting some physical activity. Moreover, since the annual number of severe injuries reported among insured persons is 25 833, the total number of severe sports injuries per year in the active population of 35M would be around 105 000. For this calculation the assumption was made that less active people would have the same incidence of severe injuries as more active, because lower fitness and sporting expertise implies higher risk, which balances their lower exposure. Additionally, we assume that these injuries, characterized in the report as more severe, could be roughly equated to those that have required hospitalization. We can further assume, that hospital admissions represent 10-15% of those contacting the hospital, so that hospital contacts can be estimated as amounting 840.000. Medically attended injuries have been estimated as twenty times as many as those admitted to hospitals, because 20 is the mean of the respective ratios for Germany and the UK, so that they amount to 2.1M. The annual amount spent by SPORTASS that covers about one quarter of hospitalized injuries in Italy is about 8.2 M Euros.

## Country reports: Israel

The Israeli report provides useful information about school sports activities but overall there is little information because a system such as EHLASS is not functioning there. In 1998 16 530 cases of injuries were reported to the Israel national Trauma Registry and of those 901 that is 5.4% were sports related. This estimate is lower than those in northern European countries, but similar to that found in Greece. It should be pointed out that information concerning exposed individuals by type of sport is available in Israel as are basic data on the school population. Thus, an EHLASS like system could complement existing sources for the generation of useful and EU comparable data. Meanwhile, preliminary estimates for Israel could be anchored to those for Greece or Italy given geographical proximity and similarities in socio-cultural background.

## Country reports: Netherlands

The report from the Netherlands presents results from the Dutch Injury Surveillance System and also from the household survey “Injuries in the Netherlands”. The results indicate that about 1.5M people suffer sports related injuries per year, out of which 55% do not seek medical care. Specifically, in 1998 170 000 sports injuries presented and were treated at an Emergency Department throughout the country. The highest number of sports injuries is linked to outdoor football on account of the high popularity of that sport and injuries are concentrated in the age group from about ten to about 45.

The Dutch report from the household survey provides useful information concerning the frequency of injuries from sports relative to injuries from any other type of activity (29%). This amounts to 690 000 injuries per year, half of which are non medically treated. Among those treated, about 50% sought medical care at an Emergency Department or by a specialist, generating a number very similar to the 170 000 indicated by the national injury surveillance system. About 4% of sports injuries victims are admitted to a hospital. The Dutch report also provides an insight on individuals still suffering from earlier injuries and on individuals suffering from gradually developing injuries as well as exposure data (annual hours) by individual sports practiced.

## Country reports: United Kingdom

Representatives from the United Kingdom in the Injury Prevention Program contributed thoroughly analyzed data for 1992 and processed data for 1998 from EHLASS. There are no striking differences between the two sets of data, when information for 1998 is crudely evaluated, so we have considered the 1992 data as presented in chapter 19 of the BMJ book "ABCs of sports medicine" [1] and the papers from the mini-symposium: "risks and benefits from sports and exercise" [2-4]. From this report information was abstracted and used to calculate the UK indices in the Table.

The chapter by Ball[1] provides realistic figures of fatal accidents per 100 million person-hours of exposure for selected sports. The results are not incompatible from those provided by Germany and Austria. They indicate that air sports and mountaineering are 30-100 times riskier than soccer and rugby. The material in the chapter is valuable because it also compares risk of death in sports with risk of death in general activities, including occupational activities. Specifically, injury death risk in aquatic sports and horse riding is lower than the corresponding risk of a cyclist. There is also information in this chapter about the risks of non fatal injuries, where rugby and soccer appear to have the lead.

Further elaboration of risk of fatal and non fatal injuries in sports activities as well as exposure estimates are provided in a more recent paper by Ball[5]. These papers also illustrate that sports injuries, though very common are rarely serious so that only 1:4000 injuries requiring attendance of an A&E Department and only 1:25000 requiring medical attention turn out to be fatal.

References


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## CONCLUSIONS

The beneficial aspect of sporting for heath can now be no longer seriously doubted by anyone. With regard to the increasing number of heart and circulatory disorders physicians continuously point out that sporting is an important way for preventing such injuries. The summary table (see results section) generated on the basis of data provided from the country reports of EU member states and Israel does not allow comparisons between countries, because differences could be due to sampling errors, registration patterns and unrecognized biases. However, comparisons serve little purpose with respect to sports injuries. The overriding issue is to determine the overall dimensions of the problem, to convey to political leaders and health authorities the need to address the relevant issues. Sports injuries are unique in that the objective cannot possibly be the reduction of sports activities, because these activities are conducive to health at the individual and the social level. Targets of intervention should be carefully chosen, and an obvious prerequisite is to ascertain the profile of sports injuries across EU.

From the existing sources and taking into account the limitations of the data we can provide the following estimations:
Mortality from sports injuries amounts about 2 per million per year or slightly more than one per hundred injury deaths. Hospital admissions equal two per thousand per year or about five per thousand sports participants per year. Sports admissions represent around 4% of hospital admissions. About thirty per thousand of the total population or about sixty per thousand sports participants sustain per year a sports injury severe enough to require medical attention. About 12 per thousand of all population contact an A&E Department per year and around fifteen percent of them are eventually hospitalized. Needless to say, that there is considerable variation among the EU member states between genders and across age groups and these differences are due in part, to the sporting ethos (mostly among countries but also between genders), inherent factors (mostly between genders but also across age

groups), sports preferences, athletic infrastructure (mostly among countries), balance between primary and secondary care and hidden biases (reflecting tradition and affecting in variable degrees many of the contrasts).

On the basis of the previously indicated rates each year more than 700 individuals die in the EU from a sports injury, whereas about 700.000 are hospitalized. These estimates represent only the tip of the iceberg because each year more than ten million people have a sports injury requiring medical attention and more than five million contact the A&E Department of a hospital. The cost of dealing with sports injuries is considerable. It is estimated to exceed ten billion Euros throughout the Union.

The EHLASS project also provides valuable information concerning the nature, body part, mechanism and severity of injury and thus, allows the rationalization of preventive measures and the calculation of the respective health care needs related to sports injuries.

Exposure to sports activities is likely to increase with the recognition of the beneficial role that sports play in personal and social life. In this perspective, prevention and control of sports injuries acquire a priority. Because of its unique features EHLASS has the potential to provide a crucial contribution for the rational development of proper measures to that effect.

## APPENDICES

## Appendix A: Sports Surveillance Questionnaire

**The data requested must be coded. Please state your coding**:

EHLASS 96

EHLASS 86

ICD-10

ICD-9

NOMESCO

ICECI

OTHER (**please define AND SUBMIT coding in form of attachment**):

---

The sources of data may be different among the participating countries. They may be provided by:

**Please tick:**

- EHLID (former EHLASS): European Home and Leisure Injuries Database
- Official athletic sources

  Confederations
  National sports teams databases

  Other (please define) ----------

- Networks of medical professionals

  Physicians
  Physiotherapists

  Other (please define) ----------

- Existing Sports Injuries databases ( please describe )
- Other sources ( please describe )

---

**Please <u>state</u> the time-period you have data for:**

**From** year: month:

**To** year: month:

---

Is treatment registered for each case? (Please tick)

Yes
No

Is time of recovery registered for each case? (Please tick)

Yes
No

---

Is time of the athlete's comeback registered for each case? (Please tick)

Yes
No

---

Please state other parameters of sports injuries you have registered in your database and mention their coding scale:

| PARAMETERS | tick | CODING |
|---|---|---|
| • Injury description | | |
| • Time & place | | |
| • injured body part | | |
| • Sport (activity) | | |
| • mechanism of accident (primary) | | |
| • Mechanism of injury (direct) | | |

---

The information (data) has to be readily available:

On disk
In a report

---

What is your time estimate for processing your data?

