

# What is a Sports Injury?

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**Abstract** Current sports injury reporting systems lack a common conceptual basis. We propose a conceptual foundation as a basis for the recording of health problems associated with participation in sports, based on the notion of impairment used by the World Health Organization. We provide definitions of sports impairment concepts to represent the perspectives of health services, the participants in sports and physical exercise themselves, and sports institutions. For each perspective, the duration of the causative event is used as the norm for separating concepts into those denoting impairment conditions sustained instantly and those developing gradually over time. Regarding sports impairment sustained in isolated events, ‘sports injury’ denotes the loss of bodily function or structure that is the object of observations in clinical examinations; ‘sports trauma’ is defined as an immediate sensation of pain, discomfort or loss of functioning that is the object of athlete self-evaluations; and ‘sports incapacity’ is the sidelining of an athlete because of a health evaluation made by a

legitimate sports authority that is the object of time loss observations. Correspondingly, sports impairment caused by excessive bouts of physical exercise is denoted as ‘sports disease’ (overuse syndrome) when observed by health service professionals during clinical examinations, ‘sports illness’ when observed by the athlete in self-evaluations, and ‘sports sickness’ when recorded as time loss from sports participation by a sports body representative. We propose a concerted development effort in this area that takes advantage of concurrent ontology management resources and involves the international sporting community in building terminology systems that have broad relevance.

## 1 Introduction

A common terminology is needed for the documentation of health problems sustained in association with participation in sports and physical exercise. If the complete health experiences of sports participation are to be adequately positioned on health policy agendas, they must be denoted by concepts that are both specific and have a clear meaning for the stakeholders involved [1]. We introduce sports impairment as the core notion for documentation of this category of health issues and derive separate concepts for denoting sports impairment observed by health professionals, recorded from athlete self-reports, and noted as time-loss from sports participation. These concepts can be used as a basis for concerted ontology development in the area.

## 2 Problem Formulation

Harm to the human body sustained while participating in sports and physical exercise is a well recognized problem

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today. The scope of this problem has often, particularly in public health settings, been restricted to the consequences of sudden, damaging events such as strains and lacerations [2]. However, overuse syndromes, without a specific, identifiable event responsible for their manifestation, are a substantial problem in sports that result from monotonous training sessions or the repetition of movement patterns [3]. Symptoms and signs (e.g., pain and functional limitations) appear gradually and so the athletes will continue to train. Demand for proper documentation of damaging events with both sudden and gradual onset varies across stakeholders and settings. While athletes and sports managers call for evidence-based strategies to minimize athletes' absence from sports, government policy-makers need evidence for deciding resource allocation to service delivery. Correspondingly, epidemiological studies involving competitive athletes have typically focused on recording time-loss events [4], and the International Classification of Disease (ICD) has been used for injury studies in general populations [5]. Importantly, the most commonly used sports injury reporting systems lack a common conceptual basis and a thorough consideration of the question 'What is a sports injury?' is now needed.

### 3 Proposal

We propose a new conceptual foundation for documentation of health problems associated with participation in sports, based on the notion of impairment used by the World Health Organization (WHO) in the functioning and disability classification: the International Classification of Functioning, Disability, and Health (ICF) [6]. We define sports impairment etiologically as a loss of body functions or deviation of structure caused by the transfer of energy during participation in sport. Adding to the WHO notion of impairment, we employ causal pathways and etiology to structure the concepts needed to define sports impairment.

In 1948, the WHO defined health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [7]. Until then, no distinction had been made between injury and disease etiologies and the types of external causes of injury were regarded as unlimited, ranging from domestic pets to firearms. However, with increasing traffic accident rates globally, the external causes of 'injury' were subsequently restricted to include only energy exchange in discrete events [8]. This energy transfer definition had its background in traffic accident prevention where it was possible for intervention measures to be directed at the specific control of energy release that resulted in the human impairment. A conceptual division between injury and disease was thus made based on the etiological differences

that divided the possibilities for preventive and therapeutic interventions.

According to its definition, the sports impairment concept does not merely cover the consequences of energy exchange in discrete events. The general basis for planned athlete performance improvement is functional overreaching; i.e., performance of bouts of physical exercise in an amount that allows performance decrements and fatigue to be reversed within a pre-planned recovery period. Non-functional overreaching occurs when physical performance does not improve and feelings of fatigue do not disappear after a recovery period, while 'overtraining' applies to the symptomatic cases. While loss of body function or structure sustained during discrete events can mainly be prevented before an incident by removing or attenuating the impact of the energy exchange, damaging consequences of exposure to repeated bouts of physical exercise can be eliminated after an initial exposure; e.g., by extending recovery periods and adjusting technique or equipment [9, 10]. Distinguishing impairment concepts based on etiology, and particularly in relation to the period of exposure to transfer of energy, is thus particularly relevant to sports injury.

