Epidemiology and prevention of injuries in young sportsmen. A 35 year observational study of the sport and art classes in the Canton of Geneva

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Abstract

Injury prevention is a priority in the field of sports medicine and in physical activity promotion, in particular for youth. Injuries can lead to long term handicaps and disengagement from physical activity. The follow up of young sportsmen in the canton of Geneva over the last 35 years has permitted to get an idea of the prevalence of injuries in young sportsmen and allows a comparison with the general population. It has also permitted to get an idea of the influence prevention has had on injuries. We found that injuries were not significantly different in youth sportsmen (0.27 injuries/child/year) than in the general age matched population, but that injury's among sporting youth occurred mainly during their sporting activities. Traditional prevention did not decrease injury prevalence but reduced the proportion of overuse injuries. Since performance level and training time increased over the study period, without a concomitant increase in injury's, it can be hypothesized that prevention contributed to performance enhancement. The concept of a learning effect, or the preventive influence, of an injury is evoked. The idea that injuries are part of athletic development (performance) and might not be reducible below a certain threshold is also discussed.

Résumé

La prévention des blessures est une priorité dans le domaine de la médecine du sport et de la promotion de l'activité physique, surtout chez les jeunes. Les blessures sportives peuvent mener à des handicaps et au désengagement sportif à moyen-long terme. Le suivi des jeunes sportifs des classes «sport et art» du Canton de Genève sur les 35 dernières années a permis de se faire une idée de la prévalence des blessures chez le jeune sportif et de comparer ces données à la population générale. Ceci nous a également permis de nous faire une idée de l'influence de la prévention sur le nombre de blessures. Nous avons trouvé que la prévalence des blessures chez les sportifs (0.27 blessures/jeune/an) n'est pas significativement différente de la population générale de jeunes du même âge, mais que les blessures chez les sportifs se produisent plutôt lors de leurs activités sportives. La prévention traditionnelle n'a pas eu d'effet sur la prévalence des blessures mais a permis de réduire la proportion de blessures de surcharge. Puisque le temps d'entrainement moyen et la performance ont augmenté pendant la période d'étude, sans augmentation concomitante des blessures, il peut être hypothétisé que la prévention a contribué à une augmentation de la performance. Le concept d'un effet éducationnel, ou préventif d'une blessure est évoqué. L'idée qu'une blessure peut faire partie du processus d'apprentissage (performance) de tout sportif, et qu'il y ait un seuil, non reductible, est également évoqué.

Introduction

The title of this text gives an idea of the perspective that will be taken to try and cover the subject of sports injuries in youth. Some distance will be taken from individual sports, sex differences and sport specific injuries to take a global look at sport injuries in Swiss youth and in particular at the children enrolled in the "Sport and Art" classes of the Canton of Geneva.

Epidemiology and prevention of injuries has been of interest for a number of years and for a number of reasons. The first recordings of a sport medical concept in Geneva go back to 1931 where 2000.– SF were allocated by the state to establish a sports medical control. The goal at the time was to "to advise certain children about the dangers linked to the abuse of badly supervised sport and to detect certain affections linked to sport…".

This then led to the creation of a Sports Medical Institute in 1946 for the following reason "Beyond the fact that this Institute is demanded by all the sports societies, the commission estimated that the question had been lingering for too long to push it out to 1948. They estimated that Geneva had the lead in this field and that Zurich might take it, if this Institute is not created", the institute unfortunately no longer exists but has been replace by other structures in the canton.

Apparently, there has been a long standing concern about the dangers of sport on the health of youth. Inactivity is a more recent preoccupation and can, to a certain extent, be linked to sports injuries. In New South Wales (Australia) 26% of parents claim that the risk of injury had stopped them from enrolling their children in a sporting activity [1].

There no longer seems to be any doubt on the beneficial health and social effects of sport and physical activity [2]. However, the belief that sport is dangerous seems to remain present in many people's minds. A number of pathologies can be linked to sporting activities; injuries (overuse, accidents), sudden death, metabolic disturbances, overtraining, burn out, eating disorders, dehydration, hypo and hyperbaric pathologies and finally Doping.

It is therefore important to establish the extent of sports injuries and the potential means of preventing them, as well as attempting to adapt the public's perception of sport.

Injury prevention has therefore become an important part of sport, with the belief that sport can become safer. This approach is supported by numerous authors of whom some have predicted that a 75% decrease in injury rates was possible [3]. The International Olympic Committee referred to prevention as the IOC's "natural duty to protect athletes and uphold the true values of sport" (Juan Antonio Samaranch) [4].

Extent of the Injury problem in Switzerland

The Bureau for the Prevention of Accidents (BPA) maintains a database on sporting injuries in Switzerland [5] based on an extrapolation from the national registries and a study done on children and seniors. This permits to see which sports generate most injuries, which age groups are most concerned, number of deaths and the evolution of injuries over time. The essential drawback of this kind of database is that it does not give any idea of exposition and injury severity.