**How many man-hours do you estimate you will need to provide the data mentioned in this questionnaire?**

What is your time estimate for submitting your data?

Please submit the definition of sports injuries you are using, indicating your sources:

## Appendix B: Coding constraints

Majority of the variables based on the EHLASS 86s coding system. This code was insufficient to describe the variables 'Type of sport' and 'Mechanism of the Accident'. 'Type of sport' has been defined from NOMESCO code and 'Mechanism of the Accident' from E-code. Alternatively these two variables could be defined from EHLASS 96 code.
Sports Injuries were separated from the whole database performing the following constraints:
The age of the injured person must be greater or equal to 5 years old and the variable 'Activity' has one of the values 41, 50, 51, 52 (EHLASS 86).
Due to different life style and behaviour we have separated the database of the sports injuries in two main age groups: the childhood (5-14 years) and the adults (15+ years).

The activity of the sports injuries was separated in 3 main groups:
1st Sports in school (41)
2nd Sports unorganised (50, 51) (including sports during school intermission)
3rd Sports organised (52)
Based on the frequencies of the recorded type of sports we analysed separately the most frequent sports. These sports are not expected to be the same in each country. Concerning the tables where the different sports are examined each country must include all the sports that their frequency exceeds the 2% of the total sample.

The tables of the analysis were not possible to include every single value of each variable. Below is the way we used to create large categories in the same variable. In cases where the frequency of a specific value of a variable exceeds the 5% it is suggested to include it as a separate category and to not add it at the 'other' category.

Variable BODY PART (EHLASS 86)

fingers=57
lower arm=54
other upper limb (51, 52, 53, 55,56, 59)
ankle=64
knee=62
other lower limb (61, 63, 65, 66, 69)
head and face (10-18)
trunk = any other body part not included in the above categories.

Variable INJURY (EHLASS 86)

contusion bruise abrasion (1, 2)
open wound=3
fracture=4
dislocation distortion (5, 6)
injury to nerves (concussion)=7

no injury=97
other = any other type of injury not included in the above categories

Variable TREATMENT (EHLASS 86)

examined and send home=1
send home after initial treatment=2
treated and follow up (3, 4)
admitted to the hospital=5
deceased=6

Variable MECHANISM (E-code)

fall on same level from slipping, tripping or stumbling =885
fall on same level from collision or shoving by or with other person (8860, 8869)
other fall (880-884, 887-888)
striking against or struck accidentally by objects or persons=917
overexertion and strenuous movements=927
other = any other mechanism not included in the above categories

Variable MECHANISM (EHLASS 86) proposed we did not use it

falls (1, 2, 3)
physical strain/overexertion=4
struck, hit, colission=6
other = any other mechanism not included in the above categories

Variable AGE

childhood group (5-14)
group1=5-8 years
group2=9-10 years
group3=11-12 years
group4=13-14 years
adults group (15+)
group1=15-17 years
group2=18-24 years
group3=25-34 years
group4=35-44 years
group5=45+ years

Variable SEX

male
female

Although we did not include in the preliminary analysis the variables ‘place of accident’, ‘day of accident’, ‘month of accident’ and ‘time of accident’ we have created the following categories. If data from other countries show remarkable results please add them to the existing tables.

Variable PLACE (EHLASS 86)

educational area (50-58)
outdoor sports and athletic fields=72
indoor sports hall =71 (if school’s sports hall can be separated is prefered)
other sports hall (70 78)
around home, transport area, playgrounds (20-30, 83)
other = any other place not included in the above categories

Variable DAY

Weekday
Weekend

Variable MONTH

spring
summer
autumn
winter

Variable TIME

group1= 8.00 a.m. - 10.59 a.m.
group2=11.00 a.m. - 13.59 p.m.
group3=14.00 p.m. - 16.59 p.m.
group4=17.00 p.m. - 19.59 p.m.
group5=20.00 p.m. - 22.59 p.m.
group6=23.00 p.m. - 7.59 a.m.

## Appendix C: Model tables

### Tables for Uniform Completion submitted to the partners

Table 1. Distribution of sports injuries in **childhood (age 5-14 years**) by age, sex and type of sport activity. Country……..Year 1998

| Variable | Sports in school | | Unorganised sports | | Organised sports | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Age (years) | | | | | | |
| 5-8 | | | | | | |
| 9-10 | | | | | | |
| 11-12 | | | | | | |
| 13-14 | | | | | | |
| Sex | | | | | | |
| male | | | | | | |
| female | | | | | | |
| Total | | | | | | |

Table 2. Distribution of sports injuries in **adults (age 15 + years**) by age, sex and type of sport activity. Country……..Year 1998

| Variable | Sports in school | | Unorganised sports | | Organised sports | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Age (years) | | | | | | |
| 15-17 | | | | | | |
| 18-24 | | | | | | |
| 25-34 | | | | | | |
| 35-44 | | | | | | |
| 45+ | | | | | | |
| Sex | | | | | | |
| male | | | | | | |
| female | | | | | | |
| Total | | | | | | |

Table 3. Distribution of sports injuries in childhood (age 5-14 years) by description of injury, Injured body part, treatment and type of sport activity in three major categories (sports in school, unorganised and organised sports). Country……Year 1998

| Variable | Sports in school | | Unorganised sports | | Organised sports | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Type of injury | | | | | | |
| contusion, abrasion | | | | | | |
| open wound | | | | | | |
| fracture | | | | | | |
| dislocation, distortion | | | | | | |
| concussion | | | | | | |
| other | | | | | | |
| Injured body part | | | | | | |
| head and face | | | | | | |
| fingers | | | | | | |
| lower arm | | | | | | |
| other upper limb | | | | | | |
| ankle | | | | | | |
| knee | | | | | | |
| other lower limb | | | | | | |
| trunk | | | | | | |
| Treatment | | | | | | |
| examined and send home | | | | | | |
| send home after initial treatment | | | | | | |
| treated and follow up | | | | | | |
| admitted to hospital | | | | | | |
| deceased | | | | | | |
| Total | | | | | | |

Table 4. Distribution of sports injuries in adults (15+ years) by description of injury, injured body part, treatment and type of sport activity in three major categories (sports in school, unorganised and organised sports). Country……..Year 1998

| Variable | Sports in school | | Unorganised sports | | Organised sports | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Type of injury | | | | | | |
| contusion, abrasion | | | | | | |
| open wound | | | | | | |
| fracture | | | | | | |
| dislocation, distortion | | | | | | |
| concussion | | | | | | |
| other | | | | | | |
| Injured body part | | | | | | |
| head and face | | | | | | |
| fingers | | | | | | |
| lower arm | | | | | | |
| other upper limb | | | | | | |
| ankle | | | | | | |
| knee | | | | | | |
| other lower limb | | | | | | |
| trunk | | | | | | |
| Treatment | | | | | | |
| examined and send home | | | | | | |
| send home after initial treatment | | | | | | |
| treated and follow up | | | | | | |
| admitted to hospital | | | | | | |
| deceased | | | | | | |
| Total | | | | | | |