The conception of sports impairment is also contingent on the setting in which the impairment is observed and reported. A representation of observations that is structured by the setting where the observation is made matters for all central stakeholders associated with competitive and recreational sports. Besides observations made in health and medical services, notions of human ill health are regularly used to describe the status of unhealthy individuals in different public sector systems (e.g., legal schemes regulating sickness benefits) and to represent an individual's perceived potential to fulfill vital life goals [11]. These three perspectives differ fundamentally with regard to worldviews. Separate concepts for denoting health problems according to each of these worldviews have been proposed [12], where

- injury and disease represent views on ill health as conceived in clinical and preventive medicine;
- incapacity and sickness represent the standpoints of society and its institutions on being unhealthy, for instance when used to evaluate entitlement to benefits due to work incapacity; and
- trauma and illness refer to ill health as conceived by persons themselves.

### 4 Solution

We provide definitions of sports impairment concepts that represent the perspectives of health services, the athletes

themselves, and sports institutions. For each perspective, the duration of the causative event is used as the norm for separating concepts into those denoting impairment conditions sustained instantly and those having developed gradually over time. By introducing sports impairment as the integrating concept for a derived set of notions, two important shortcomings in current sports injury terminology are addressed:

- health problems caused by isolated exposure to a transfer of energy in discrete events and excessive bouts of physical exercise differ in etiology and require different categories of clinical and preventive interventions; and
- health service, sports institution, and athlete observations and reports on ill health are based on essentially different worldviews.

Regarding sports impairment sustained in isolated events, we suggest the following terminology.

- ‘Sports injury’ to denote the loss of bodily function or structure that is the object of observations in clinical examinations.
- ‘Sports trauma’ to denote an immediate sensation of pain, discomfort or loss of functioning that is the object of athlete self-evaluations.
- ‘Sports incapacity’ to denote the sidelining of an athlete because of a health evaluation made by a legitimate sports medicine authority that is the object of time loss observations (Table 1).

Sports injuries can be reported using general diagnosis systems such as the ICD [6] or corresponding systems specifically adapted to sports [13, 14], and the basic codes can be further categorized by body region and nature of injury [15]. Sports incapacity is reported using systems for recording time loss from sports participation [16], while sports trauma is accounted for by athletes’ self-report. Events in both of the latter categories can also be coded using the ICF (Fig. 1).

Correspondingly, sports impairment caused by excessive bouts of physical exercise is denoted as follows.

- ‘Sports disease’ (overuse syndrome) when observed by health service professionals during clinical examinations.
- ‘Sports illness’ when observed by the athlete in self-evaluations.
- ‘Sports sickness’ when recorded as time loss from sports participation by a sports body representative.

Sports injuries, like sports-related disease, can be coded using diagnosis systems. Sports sickness is reported using time-loss recording methods, while sports illness is

**Table 1** Sports impairment concepts for use in reports of observations made in clinical examinations, in athlete self-reports, and in reports of time loss from sports performance

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#### Clinical examination

##### *Sports injury*

Loss or abnormality of bodily structure or functioning resulting from an isolated exposure to physical energy during sports training or competition that following examination is diagnosed by a clinical professional as a medically recognized injury

##### *Sports disease (overuse syndrome)*

Loss or abnormality of bodily structure or functioning resulting from repeated bouts of physical load without adequate recovery periods in association with sports training or competition that following examination is diagnosed by a clinical professional as a medically recognized disease or syndrome

#### Athlete self-report

##### *Sports trauma*

An immediate sensation of pain, discomfort, or loss of functioning associated, by an athlete, with an isolated exposure to physical energy during sports training or competition having an intensity and quality making the sensation being interpreted by the athlete as discordant with normal body functioning

##### *Sports illness*

A progressively developing sensation of pain, discomfort or loss of functioning associated, by an athlete, with repeated bouts of physical load during sports training or competition without a adequate recovery periods that reach an intensity and quality making the sensation being interpreted by the athlete as discordant with normal body functioning

#### Sports performance

##### *Sports incapacity*

Sidelining of athlete by a sports authority (the athlete her/himself, coach, manager, sports committee) due to reduced ability to perform a planned sports activity following an isolated exposure to physical energy during sports training or competition

