

More data needed on injury risk among young elite athletes

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ABSTRACT

Injuries can counter the beneficial effects of sports participation at a young age if a child or adolescent is unable to continue to participate because of residual effects of injury. Independent of activity level, injuries represent a considerable problem for the athlete and can result in an increased potential for future disability and inactivity. Injuries are also referred to as one of the major reasons for athletes to drop out of sports. Systematic injury registrations at the youth and adolescent level have been performed in recreational sports to gain knowledge on injury risk, as well as on the most common and most severe sport specific injuries. However, information on injury risk of the young athlete competing in high level sports seems less available or unknown. This paper reviews the current knowledge on injury risk of the youth and adolescent elite athlete participating in sports presented in the Youth Olympic Games 2010. Apart from football, little is known on injury epidemiology among young elite athletes. Systematic injury surveillance of this highly competitive population is needed to monitor injuries, identify high risk sports, and ensure new knowledge on injury trends, which can form the basis for further research on injury risk factors, mechanisms, and in the final step, on injury prevention.

INTRODUCTION

Although significant evidence suggests that sports participation is beneficial from a public health perspective,¹⁻³ injuries are significant negative side effects on both the short and long term.⁴

Youth have high participation rates in sports, and sports is the leading cause of youth injury in many countries.⁵⁻⁶ Data from a Canadian report state that 33-41% of youth have had at least one serious sport injury for which they had to seek medical attention.⁷ Injuries, independent of activity level, represent a considerable problem for the athlete, the team, and, in sports with a given popularity, for the society at large. However, to date, few well-conducted studies are available on long term health outcomes following youth sports injuries.⁸

Injuries are also referred to as one of the major reasons for athletes to drop out of sports. A survey on former Norwegian female top level athletes, representing 38 sports, revealed that 24% of them chose to quit their careers because of injuries (Sundgot-Borgen, personal communication). Other studies, analysing the dropping out phenomena in sports due to injury, are limited primarily to gymnasts and implicate such injuries as anterior cruciate rupture and osteochondritis dissecans of the elbow joint in the early retirement of young athletes.⁸ As a consequence, many

talented athletes choose or are forced to give up their promising sports careers.

Thus, to maximise the health benefits of life-long sports and exercise, and to minimise the direct and indirect costs associated with injury, identifying athletes at high injury risk early and providing them with targeted tools to prevent sports injuries is a significant goal. Following the four-stage model of van Mechelen *et al*,⁹ injury epidemiology is the first step in the development of effective injury prevention strategies.

At the elite level, international sporting federations organise competitions in various age classes ranging from as low as under-13 up to under-21, depending on the sport. These competitions also represent important showgrounds for young athletes; in some sports, this is often where talented athletes are identified for a future professional career.¹⁰

The International Olympic Committee has decided to create a new sporting event for young athletes, and the first Summer Youth Olympic Games will be held on 14-26 August 2010 in Singapore. The games will bring together around 3600 athletes, aged 14-18 years, from all over the world to participate in high level competitions. The programme of the Youth Olympic Games will include all the 26 sports scheduled on the 2012 Summer Olympic Games, but with a limited number of disciplines and events (table 1).

Systematic injury registrations at youth levels have been performed in recreational sports.¹¹⁻¹⁷ However, little is known about the injury risk of the young athlete competing at high level sports. The aim of this paper was to review the current knowledge on injury risk of the youth and adolescent elite athlete competing in sports presented on the programme for the Youth Olympic Games 2010.

METHODOLOGY

A comprehensive search in the literature was performed in the data bases PubMed, Medline,

Table 1 The 26 sports of the Youth Olympic Games 2010 in Singapore

Aquatics	Archery	Athletics	Badminton
Basketball	Boxing	Canoe-kayak	Cycling
Equestrian	Fencing	Field hockey	Football
Gymnastics	Handball	Judo	Modern pentathlon
Rowing	Sailing	Shooting	Table tennis
Taekwondo	Tennis	Triathlon	Volleyball
Weightlifting	Wrestling		

Cochrane and Embase using various combinations of the following key words over the years 1966 to March 2010: 'injury', 'injuries', 'youth', 'adolescent', 'athletes', 'elite', 'national level', 'sports', 'aquatics', 'swimming', 'diving', 'archery', 'athletics', 'badminton', 'basketball', 'boxing', 'canoe', 'cycling', 'equestrian', 'fencing', 'field hockey', 'football', 'gymnastics', 'handball', 'judo', 'kayak', 'modern pentathlon', 'rowing', 'sailing', 'shooting', 'table tennis', 'taekwondo', 'tennis', 'triathlon', 'volleyball', 'weightlifting', 'wrestling'.