Table 5. Distribution of sports injuries in childhood (age 5-14 years) by age, sex, type of injury and type of sports. Country……..Year 1998

| Variable | Basketball | | Football | | Volleyball | | Gymnastics | | Track and field | | Compat | | Other | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| Age (years) | | | | | | | | | | | | | | |
| 5-8 | | | | | | | | | | | | | | |
| 9-10 | | | | | | | | | | | | | | |
| 11-12 | | | | | | | | | | | | | | |
| 13-14 | | | | | | | | | | | | | | |
| Sex | | | | | | | | | | | | | | |
| male | | | | | | | | | | | | | | |
| female | | | | | | | | | | | | | | |
| Type of injury | | | | | | | | | | | | | | |
| contusion, abrasion | | | | | | | | | | | | | | |
| open wound | | | | | | | | | | | | | | |
| fracture | | | | | | | | | | | | | | |
| dislocation, distortion | | | | | | | | | | | | | | |
| concussion | | | | | | | | | | | | | | |
| other | | | | | | | | | | | | | | |
| Injured body part | | | | | | | | | | | | | | |
| head and face | | | | | | | | | | | | | | |
| fingers | | | | | | | | | | | | | | |
| lower arm | | | | | | | | | | | | | | |
| other upper limb | | | | | | | | | | | | | | |
| ankle | | | | | | | | | | | | | | |
| knee | | | | | | | | | | | | | | |
| other lower limb | | | | | | | | | | | | | | |
| trunk | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | | |

Table 6. Distribution of sports injuries in adults (15+ years) by age, sex, type of injury and type of sport.
Country……..Year 1998

| Variable | Basketball | | Football | | Volleyball | | Gymnastics | | Track and field | | Compat | | Other | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| Age (years) | | | | | | | | | | | | | | |
| 15-17 | | | | | | | | | | | | | | |
| 18-24 | | | | | | | | | | | | | | |
| 25-34 | | | | | | | | | | | | | | |
| 35-44 | | | | | | | | | | | | | | |
| 45+ | | | | | | | | | | | | | | |
| Sex | | | | | | | | | | | | | | |
| male | | | | | | | | | | | | | | |
| female | | | | | | | | | | | | | | |
| Type of injury | | | | | | | | | | | | | | |
| contusion, abrasion | | | | | | | | | | | | | | |
| open wound | | | | | | | | | | | | | | |
| fracture | | | | | | | | | | | | | | |
| dislocation, distortion | | | | | | | | | | | | | | |
| concussion | | | | | | | | | | | | | | |
| other | | | | | | | | | | | | | | |
| Injured body part | | | | | | | | | | | | | | |
| head and face | | | | | | | | | | | | | | |
| fingers | | | | | | | | | | | | | | |
| lower arm | | | | | | | | | | | | | | |
| other upper limb | | | | | | | | | | | | | | |
| ankle | | | | | | | | | | | | | | |
| knee | | | | | | | | | | | | | | |
| other lower limb | | | | | | | | | | | | | | |
| trunk | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | | |

Table 7: Distribution of the sports injuries recorded by age, type of and injured body part.
Country……..Year 1998

| Injured body part | age group | contusion bruise abrasion | | open wound | | fracture | | dislocation distortion | | concussion | | other | | no injury | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) |
| | | | | | | | | | | | | | | | | | |
| fingers | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| Lower arm | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| other upper limb | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| Ankle | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| Knee | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| other lower limb | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| head and face | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| Trunk | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

Table 8: Distribution of the sports injuries recorded by age, mechanism of the accident and injured body part.
Country……..Year 1998

| Injured body part | age group | Mechanism of injury | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | fall on same level from slipping, tripping or stumbling | | fall on same level from collision or shoving by or with other person | | other type of fall | | striking against or struck accidentally by objects or persons | | overexertion and strenuous movements | | other mechanism | | total | |
| | | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) |
| fingers | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| lower arm | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| other upper limb | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| ankle | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| knee | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| other lower limb | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| head and face | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| trunk | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Table 9: Distribution of the sports injuries recorded by age, mechanism of the accident and type of injury.
Country……..Year 1998

| Type of injury | age group | fall on same level from slipping, tripping or stumbling | | fall on same level from collision or shoving by or with other person | | other fall | | striking against or struck accidentally by objects or persons | | overexertion and strenuous movements | | other | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) |
| | | | | | | | | | | | | | | | |
| contusion bruise abrasion | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| open wound | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Fracture | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| dislocation distortion | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| concussion | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| no injury | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

Table 10: Distribution of the 3715 sports injuries recorded by age, type of sport and season of the year. Country: …….1998

| Type of sport | Age group | Winter | | Spring | | Summer | | Autumn | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | (%) | N | (%) | N | (%) | N | (%) |
| Basketball | | | | | | | | | |
| Football | | | | | | | | | |
| Volleyball | | | | | | | | | |
| Gymnastics | | | | | | | | | |
| Track and fields | | | | | | | | | |
| Combat | | | | | | | | | |
| Other | | | | | | | | | |

Table 7.1-5: Distribution of ……sports injuries in …… (e.g.baskeball) recorded by age, type of injury and injured body part. Country: ……. 1998

| Injured body part | age group | contusion bruise abrasion | | open wound | | fracture | | dislocation distortion | | concussion | | other | | no injury | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) |
| Fingers | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |
| lower arm | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |
| other upper limb | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |
| Ankle | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |
| Knee | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |
| other lower limb | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |
| head and face | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |
| Trunk | 5-14 | | | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | | | |

Table 8.1-5: Distribution of the …… sports injuries ……(e.g.basketball) recorded by age, mechanism of the accident and injured body part. Country: …….. 1998

| Injured body part | age group | fall on same level from slipping, tripping or stumbling | | fall on same level from collision or shoving by or with other person | | other fall | | striking against or struck accidentally by objects or persons | | overexertion and strenuous movements | | other | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) |
| fingers | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| lower arm | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| other upper limb | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| ankle | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| knee | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| other lower limb | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| head and face | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| trunk | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |

Table 9.1-5 : Distribution of the …….. sports injuries ……..(e.g.basketball) recorded by age, mechanism of the accident and type of injury. Country: …….1998

| Type of injury | age group | fall on same level from slipping, tripping or stumbling | | fall on same level from collision or shoving by or with other person | | other fall | | striking against or struck accidentally by objects or persons | | overexertion and strenuous movements | | other | | total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) | N | (%) |
| contusion bruise abrasion | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| open wound | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| fracture | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| dislocation distortion | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| concussion | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| other | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |
| no injury | 5-14 | | | | | | | | | | | | | | |
| | 15+ | | | | | | | | | | | | | | |

# Appendix D: Sports Injuries Questionnaires

## SPORTS INJURIES SURVEILLANCE QUESTIONNAIRE ADDRESSED TO TRAINERS

ID |__|__|__|
Name…….
Tel |__|__|__|__|__|__|__|__|__|__|__| Sex |_____| Age |__|__|
Education……... Profession……
Sport……. Professional Amateur
Number of persons you trained…….
Hours of training per week:……..
Ages of athletes…….Sex of athletes Male:…….. Female…….
Is there in your club: Doctor…… Physiotherapist…….
Injury lead to absence from training or competition for a day at least. Serious injury lead to absence for a week, at least.
Number of injuries
1998: in training ……..in games…….. serious ones……..
1999: in training……. in games…….. serious ones……..
2000: in training……. in games…….. serious ones...……

Did your athletes ever get injured during training?
How many times this happened: in the start……. in the middle……. in the end……
How many times this happened: with the presence of trainer…… without trainer……..