For 2003, the data shows that youth under 16 were the greatest purveyors of sport injuries compared to the 17–25, 26–45, 46–64 and 65+ age groups. The 2010 data compares the 0–16 to the 17–64 group, which makes it harder to compare due to the large disparity in population size. Compared to other sports, ball sports (33% of total injuries), winter sports (32%) and gymnastics (8%), have the highest injury rates. Deaths during sport involved mainly mountaineering (36% of total), winter sports (27%), water sports (17%), free flight (11%) and horse riding (4%). As to the evolution over time, the total number of injuries per year has stayed more or less constant since 1998 at around 285,000 for the Swiss population (6M), with some yearly fluctuations.

More recent data from the BPA shows a discrete rise in the overall number of injuries since 2008 (403,000), despite numerous preventive interventions. These data are of course, overall injuries and do not take exposition into consideration.

An extensive study was carried out in 1987–1989 by de Loës et al. [6] on a group of 14–20 year old sportsmen involved in the Swiss "youth and sport" program. It concerned 350,000 sportsmen, participating in 32 different sports over 3 years, representing 13.2 million hours of exposure and resulting in 16,120 injuries (about 5000/year)

In general, men had more injuries than women. In men, the highest rate of injury per 1000 h was in Ice hockey (.86) followed by handball (.72) and Soccer (.66). In Women handball was responsible for most injuries (.76) followed by Soccer (.66) and Basketball (.49). Comparison by sex showed significantly higher rates in women's basketball, alpine skiing, volleyball and alpinism compared to men. The inverse was found in hiking.

Considering the paucity of literature including exposition, this study gives us valuable information on the sports and the sexes that should be given special attention in a preventive perspective. There is unfortunately very little data concerning sports injuries in children that takes exposure into consideration and this certainly opens a field for future research [8].

The "Sport and Art" classes in Geneva

Classes offering an adapted timetable, a sports medical follow up and a preventive program have existed in Geneva schools since 1980. Each year, about 160 youth between 12 and 16, practising sport at a high level (average 10 hours/week), in 20 different sports and arts are enrolled. The number of classes has increased considerably over the last few years to include team sports like football and Ice hockey. There are now about 300 places in secondary school and about 230 in senior secondary school.

Data collection was established from the beginning, using school nurses and an annual medical check up. The first notions of incidence and risk factors were presented by Schnyder [8] in 1986 and showed an overall incidence of about 0.9 injuries per 1000 hours of sport and risk factors like delayed bone age was established as an important factor for overuse injuries.

Following indications in Van Mechelen's [9] definitive sequence of prevention, we conducted, in 1994, a cross-sectional study of 97 youth (51 girls, 46 boys, age 12–16) from the "sport and art" classes in order to explore the aetiology and mechanisms of sports injuries [10]. The results showed no difference in the absolute number of injuries from age 12 to 16 (.61injuries / 1000h of sport), a sports injury being defined as an injury having entailed at least a 3 day interruption in training.

A similar trend in injuries and age was also found in Michaud's study on Swiss youth, who found a better correlation between injuries and puberty than with age [10]. We however, showed that the proportion of overuse injuries increased with age from 11% at age 12 to 48% at age 16. It is also noteworthy that 48% of the injuries in the 12–13 year old group occurred outside their sports activities.

Intrinsic motivation was the only risk factor significantly correlated to injuries (p=.017) in our study, meaning that the highly intrinsically motivated sportsmen would tend to be more at risk for injuries. Factors like endurance, flexibility, explosive power, warm-up, age and training hours showed no significant correlation.

The transversal study conducted in 1994 was also aimed at establishing preventive behaviour. Noteworthy aspects were; warm up was conducted by 90% of the young sportsmen, stretching after sport was performed by about 50%, self estimated insufficient sleep, recuperation and leisure time became increasingly frequent going from age 12 to 16. At age 16, 50% of the group estimated having insufficient leisure time, 40% insufficient sleep time and 30% insufficient recuperation time.

A recent study on sleep among our young sportsmen showed considerable disparity in sleep between students and between sports. It was, for example, noted that the average number of sleeping hours of one group of sportsman was on average half an hour shorter than the average for the rest of the group. This led to refocusing on sleep in that group, which is estimated to be an important protective factor, when it comes to sports injuries.

Following these observations we introduced a prevention program including: a pre participation evaluation, an annual physiological evaluation, diet and psychological assessment, class interventions (diet, psychology, medical), interventions in clubs, doping prevention and an information journal to parents, coaches and school staff on injury prevention. We tried to bear in mind that any preventive intervention has secondary effects and could end up worrying participants [12]. We also found it difficult to implement certain risk factors, like strong intrinsic motivation, knowing this might be one of the key factors for performance.

An evaluation was carried out over the next 12 year period and included all parameters mentioned above; injuries, exposure, injury context and sport. Exposure was difficult to evaluate for some sports. e.g. Skiing and Ice hockey are very seasonal sports, difficulty in calculating competition exposure (played 10 or 90 minutes), some sports have long hours but low intensity etc. We however feel that the bias stayed similar from year to year.