##### *Sports sickness*

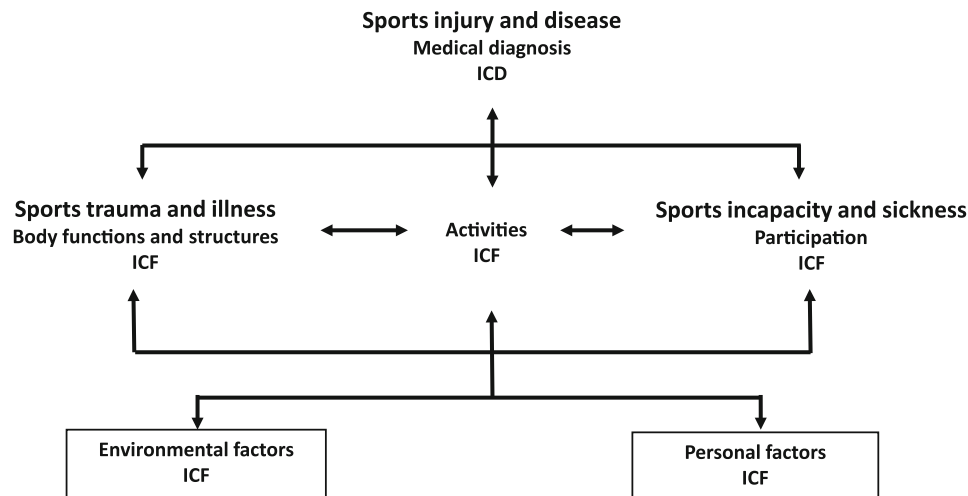
Sidelining of athlete by a sports authority (the athlete her/himself, coach, manager, sports committee) due to reduced ability to perform a planned sports activity following repeated bouts of physical load without adequate recovery periods in association with sports training or competition

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accounted for by athletes’ self-report. Events in both the latter categories can be coded using the ICF.

## 5 Examples

In this section, the new conceptual foundation for documentation of health problems having their origin in sports participation is demonstrated using two case vignettes. The first vignette, exemplifies how sports impairment sustained in an isolated event is represented by notions and terms categorized using the sports injury, trauma, and incapacity concepts, referring to views on ill health as conceived in clinical and preventive medicine, by sportspersons



**Fig. 1** Display of associations between the proposed framework of sports impairment concepts and the family of international classifications developed by the World Health Organization (WHO). The International Classification of Diseases (ICD) is the standard

diagnostic tool for epidemiology, health management and clinical purposes, while the International Classification of Functioning, Disability and Health, known more commonly as ICF, is a classification of health and health-related domains

themselves, and from the standpoints of sports institutions and society, respectively. Correspondingly, the second vignette exemplifies how sports impairment sustained in excessive bouts of physical exercise is represented by notions and terms categorized using the concepts of sports disease (overuse syndrome), trauma and sickness.

**Case 1** During a Women's Champions League football game, an attacker collides with a defender when the former is trying to control a cross ball, causing both players to fall to the ground. In the fall, the attacker's right ankle is caught between the opponent's leg and the turf. The player feels instant pain from the ankle region. Although she had not hurt her ankle before, she immediately understands that she has sustained significant trauma and calls for medical assistance. Within seconds, the player receives first aid from the team physiotherapist. Thereafter, she is rapidly carried off the field. At the sideline, she reports severe pain on a Numerical Rating Scale (score 8/10) and the physiotherapist decides to transport her to the nearby university hospital. Further examination with ultrasound and clinical tests at the emergency room reveals a partial rupture of the anterior tibiofibular ligament, but no fracture. The attending physician records the injury as "sprain of tibiofibular ligament of right ankle" using the ICD-10 code S93.431. The player is discharged from the hospital on the same day. She undergoes a standardized rehabilitation program under the supervision of the team physiotherapist and is permitted to progress to the next phase after successful completion of the preceding one. Twenty-one days after the event, she is allowed to return to unrestricted play with her team after meeting standardized return-to-play criteria. At that time, she experiences no further pain from her ankle when

participating in normal soccer training. In the report to the football association, the player's incapacity is classified as moderate based on the period of time loss (21 days).

**Sports injury** Sprain of tibiofibular ligament of right ankle ICD-10 code S93.431

**Sports trauma** Self-reported lower leg pain (Numerical Rating Scale) decreasing from score 8/10 immediately after the event to score 0/10 three weeks after the event.