Were they ever injured in a game
How many times this happened: in the start……. in the middle……. in the end……

Your opinion for prevention of injury in the sport you are specialised
……
……
How soon these injuries were treated…….
Usual time of recovery……
Usual time of warming up……..
Usual time of training…….
Treatment: Public hospital Private Health institution Private practice
Treatment: Surgery Medical
Who covered the cost?…….

Place that accidents usually happen…….……
Injured body part (the 3 most common)
1……
2…..……...
3……
Type of injury (the 3 most common)
1……
2…..……...
3……

Usual mechanism of accidents……..…….……..
Usual mechanism of injury…….……
What do you think caused this injury……...……

Mean time of rehabilitation ……
Place and equipment that are used……...
Are the place and the equipment safe?……..
What proportion of the athletes follow the safety measures……..
Absence of safety measures result in what proportion of injuries ? ……...

**SPORTS INJURIES SPORTS INJURIES SURVEILLANCE QUESTIONNAIRE ADDRESSED TO ATHLETES**

ID |__|__|__| Informer…..…… Interviewer……
Name……
Residence……..
Tel |__|__|__|__|__|__|__|__|__|__|__| Sex |_____| Age |__|__|
Mother's education…….. Father's education…….
Education……... Profession……
Sport……. Professional Amateur
Athletic club……..
Hours of training per week: personally ……with team……..……..…
Days participating in games: per month…… per year……..……
How many hours you exercising in a performance day……
Injury lead to absence from training or competition for a day at least. Serious injury lead to absence for a week, at least.
Number of injuries
1998: in training ……..in games…….. serious ones……..
1999: in training……. in games…….. serious ones……..
2000: in training……. in games…….. serious ones...……

Were you ever injured during training?
How many times this happened: in the start……. in the middle……. in the end……
How many times this happened: with the presence of trainer…… without trainer……..

Were you ever injured in a game?
How many times this happened: in the start……. in the middle……. in the end……

Your opinion for prevention of injury in the sport you exercise
……
……

Date of injury…… Time of injury……..
Treatment: Public hospital Private Health institution Private practice
By whom you were accompanied?……

Insurance: Public Personal Both

Treatment: Surgery Medical

Place that the accident happened…….……
Injured body part
1……
2…..……...
3……
Type of injury
1……
2…..……...
3……

Mechanism of accident…….……..
Mechanism of injury……

Time of rehabilitation ……..
Time of re-entry in
competition……...
First aid was provided by……
What do you think caused this injury?……..

**DOPING QUESTIONNAIRE**

First Letters of Name ……
Place of Residence ……...
Sex |_____|
Sport exercise |_____|
Age |__|__|
Education ……
Profession ……

Smoking YES |__| NO |__|
Use of Alcohol YES |__| NO |__|

Did you know an athlete who use at least one time anything of the following:

Legal Drugs YES |__| NO |__| Name one drug if you wish……

Banned Drugs YES |__| NO |__| Name one drug if you wish……

Nutritional Supplements YES |__| NO |__| Name one drug if you wish……

Continuous and systematic use YES |__| NO |__|
Did you think that these drugs improve performance? YES |__| NO |__|

Did you know the hazards for health, from the misuse of these drugs?
YES |__| NO |__|

Did anyone proposed to you these drugs? YES |__| NO |__|

Athletes comments
……...……...……
……..

## Appendix E: National Reports of participating countries

# AUSTRIA

## Sports injuries in Austria
## National Report

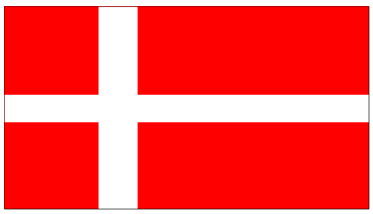
**Dr. Robert Bauer,**
**Mag. Katrin Schneider**
**Dr. Rupert Kisser**

**Sicher Leben**
**Austrian Institute for Home and Leisure Safety**

**2000**

(Available on request)

# DENMARK



## Sports injuries in Denmark
## National Report

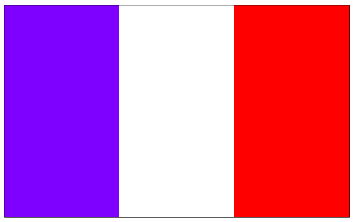
**Dr. Henning Bay-Nielsen**

**The Danish Accident Register**
**National Institute of Public Health**

**2000**

(Available on request)

# FRANCE



# Sports injuries in FRANCE
# National Report

**Cristine Duval**
**Marie Laurence Bouvet**
**Mark Nectoux**

**PSYTEL**

**2000**

(Available on request)

# GERMANY

## Sports injuries in GERMANY
## National Report

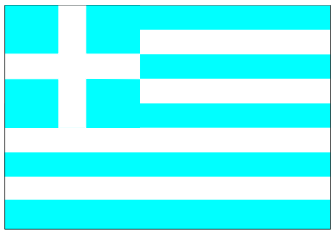
**Thomas Henke, Chair of Sports Medicine,**

**Ruhr-University Bochum**
**Heribert Gläser, ARAG Sports Insurance, Düsseldorf**

**2000**

(Available on request

# GREECE



## Sports injuries in GREECE
## National Report

**Eleni Petridou M.D., M.P.H.**
**Maria Belechri M.D.**
**Nick Dessypris**
**Delia Alexe M.D.**
**Maria Moustaki M.D.**
**Spyros Marinopoulos M.D.**
**Eleni Maragaki**
**Charlie Xintaras Ph.D.**
**Dimitrios Trichopoulos M.D.**

**Center for Research and Prevention of Injuries among the Young (CEREPRI)**
**Department of Epidemiology and Hygiene**
**University of Athens School of Medicine**
**Athens, Greece**

**2000**

(Available on request)

# ISRAEL

## Sports injuries in ISRAEL
## National Report

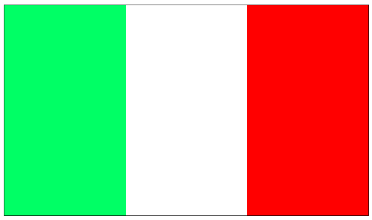
**Rosa Gofin, M.D., M.P.H.**

**Department of Social Medicine**
**Hadassah Medical Organization and the Braun School of Public health and Community Medicine- Hebrew University and Hadassah. Jerusalem**

**2000**

(Available on request)

# ITALY



## Sports injuries in ITALY
## National Report

**Alberto Giulio Marchi [1] MD**
**Gianni Messi[1] MD**
**Daniela Di Bello[2] MD**
**Luisa Crevatin[1]**
**Marina Duranti[1]**
**Luciana Del Rosso Rossi[1]**

**[1]Head Unita Operativa Pronto Soccorso Pediatrico-Primo Accoglimento, IRCCS BURLO Garofolo**
**[2]Unita Operativa Ortopedia e Traumatologia, IRCCS BURLO Garofolo**