An article was included in the search when the abstract was written in English and clearly expressed data on injury risk, or a full text version of a paper with relevant information on injury risk was available. Age of the participating athletes had to cover the predefined age range of 14–18 years, and athletes had to compete at the national or international level. Injury risk should be reported by injury incidence and ideally be obtained prospectively. However, articles describing prospective and retrospective data collection designs were included in this review. Other relevant articles were identified by cross-referencing the citation lists of articles selected from the electronic search. The search was limited to abstracts and articles published in peer-reviewed journals.

RESULTS

A total of 13 studies could be identified presenting data on injury risk of youth and adolescent elite athletes competing in football,^{18–25} rowing,²⁶ field hockey,²⁷ badminton²⁸ and gymnastics^{29,30} (table 2). These five sports represent one fifth (19%) of all sports included in the Youth Olympic Games 2010.

Of the 13 studies, 10 were designed prospectively, eight of which were on football players,^{18–25} and one study each on field hockey players²⁷ and gymnasts.²⁹ Three other investigations collected data on injuries and exposure retrospectively.^{26,28,30}

In football, the largest sport in terms of participating members,³¹ four studies were designed to follow their populations over 10,²³ eight,²⁰ six¹⁹ and two seasons.²⁴ In addition, there are four papers published to compare data from a total of 14 male and female junior World and European Championship tournaments: nine tournaments for males and females in the under 19 age group^{18,21,22} and five tournaments for male under 17 players.^{18,25}

Table 2 summarises the injury risk expressed as the number of injuries, the number of injuries per athlete per season, and injury incidence as injuries per 1000 h or athlete exposures for male and female elite young athletes competing through regular seasonal activities,^{19,20,23,24,26,28–30} training camps and national tournaments²⁷ or major sports events.^{18,21,22,25}

Comparing injury risk between sports, the highest injury rates by far were found in female field hockey²⁷ and female and male international football tournaments,^{18,21,22,25} followed by seasonal female football,²⁰ badminton,²⁸ and gymnastics.^{29,30} The lowest injury rates were registered for rowing athletes.²⁶

Among all football studies representing regular league play, French female football topped the risk statistics with an overall injury rate among the 15- to 19-year-olds of 6.4 per 1000 h of play; 22.4 and 4.6 per 1000 match and training hours, respectively.²⁰ Match and training injury rates of 9- to 16-year-old boys in UK youth academy football of 10.5 and 1.4 injuries per 1000 playing hours¹⁹ were comparable to French long term data on youth male football players aged 13–15 years,

with 11.2 and 3.9 injuries per 1000 match and training hours, respectively.²³

DISCUSSION

This review on injury epidemiology among youth and adolescent elite athletes competing in the 26 selected sports illustrates that there is a lack of well designed injury surveillance studies targeting this population. Only 13 studies in five sports have addressed the topic of injury epidemiology among young elite athletes. These investigations, eight of them on football players, represent 19% of all sports presented in the Youth Olympic Games 2010. Among the present studies, a total of three were designed to register data retrospectively by using surveys,^{26,28,30} and four studies monitored fewer than 80 athletes.^{27–30}

In other words, while injury risk is well documented for the young elite football player, little or no information on injury risk is available for youth and adolescent elite athletes competing in the remaining Summer Olympic sports.

Injury surveillance at youth and adolescent elite level

Injury surveillance in elite sports events is an important task to ensure safety, to preserve the health of the athlete, and to allow high lifelong activities in sports. Based on the present studies on youth and adolescent elite athletes, the highest injury risk was found for female field hockey players,²⁷ male and female football tournament players,^{18,21,22,25} as well as for French female football players.²⁰

Data on injury risk in seasonal elite football revealed surprisingly high injury rates for 15- to 19-year-old French female football players.²⁰ These figures reflect similar³² or even higher injury rates than recorded in adult elite level female football.^{33,34} The incidence of match injuries²⁰ was also notably higher than match injury rates found among male youth and adolescent football players,²³ suggesting that adolescent elite female football players are at high injury risk.