**Sports incapacity** Type: Strain; Body part: Ankle; Side: right; Previous injury: no; Severity: moderate.

**Case 2** A female long-distance runner striving to make the national team for the European Athletics Championships due in 4 months consults her physician for increasing pain from her right ankle. In the illness section of her weekly surveillance report to the Athletics Association, the athlete scores 3/10 on lower leg pain. The pain has developed gradually and she has never, from what she can remember, "twisted her ankle". In her youth, the athlete also played soccer and participated in orienteering. In these settings, she became accustomed to running on uneven surfaces and she still often runs on forest trails and participates in cross-country races. Following examination, the sports physician explains to the athlete that she suffers from a chronic ankle strain (coded as ICD-10-CM as M25.371 "Other instability, right ankle"). She is also referred to the university hospital for an MRI to rule out an osteochondral defect. After the physician consultation, the athlete sees the physiotherapist working at the sports clinic. He gives the athlete instructions for a training program to strengthen the muscles around the ankle and schedules a follow-up meeting the next day for fitting of insoles and an ankle brace. In addition, the athlete is instructed to only run

on even surfaces, and avoid dirt roads and forest tracks. The athlete is asked to return to the clinic together with her coach when the MRI report is at hand to plan a long-term treatment strategy, including possible surgical interventions. Due to the approaching championships, the athlete continues to train according to her schedule. Consequently, no sickness (time loss) is recorded.

*Sports disease (overuse syndrome)* Other instability, right ankle ICD-10-CM M25.371.

*Sports illness* Lower leg pain score (Numerical Rating Scale) 3/10 in the illness section of weekly athlete monitoring.

*Sports sickness* None recorded.

## 6 Discussion

An unambiguous and sound set of concepts is needed to cover the complete health experiences of contemporary sports and organized physical exercise participants. The global decline of acute infections and an increasing number of elderly have led to chronic conditions being the dominant health challenge. Frameworks of health concepts adapted to this situation have been developed, such as that used as the basis for the ICF [6]. Simultaneously, participation in organized sports has, for both children and adults, moved towards increased competitiveness and higher training loads [17, 18], and physical exercise is today vigorously promoted among the elderly in both the treatment and prevention of chronic diseases [19]. However, indicators of morbidity related to participation in sports and physical exercise have not been adjusted to account for these transformations. It is our view that such indicators now need to be modified from consequence of injury and disease terminologies towards a ‘components of health’ set of concepts. Nonetheless, to support identification of risk factors, it will still be necessary to structure sports impairment concepts by causal mechanisms, and in particular to differentiate between discrete and enduring causal processes. Especially for documentation of sports impairment associated with overuse syndromes, the participants’ self-reports of symptoms need to be included as an integral part of data collection frameworks, as has recently also been advocated by Clarsen et al. [20]. Only in this way can knowledge be attained on how sensations of pain, discomfort, and loss of functioning are interpreted and related to damages to anatomical structures and physiological functions. Recent neuroscience models indicate that humans perceive ‘feelings’ from the body that provide a summation of their physical condition and underlying mood and emotional states [21]. These feelings represent a sense of the physiological condition of the entire body, redefining ‘interoception’ as a component in

systemic homeostatic regulation. Even though there has been a rapid advance in the development of instruments for self-reports of symptoms and health conditions, only a few are available for participants in sports and organized physical activities [22].

The framework of concepts presented in this current opinion statement should not be seen as an endpoint, but as the basis for a synchronized development program where general epidemiologists and public health informaticians both play central roles. In this effort, current sports-specific terminologies need to be integrated with the family of international classifications developed by the WHO. In particular, the ICF will be important for meeting the challenge of preventing chronic conditions as the adverse sequelae of sports overuse. Future research should focus on developing an ICF core set of items covering sport, as well as adjusting the ICD to include codes for specific sports settings and sports-related external causes [23]. The greatest need for adjustment concerns terminologies used for the description of sports impairment sustained progressively in repeated bouts of exercise. Overuse syndromes now represent approximately 50 % of pediatric sport-related morbidity [24, 25]. For these conditions, neither current medical diagnosis codes nor time-loss injury notions are sufficient for either clinical use or population-level health monitoring. A concerted terminology development effort in this area should take advantage of concurrent ontology management resources [26], and the international sporting community should be involved in building terminology systems that have relevance for sportspersons, clinicians, researchers, sports institutions and health authorities alike.

## 7 Conclusion

We have provided definitions of sports impairment concepts that represent the perspectives of health services, the athletes themselves, and sports institutions. For each perspective, the duration of the causative event is used as the norm for separating concepts into those denoting impairment conditions sustained instantly and those having developed gradually over time. This framework of concepts presented should not be seen as an endpoint, but as the basis for a synchronized development program where general epidemiologists and public health informaticians play jointly central roles.

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