**2000**

(Available on request)

# NETHERLANDS

## Sports injuries in NETHERLANDS
## National Report

**Fons Blankendaal**
**Rieneke Dekker**
**Saakje Mulder**

**Consumer Safety Institute**
**The Netherlands**

**2000**

(Available on request)

## Appendix G: Popular sports by participating country

# AUSTRIA

**Sports injuries in the EU countries in view of 2004 Olympics:**
**Harvesting information from existing databases**

Frequency of Sports
**Data source:** Official Survey on "Sports, Leisure and Home Accidents" (Statistics Austria) 1997

| | AUSTRIA | |
|---|---|---|
| | Persons exercising N | Persons exercising % |
| **OLYMPIC SPORTS** | | |
| **Archery** | | |
| **Athletics** | 851.200 | 4.6 |
| **Marathon** | | |
| **Badminton** | | |
| **Baseball** | | |
| **Basketball** | | |
| **Boxing** | | |
| **Canoeing** | | |
| **Flat water** | | |
| **Slalom** | | |
| **Cycling** | | |
| **Track** | | |
| **Road** | 2.966.000 | 16.0 |
| **Mountain bike** | 397.900 | 2.1 |
| **Equestrian** | 202.100 | 1.1 |
| **Jumping** | | |
| **Dressage** | | |
| **Three-day event** | | |
| **Fencing** | | |
| **Football** | 590.700 | 3.2 |
| **Gymnastics** | 1.469.000 | 7.9 |
| **Artistic** | | |
| **Rhythmic** | | |
| **Trampoline** | | |
| **Handball** | | |
| **Hockey** | | |
| **Judo** | | |
| **Modern Pentathlon** | | |
| **Rowing** | | |
| **Sailing** | | |
| **Windsurfing** | | |
| **Shooting** | | |
| **Softball** | | |
| **Aquatics** | | |
| **Swimming** | 2.384.000 | 12.9 |

| | | |
|---|---|---|
| **Diving** | | |
| **Water polo** | | |
| **Synchronized** | | |
| **Table tennis** | | |
| **Taek wondo** | | |
| **Tennis** | 694.700 | 3.7 |
| **Triathlon** | | |
| **Volleyball** | | |
| **Beach Volley** | | |
| **Weightlifting** | | |
| **Wrestling** | 73.100* | 0.4 |
| **Freestyle** | | |
| **Greco-Roman** | | |
| **WINTER OLYMPIC SPORTS** | | |
| **Alpine skiing** | 2.313.000 | 12.5 |
| **Biathlon** | | |
| **Bobsleigh** | | |
| **Cross Country Skiing** | | |
| **Curling** | | |
| **Ice skating (Figure Skating)** | 1.322.000 | 7.1 |
| **Freestyle Skiing** | | |
| **Ice Hockey** | | |
| **Luge** | | |
| **Nordic Combined** | | |
| **Short Track Speed Skating** | | |
| **Skeleton** | | |
| **Ski Jumping** | | |
| **Snowboarding** | 274.100 | 1.5 |
| **Inline skating (Speed Skating)** | 490.400 | 2.6 |
| **NON OLYMPIC SPORTS** | | |
| **Aerobics** | | |
| **Ballet/dance/jazz** | | |
| **Billiards** | | |
| **Body building** | | |
| **Bowling** | | |
| **Bowls (law & carpet)** | | |
| **Cricket** | | |
| **Fitness training** | | |
| **Fishing** | | |
| **Golf** | | |
| **Hiking** | 2.355.000 | 12.7 |
| **Hunting** | | |
| **Indoor soccer** | | |
| **Korfball** | | |
| **Martial art** | | |
| **Motoring** | | |
| **Motor-boating** | | |
| **Netball** | | |
| **Running jogging** | | |

| | | |
|---|---|---|
| **Rock Climbing** | 108.700 | 0.6 |
| **Rugby** | | |
| **Skateboarding** | 106.600 | 0.6 |
| **Squash** | 173.600 | 0.9 |
| **Walking / Ramble** | | |
| **VTT** | | |
| **Other ball sports** | 398.100 | 2.1 |
| **Other winter sports** | 961.600 | 5.2 |
| **Other sports** | | |
| **Total** | 18.544.200 | 100.0 |

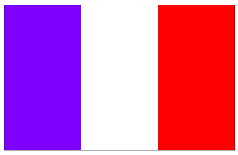
*All combat sports included

# FRANCE

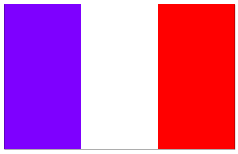
**Sports injuries in the EU countries in view of 2004 Olympics:**
Harvesting information from existing databases

Frequency of Sports
**Data source:** Investigate BVA/L' Equipe (1997) with a representative sample of 1010 persons 15+ years old.

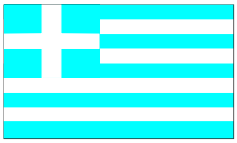
| | FRANCE |
|---|---|
| | Persons exercising % |
| **OLYMPIC SPORTS** | |
| **Archery** | |
| **Athletics** | 15.0 |
| **Marathon** | |
| **Badminton** | |
| **Baseball** | |
| **Basketball** | 8.0 |
| **Boxing** | |
| **Canoeing** | |
| **Flatwater** | |
| **Slalom** | |
| **Cycling** | 18.0 |
| **Track** | |
| **Road** | |
| **Mountain bike** | |
| **Equestrian** | 3.0 |
| **Jumping** | |
| **Dressage** | |
| **Three-day event** | |
| **Fencing** | |
| **Football** | 16.0 |
| **Gymnastics** | 14.0 |
| **Artistic** | |
| **Rhythmic** | |
| **Trampoline** | |
| **Handball** | |
| **Hockey** | |
| **Judo** | |
| **Modern Pentathlon** | |
| **Rowing** | |
| **Sailing** | |
| **Windsurfing** | |
| **Shooting** | |
| **Softball** | |
| **Aquatics** | |
| **Swimming** | 21.0 |



| | |
|---|---|
| **Diving** | |
| **Water polo** | |
| **Synchronized** | |
| **Table tennis** | |
| **Tae kwondo** | |
| **Tennis** | 14.0 |
| **Triathlon** | |
| **Volleyball** | 6.0 |
| **Beach Volley** | |
| **Weightlifting** | |
| **Wrestling** | |
| **Freestyle** | |
| **Greco-Roman** | |
| **WINTER OLYMPIC SPORTS** | |
| **Alpine skiing** | 7.0 |
| **Biathlon** | |
| **Bobsleigh** | |
| **Cross Country Skiing** | |
| **Curling** | |
| **Ice skating (Figure Skating)** | |
| **Freestyle Skiing** | |
| **Ice Hockey** | |
| **Luge** | |
| **Nordic Combined** | |
| **Short Track Speed Skating** | |
| **Skeleton** | |
| **Ski Jumping** | |
| **Snowboarding** | |
| **Inline skating (Speed Skating)** | |
| **NON OLYMPIC SPORTS** | |
| **Aerobics** | |
| **Ballet/dance/jazz** | |
| **Billiards** | |
| **Body building** | |
| **Bowling** | |
| **Bowls (law & carpet)** | |
| **Cricket** | |
| **Fitness training** | |
| **Fishing** | |
| **Golf** | |
| **Hiking** | |
| **Hunting** | |
| **Indoor soccer** | |
| **Korfball** | |
| **Martial art** | |
| **Motoring** | |
| **Motor-boating** | |
| **Netball** | |
| **Running jogging** | |



| | |
|---|---|
| **Rock Climbing** | |
| **Rugby** | 4.0 |
| **Skateboarding** | |
| **Squash** | |
| **Walking /ramble** | 14.0 |
| **VTT** | 10.0 |
| **Other ballsports** | |
| **Other winter sports** | |
| **Other sports** | |