Mismatches in biological maturity between young athletes may also have implications for an increased injury risk, specifically in sports that are characterised by physical contact between teammates and opponents—for example, in ball team sports and martial arts. Competing regularly against older, more mature, and heavier opponents may lead to a higher incidence of injury in younger athletes.^{17,20} In addition, many of the most talented athletes are competing for several teams or in higher age groups, which leads to a mismatch between competition participating and training/recovery and presumably to an increased injury risk.³⁵

In the investigation on badminton players,²⁸ data were also recorded for older elite badminton players, and, interestingly, the junior athletes had higher injury rates compared to their senior counterparts. The authors postulated that the elite junior athlete goes through transition from less intensive training to very intensive training, resulting in tensile loading and stresses on their musculoskeletal system for which they are unaccustomed and thereby at increased injury risk.²⁸ As the intensity of competition is linked most likely to an increased risk of injury, the present findings may also be supported by the high injury rates found in field hockey²⁷ and football tournament players.^{18,21,22,25}

To sum up, the young elite athlete seems to be subjected to a high injury risk. However, the current knowledge on injury risk for this population is, apart from football, based on few

Table 2 Risk of injuries expressed as the number of injuries, the number of injuries per athlete per season, and injury incidence and for adolescent elite athletes of different sports

Reference country, season, follow-up period	Population	Sport	No. of all injuries	Injury recording, definition	Injuries per athlete per season	Injury incidence per 1000 h		
						Competition	Training	Total
Seasonal activities								
Johnson <i>et al</i> ¹⁹ UK, 2001–2007, 6 years	Male n=292 9–16 years	Football (soccer)	476	Prospective, ?	0.27	10.5	1.4	
Le Gall <i>et al</i> ²⁰ France, 1998–2006, 8 years	Female n=119 15–19 years	Football (soccer)	619	Prospective, time loss	0.65	22.4	4.6	6.4
Le Gall <i>et al</i> ²³ France, 1993–2003, 10 years	Male n=528 13–15 years	Football (soccer)	1152	Prospective, time loss	0.22	11.2	3.9	4.8
Price <i>et al</i> ²⁴ UK, 1999–2001, 2 years	Male n=4773 9–19 years	Football (soccer)	3805	Prospective, time loss	0.40			
Smoljanovic <i>et al</i> ²⁶ World Cup athletes, 2006–2007, 1 year	Male n=231 18 years	Rowing	209	Retrospective by survey, time loss	0.90		2.0*	
	Female n=167 18 years	Rowing	184	Retrospective by survey, time loss	1.10		2.4*	
Yung <i>et al</i> ²⁸ Hong Kong, 2003, 1 year	Male + female n=11 16–21 years	Badminton	37	Retrospective by survey, time loss	3.36	5.9	2.8	3.1
Kolt and Kirkby ²⁹ Australia, 1999, 1½ years	Female n=24 11–19	Gymnastics	151	Prospective, time loss or modification of gymnastics sessions	4.19		2.6	
Kolt and Kirkby ³⁰ Australia, 1995, 1 year	Female n=47 11–19	Gymnastics	111	Retrospective by survey, time loss	2.36		1.6	
Training camps and tournaments								
Hägglund <i>et al</i> ¹⁸ U19 European Championships, 2006, 2007, 2008	Female n=433 18 years	Football (soccer)	43	Prospective, time loss	Not relevant	11.7–28.2	1.1–7.4	4.9–13.5
U19 European Championships, 2006, 2007, 2008	Male n=436 18 years	Football (soccer)	38	Prospective, time loss	Not relevant	16.3–27.8	1.5–2.1	6.4–13.0
U17 European Championships, 2006, 2007, 2008	Male n=433 16 years	Football (soccer)	40	Prospective, time loss	Not relevant	20.7–28.6	1.2–5.6	8.4–13.3
Waldén <i>et al</i> ²² U19 European Championships, 2005	Male n=144 18 years	Football (soccer)	17	Prospective, time loss	Not relevant	30.4	2.9	13.4
Junge and Dvorak ²¹ U19 World Championships, 2002, 2004	Female n=432† 16–19 years	Football (soccer)	?	Prospective, tissue (expected time loss)	Not relevant	68–85 (20–49)		
Junge <i>et al</i> ²⁵ U17 World Championships, 1999, 2001	Male n=576† 16 years	Football (soccer)	146	Prospective, tissue (expected time loss)	Not relevant	51.0–88.1 (19.2–32.7)		
Rishiraj <i>et al</i> ²⁷ Canada, 1996–2000, 5 years	Female n=75 18 years	Field hockey	192	Prospective, time loss	Not relevant	67.5*	68.0*	67.9*