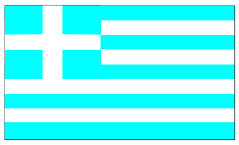
# GREECE

**Sports injuries in the EU countries in view of 2004 Olympics: Harvesting information from existing databases**

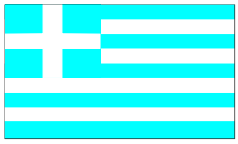
Frequency of Sports

**Data source:** Phone Inquiry to federations and associations

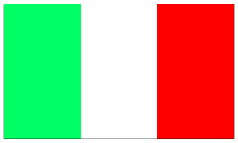
| | GREECE | |
|---|---|---|
| | Persons exercising N | Persons exercising % |
| **OLYMPIC SPORTS** | | |
| **Archery** | | |
| **Athletics** | | |
| **Marathon** | | |
| **Badminton** | | |
| **Baseball** | | |
| **Basketball** | 190.000 | 34.4 |
| **Boxing** | | |
| **Canoeing** | | |
| **Flat water** | | |
| **Slalom** | | |
| **Cycling** | 12.800 | 2.3 |
| **Track** | | |
| **Road** | | |
| **Mountain bike** | | |
| **Equestrian** | | |
| **Jumping** | | |
| **Dressage** | | |
| **Three-day event** | | |
| **Fencing** | 2.500 | 0.5 |
| **Football** | 200.000 | 36.2 |
| **Gymnastics** | 3.500 | 0.6 |
| **Artistic** | | |
| **Rhythmic** | | |
| **Trampoline** | | |
| **Handball** | 19.000 | 3.4 |
| **Hockey** | | |
| **Judo** | | |
| **Modern Pentathlon** | | |
| **Rowing** | | |
| **Sailing** | | |
| **Windsurfing** | | |
| **Shooting** | | |
| **Softball** | | |
| **Aquatics** | | |
| **Swimming** | 30.000 | 5.4 |
| **Diving** | 3.000 | 0.5 |
| **Water polo** | 5.000 | 0.9 |
| **Synchronized** | 3.000 | 0.5 |



| | | |
|---|---|---|
| **Table tennis** | | |
| **Tae kwondo** | | |
| **Tennis** | 3.500 | 0.6 |
| **Triathlon** | | |
| **Volleyball** | 80.000 | 14.5 |
| **Beach Volley** | | |
| **Weightlifting** | | |
| **Wrestling** | | |
| **Freestyle** | | |
| **Greco-Roman** | | |
| **WINTER OLYMPIC SPORTS** | | |
| **Alpine skiing** | | |
| **Biathlon** | | |
| **Bobsleigh** | | |
| **Cross Country Skiing** | | |
| **Curling** | | |
| **Ice skating (Figure Skating)** | | |
| **Freestyle Skiing** | | |
| **Ice Hockey** | | |
| **Luge** | | |
| **Nordic Combined** | | |
| **Short Track Speed Skating** | | |
| **Skeleton** | | |
| **Ski Jumping** | | |
| **Snowboarding** | | |
| **Inline skating (Speed Skating)** | | |
| **NON OLYMPIC SPORTS** | | |
| **Aerobics** | | |
| **Ballet/dance/jazz** | | |
| **Billiards** | | |
| **Body building** | | |
| **Bowling** | | |
| **Bowls (law & carpet)** | | |
| **Cricket** | | |
| **Fitness training** | | |
| **Fishing** | | |
| **Golf** | | |
| **Hiking** | | |
| **Hunting** | | |
| **Indoor soccer** | | |
| **Korfball** | | |
| **Martial art** | | |
| **Motoring** | | |
| **Motor-boating** | | |
| **Netball** | | |
| **Running jogging** | | |
| **Rock Climbing** | | |
| **Rugby** | | |
| **Skateboarding** | | |



| | | |
|---|---|---|
| **Squash** | | |
| **Waliking/ ramble** | | |
| **VTT** | | |
| **Other ballsports** | | |
| **Other winter sports** | | |
| **Other sports** | | |
| **Total** | 552.300 | 100.0 |



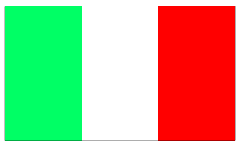
# ITALY

**Sports injuries in the EU countries in view of 2004 Olympics: Harvesting information from existing databases**

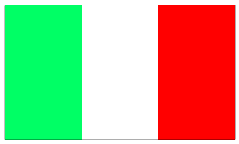
Frequency of Sports

**Data source:** CONI-ISTAT (Italian Institute of Statistics)

| | ITALY | |
|---|---|---|
| | Persons exercising N | Persons exercising % |
| **OLYMPIC SPORTS** | | |
| **Archery** | | |
| **Athletics** | 1.500.000 | 8.4 |
| **Marathon** | | |
| **Badminton** | | |
| **Baseball** | | |
| **Basketball** | 600.000 | 3.4 |
| **Boxing** | | |
| **Canoeing** | | |
| **Flat water** | | |
| **Slalom** | | |
| **Cycling** | 1.400.000 | 7.9 |
| **Track** | | |
| **Road** | | |
| **Mountain bike** | | |
| **Equestrian** | | |
| **Jumping** | | |
| **Dressage** | | |
| **Three-day event** | | |
| **Fencing** | | |
| **Football** | 3.700.000 | 20.8 |
| **Gymnastics** | 3.000.000 | 16.8 |
| **Artistic** | | |
| **Rhythmic** | | |
| **Trampoline** | | |
| **Handball** | | |
| **Hockey** | | |
| **Judo** | | |
| **Modern Pentathlon** | | |
| **Rowing** | | |
| **Sailing** | | |



| | | |
|---|---|---|
| Windsurfing | | |
| **Shooting** | | |
| **Softball** | | |
| **Aquatics** | | |
| **Swimming** | 2.500.000 | 14.0 |
| **Diving** | | |
| **Water polo** | | |
| **Synchronized** | | |
| **Table tennis** | | |
| **Tae kwondo** | | |
| **Tennis** | 1.600.000 | 9.9 |
| **Triathlon** | | |
| **Volleyball** | 1.000.000 | 5.6 |
| **Beach Volley** | | |
| **Weightlifting** | | |
| **Wrestling** | | |
| **Freestyle** | | |
| **Greco-Roman** | | |
| **WINTER OLYMPIC SPORTS (*)** | | |
| **Alpine skiing** | | |
| **Biathlon** | | |
| **Bobsleigh** | | |
| **Cross Country Skiing** | | |
| **Curling** | | |
| **Ice skating (Figure Skating)** | | |
| **Freestyle Skiing** | | |
| **Ice Hockey** | | |
| **Luge** | | |
| **Nordic Combined** | | |
| **Short Track Speed Skating** | | |
| **Skeleton** | | |
| **Ski Jumping** | | |
| **Snowboarding** | | |
| **Inline skating (Speed Skating)** | | |
| **NON OLYMPIC SPORTS** | | |
| **Aerobics** | | |
| **Ballet/dance/jazz** | | |
| **Billiards** | | |
| **Body building** | | |



| | | |
|---|---|---|
| **Bowling** | | |
| **Bowls (law & carpet)** | | |
| **Cricket** | | |
| **Fitness training** | | |
| **Fishing** | | |
| **Golf** | | |
| **Hiking** | | |
| **Hunting** | 600.000 | 3.4 |
| **Indoor soccer** | | |
| **Korfball** | | |
| **Martial art** | | |
| **Motoring** | | |
| **Motor-boating** | | |
| **Netball** | | |
| **Running jogging** | | |
| **Rock Climbing** | | |
| **Rugby** | | |
| **Skateboarding** | | |
| **Squash** | | |
| **Walking/ ramble** | | |
| **VTT** | | |
| **Other ball sports** | | |
| **Other winter sports *** | 1.900.000 | 10.7 |
| **Other sports** | | |
| **Total** | 17.800.00 | 100.00 |

* In Italy there are 2 Federations:

- FISG **(Ice Sports** Italian Federation) for curling, ice skating, ice hockey, short track speed, inline skating activities
- FISI (**Winter Sports** Italian Federation) for all the others activities: alpine skiing, bobsleigh, cross country skiing, freestyle skiing, nordic combined, skeleton, ski jumping, snowboarding

The number of 1.900.000 persons on variable “other winter sports” may be referred only to Winter Sports or also to Ice Sports . Perhaps for Italy they can be considered as “Winter Sports” instead of “other winter sports”

# NETHERLANDS

**Sports injuries in the EU countries in view of 2004 Olympics: Harvesting information from existing databases**

Frequency of Sports

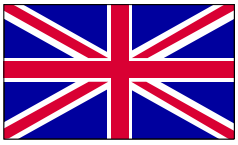
**Data source:** Household Survey "Injuries in Netherlands"

| | NETHERLANDS | |
|---|---|---|
| | Yearly number of hours exercising N | Yearly number of hours exercising % |
| **OLYMPIC SPORTS** | | |
| **Archery** | | |
| **Athletics** | 46.060.880 | 2.7 |
| **Marathon** | | |
| **Badminton** | 31.535.000 | 1.9 |
| **Baseball** | 7.855.478 | 0.5 |
| **Basketball** | 20.089.285 | 1.2 |
| **Boxing** | 9.708.726* | 0.6 |
| **Canoeing** | | |
| **Flat water** | | |
| **Slalom** | | |
| **Cycling** | 36.856.839 | 2.2 |
| **Track** | | |
| **Road** | | |
| **Mountain bike** | | |
| **Equestrian** | 81.338.549 | 4.9 |
| **Jumping** | | |
| **Dressage** | | |
| **Three-day event** | | |
| **Fencing** | | |
| **Football** | 303.003.494 | 18.1 |
| **Gymnastics** | 86.989.230 | 5.2 |
| **Artistic** | | |
| **Rhythmic** | | |
| **Trampoline** | 326.847 | 0.02 |
| **Handball** | 34.784.299 | 2.1 |
| **Hockey** | 50.796.696** | 3.0 |
| **Judo** | 31.418.393*** | 1.9 |
| **Modern Pentathlon** | | |
| **Rowing** | 16.423.549 | 1.0 |
| **Sailing** | 14.866.225 | 0.9 |
| **Windsurfing** | 3.405.253 | 0.2 |
| **Shooting** | 5.934.223 | 0.3 |
| **Softball** | | |
| **Aquatics** | | |
| **Swimming** | 145.800.005 | 8.7 |
| **Diving** | | |

| | | |
|---|---|---|
| **Water polo** | 6.158.396 | 0.4 |
| **Synchronized** | | |
| **Table tennis** | 11.165.932 | 0.7 |
| **Tae kwondo** | | |
| **Tennis** | 240.531.485 | 14.4 |
| **Triathlon** | | |
| **Volleyball** | 58.254.344 | 3.5 |
| **Beach Volley** | | |
| **Weightlifting** | 3.503.595 | 0.2 |
| **Wrestling** | 445.651 | 0.0 |
| **Freestyle** | | |
| **Greco-Roman** | | |
| **WINTER OLYMPIC SPORTS** | | |
| **Alpine skiing** | | |
| **Biathlon** | | |
| **Bobsleigh** | | |
| **Cross Country Skiing** | | |
| **Curling** | | |
| **Ice skating (Figure Skating)** | 31.846.097 | 1.9 |
| **Freestyle Skiing** | 7.849.682 | 0.5 |
| **Ice Hockey** | | |
| **Luge** | | |
| **Nordic Combined** | | |
| **Short Track Speed Skating** | | |
| **Skeleton** | | |
| **Ski Jumping** | | |
| **Snowboarding** | | |
| **Inline skating (Speed Skating)** | | |
| **NON OLYMPIC SPORTS** | | |
| **Aerobics** | 40.122.994 | 2.4 |
| **Ballet/dance/jazz** | | |
| **Billiards** | 11.586.337 | 0.7 |
| **Body building** | 7.950.536 | 0.5 |
| **Bowling** | 7.744.202 | 0.5 |
| **Bowls (law & carpet)** | | |
| **Cricket** | 12.717.034 | 0.7 |
| **Fitness training** | 147.416.512 | 8.8 |
| **Fishing** | 8.919.491 | 0.5 |
| **Golf** | 25.262.618 | 1.5 |
| **Hiking** | | |
| **Hunting** | | |
| **Indoor soccer** | 17.464.701 | 1.0 |
| **Korfball** | 32.155.966 | 1.9 |
| **Martial art** | | |
| **Motoring** | 5.602.675 | 0.3 |
| **Motor-boating** | | |
| **Netball** | | |
| **Running jogging** | 48.202.427 | 2.9 |
| **Rock Climbing** | | |

| | | |
|---|---|---|
| **Rugby**<br>**Skateboarding**<br>**Squash**<br>**Walking/ramble**<br>**VTT**<br>**Other ball sports**<br>**Other winter sports**<br>**Other sports** | 22.496.488 | 1.3 |
| **Total** | 1.674.590.134 | 100.0 |

*Kick Boxing included, **Ice Hockey Included, ***Taekwondo/Karate/jiu-jitsu included