*Per 1000 athlete exposures.

†Based on a squad of 18 players for 12 (female) and 16 (male) qualified teams for each tournament.

and for the most part small studies. Large prospective investigations are needed in most sports.

What is needed?

The purpose of injury surveillance is to monitor injury trends and in a next step target injury control measures in an attempt to reduce injury risk.

As an example, injury surveillance has been introduced in the FIS (Fédération Internationale de Ski) World Cup disciplines

over three seasons, aimed to identify, describe and analyse over time the injury risks and injury patterns in skiing and snowboarding with a view to use this knowledge to reduce the risk of injuries among the top level athletes.³⁶

To reach this goal, comprehensive injury surveillance studies have recently been conducted for top level adult athletes in single elite events including football,^{21 25 37 38} rugby,^{39–41} handball,⁴² athletics,⁴³ beach volleyball⁴⁴ and swimming.⁴⁵ Injury surveillance studies have also been performed in large

multisport events, such as the Olympic Games in Athens 2004⁴⁶ and in Beijing 2008,⁴⁷ and the applied methods to collect injuries have been shown to be reliable and feasible.

Results from the Summer Olympics Games 2008, for example, revealed that in relation to the number of registered athletes, the risk of incurring an injury was highest in football (soccer), taekwondo, field hockey, team handball, weightlifting and boxing (all $\geq 15\%$ of the athletes), and lowest for sailing, canoeing/kayaking, rowing, synchronised swimming, diving, fencing and swimming (all $\leq 5\%$ of the athletes).⁴⁷

With these systematic injury registrations, high risk sports will be identified, including their most common and most severe injuries. As, however, injury risk and patterns of young elite athletes may vary from their older professional counterparts, injury surveillance of young elite athletes is needed to gain knowledge about the injury risk among this highly competitive population.

The second step in the development of injury preventive strategies is to map the causes of injuries, and to identify their risk factors and mechanisms⁹; in football, knowledge from injury epidemiology has been used to follow-up football players further on injury risk factors^{48–51} and injury mechanisms.^{52–54} With increased knowledge on intrinsic and extrinsic risk factors, as well as the inciting event, athletes at high injury risk may be identified earlier in their careers and targeted to individualised injury prevention strategies. As a consequence, the risk of additional injuries, possible serious long term health consequences, and dropouts from sports can be decreased. However, this basic information on injury epidemiology is lacking for most of the other sports, selected for this review, and all the above will justify introducing comprehensive injury surveillance systems at the youth and adolescent elite sports level.

Based on the experiences from former injury surveillance during major multi sports events, such as the 2008 Olympics⁴⁷ and, more recently, the Winter Olympics in Vancouver, arenas such as the new sports event for elite youths, the Youth Olympic Games, should be evaluated for establishing systematic injury surveillance in this population. The key to a meaningful epidemiology study lies in an organised data collection process with a coordinated effort from the sports medicine professionals, the coaches, and the athletes, and finally systematic analyses. Well designed prospective injury recording methods are strongly emphasised to minimise recall bias.

CONCLUSION

Apart from football, little knowledge is available on injury epidemiology among young elite athletes competing in sports that are programmed for the Summer Olympic Games. Systematic injury surveillance studies should be established in major multi sports events such as the Youth Olympic Games to monitor injury trends, identify high risk sports, and ensure new knowledge on injury trends which can form the basis for further research on injury risk factors, mechanisms, and, in the final step, injury prevention.

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