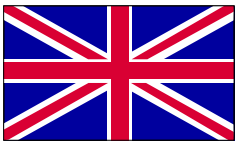
# UNITED KINGDOM

**Sports injuries in the EU countries in view of 2004 Olympics: Harvesting information from existing databases**

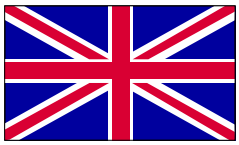
Frequency of Sports

**Data source:** Ball DJ. MINI-SYMPOSIUM: Risks and benefits of sports and exercise. Part 1 of a 3 part series. Assessing the risks. Sports Exercise and Injury. 1998; 4:3-9

| | UNITED KINGDOM | |
|---|---|---|
| | Exposure (millions) N | Exposure (millions) % |
| **OLYMPIC SPORTS** | | |
| **Archery** | | |
| **Athletics** | 14 | 0.8 |
| **Marathon** | | |
| **Badminton** | 55 | 3.3 |
| **Baseball** | | |
| **Basketball** | 18 | 1.1 |
| **Boxing** | | |
| **Canoeing** | | |
| **Flat water** | | |
| **Slalom** | | |
| **Cycling** | | |
| **Track** | | |
| **Road** | | |
| **Mountain bike** | | |
| **Equestrian** | 42 | 2.5 |
| **Jumping** | | |
| **Dressage** | | |
| **Three-day event** | | |
| **Fencing** | | |
| **Football** | 129 | 7.8 |
| **Gymnastics** | | |
| **Artistic** | | |
| **Rhythmic** | | |
| **Trampoline** | | |
| **Handball** | | |
| **Hockey** | 9 | 0.5 |
| **Judo** | | |
| **Modern Pentathlon** | | |
| **Rowing** | | |
| **Sailing** | 32* | 1.9 |
| **Windsurfing** | | |
| **Shooting** | | |
| **Softball** | | |
| **Aquatics** | | |
| **Swimming** | 407 | 24.6 |
| **Diving** | | |
| **Water polo** | | |



| | | |
|---|---|---|
| **Synchronized** | | |
| **Table tennis** | 32 | 1.9 |
| **Tae kwondo** | | |
| **Tennis** | 46 | 2.8 |
| **Triathlon** | | |
| **Volleyball** | | |
| **Beach Volley** | | |
| **Weightlifting** | | |
| **Wrestling** | | |
| **Freestyle** | | |
| **Greco-Roman** | | |
| **WINTER OLYMPIC SPORTS** | | |
| **Alpine skiing** | | |
| **Biathlon** | | |
| **Bobsleigh** | | |
| **Cross Country Skiing** | | |
| **Curling** | | |
| **Ice skating (Figure Skating)** | | |
| **Freestyle Skiing** | 9 | 0.5 |
| **Ice Hockey** | | |
| **Luge** | | |
| **Nordic Combined** | | |
| **Short Track Speed Skating** | | |
| **Skeleton** | | |
| **Ski Jumping** | | |
| **Snowboarding** | | |
| **Inline skating (Speed Skating)** | | |
| **NON OLYMPIC SPORTS** | | |
| **Aerobics** | | |
| **Ballet/dance/jazz** | | |
| **Billiards** | 342** | 20.6 |
| **Body building** | | |
| **Bowling** | | |
| **Bowls (law & carpet)** | 74 | 4.5 |
| **Cricket** | 18 | 1.1 |
| **Fitness training** | | |
| **Fishing** | 37 | 2.2 |
| **Golf** | 125 | 7.5 |
| **Hiking** | 9 | 0.5 |
| **Hunting** | | |
| **Indoor soccer** | | |
| **Korfball** | | |
| **Martial art** | | |
| **Motoring** | 14*** | 0.8 |
| **Motor-boating** | | |
| **Netball** | 9 | 0.5 |
| **Running jogging** | 180 | 10.9 |
| **Rock Climbing** | | |
| **Rugby** | 14 | 0.8 |



| | | |
|---|---|---|
| **Skateboarding** | | |
| **Squash** | 42 | 2.5 |
| **Walking/ ramble** | | |
| **VTT** | | |
| **Other ball sports** | | |
| **Other winter sports** | | |
| **Other sports** | | |
| **Total** | 1.657 | 100.0 |

*Rowing, paddling, surf sail boating, sailing and motor-boating
**Billiards, snooker and pool
***Motor cycling, car racing/rallying and go-carting

# ISRAEL

**Sports injuries in the EU countries in view of 2004 Olympics: Harvesting information from existing databases**

Frequency of Sports

**Data source:** Phone Inquiry to sports federations and associations

| ISRAEL | | |
|---|---|---|
| | N | % |
| **OLYMPIC SPORTS** | | |
| **Archery** | 200 | 0.1 |
| **Athletics** | 400 | 0.1 |
| **Marathon** | | |
| **Badminton** | 400 | 0.1 |
| **Baseball** | 200 | 0.1 |
| **Basketball** | 30.000 | 8.8 |
| **Boxing** | 400 | 0.1 |
| **Canoeing** | 550 | 0.2 |
| **Flat water** | | |
| **Slalom** | | |
| **Cycling** | 2.000 | 0.6 |
| **Track** | | |
| **Road** | | |
| **Mountain bike** | | |
| **Equestrian** | 2.000 | 0.6 |
| **Jumping** | | |
| **Dressage** | | |
| **Three-day event** | | |
| **Fencing** | 750 | 0.2 |
| **Football** | 35.000 | 10.3 |
| **Gymnastics** | 1.700 | 0.5 |
| **Artistic** | | |
| **Rhythmic** | | |
| **Trampoline** | | |
| **Handball** | 3.900 | 1.1 |
| **Hockey** | 200 | 0.1 |
| **Judo** | 7.500 | 2.2 |
| **Modern Pentathlon** | | |
| **Rowing** | | |
| **Sailing** | 30.000 | 8.8 |
| **Windsurfing** | | |
| **Shooting** | 4.000 | 1.2 |
| **Softball** | 200 | 0.1 |
| **Aquatics** | 3.500 | 1.0 |
| **Swimming** | | |
| **Diving** | | |
| **Water polo** | | |
| **Synchronized** | | |
| **Table tennis** | 3.000 | 0.9 |
| **Tae kwondo** | 5.000 | 1.5 |
| **Tennis** | 52.500 | 15.4 |
| **Triathlon** | | |

| | | |
|---|---|---|
| **Volleyball** | 4.800 | 1.4 |
| **Beach Volley** | | |
| **Weightlifting** | 200 | 0.1 |
| **Wrestling** | 2.000 | 0.6 |
| **Freestyle** | | |
| **Greco-Roman** | | |
| **WINTER OLYMPIC SPORTS** | | |
| **Alpine skiing** | | |
| **Biathlon** | | |
| **Bobsleigh** | | |
| **Cross Country Skiing** | | |
| **Curling** | | |
| **Ice skating (Figure Skating)** | | |
| **Freestyle Skiing** | | |
| **Ice Hockey** | | |
| **Luge** | | |
| **Nordic Combined** | | |
| **Short Track Speed Skating** | | |
| **Skeleton** | | |
| **Ski Jumping** | | |
| **Snowboarding** | | |
| **Inline skating (Speed Skating)** | | |
| **NON OLYMPIC SPORTS** | | - |
| **Aerobics** | 120.000 | 35.2 |
| **Ballet/dance/jazz** | | |
| **Billiards** | | |
| **Body building** | | |
| **Bowling** | | |
| **Bowls (law & carpet)** | | |
| **Cricket** | | |
| **Fitness training** | | |
| **Fishing** | | |
| **Golf** | | |
| **Hiking** | | |
| **Hunting** | | |
| **Indoor soccer** | | |
| **Korfball** | | |
| **Martial art** | 30.000* | 8.8 |
| **Motoring** | | |
| **Motor-boating** | | |
| **Netball** | | |
| **Running jogging** | | |
| **Rock Climbing** | | |
| **Rugby** | | |
| **Skateboarding** | | |
| **Squash** | | |
| **Walking/ Ramble** | | |
| **VTT** | | |
| **Other ball sports** | | |
| **Other winter sports** | | |
| **Other sports** | | |
| **Total** | 340.400 | 100.0 |

*Other than judo, boxing and taek wondo