Over the 12 year period, there was an initial, non significant (RR=1.20, p=.28) drop in overall injuries per 1000h between 1990 (0.84 injuries per 1000h) and 1998 (0.6 injuries per 1000h). Since 1998 there has been a relatively constant incidence of injuries fluctuating around 0.6 injuries / 1000h *(Fig 1)*. Considering the relatively heterogenous group of sports in our cohort, combining team sports with individual sports and girls with boys, a value of 0.6 injuries per thousand hours is relatively close to that found in Theisen's publication on injury risk in team and individual youth sports (average: .45 injuries/1000h) [13]. It must be taken into consideration that certain high risk sports, like motocross and BMX, were included in our group.

However when looking more closely at the type of injury, one notices a significant decrease in overuse injuries (RR=2.05, p<.01), compensated to a certain extent by a concomitant increase in accidents, thus maintaining the same overall incidence of injuries *(Fig 2)*. It is, as such, difficult to ascertain whether this is a high or a low level of injury because we do not have a control group. These values have stayed more or less constant over the years as has the proportion of overuse injuries.

Analysing our data as "injury per child per year", permitted to compare our data with two studies done in the general population. The first study is a hospital based study in a mid-size nearby city in 1990 [14] and the other; a school based survey done in 1996 in the neighbouring Canton of Vaud [11]. Both studied children in the same age group. Our data shows an overall injury incidence of about 0.27 injuries per child per year in the "sport and art" classes compared to 0.22 (RR=1.24) for the Hospital based study and 0.24 (RR=1.17) for the survey. There was no statistical difference in the injury incidence between the "sport and art" classes and the age matched general population. It must be take in to consideration that the hospital based study only included children having sought medical care, that the survey included all injuries "having needed a nurses or a physicians care" and that the studies were conducted during different time periods than ours.

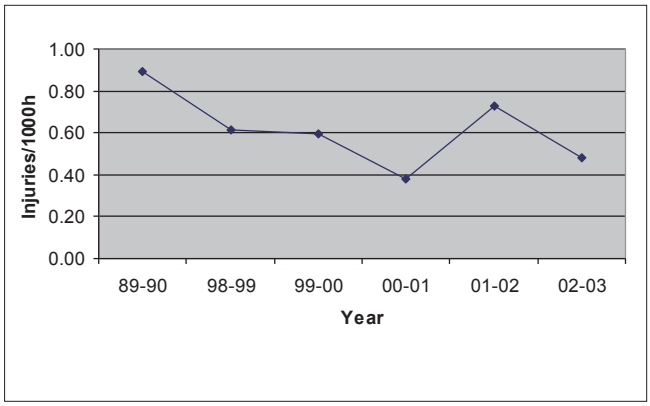

Figure 1: Number of injuries per 1000 h of sport

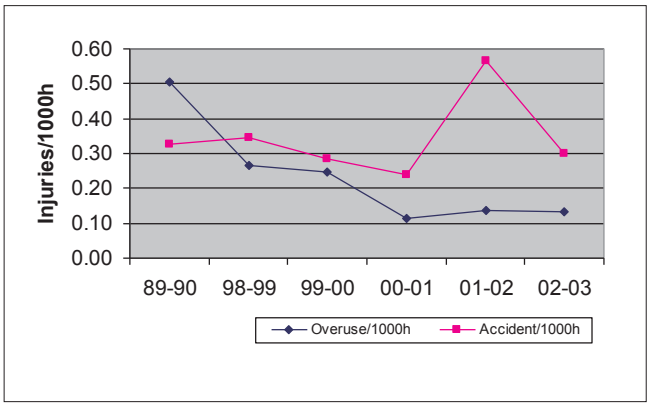

Figure 2: Number of overuse and accidental injuries per 1000 hours of sport

As to the circumstances leading to injuries, training was consistently the environment in which most injuries occurred *(Fig 3)*.

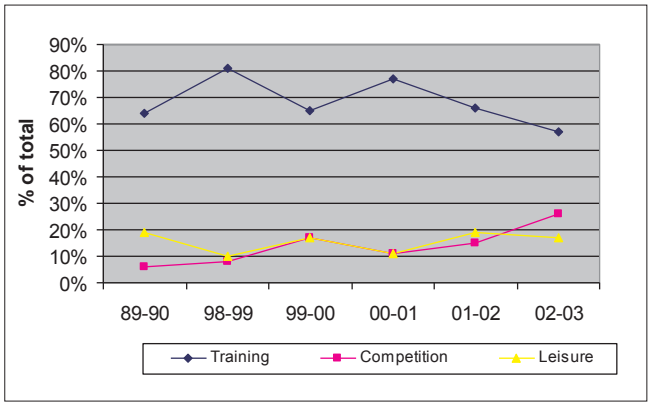

Figure 3: Circumstances leading to injury as a % of total injuries

Does injury prevention work?

Consulting the evidence on injury prevention in sport leaves a number of question marks, the majority of studies not fulfilling evidence based inclusion criteria [15,16]. The only significant risk factor systematically described in the literature being a pervious injury. A systematic review done in 2007 by Abernathy [17] however shows a short term effect of preseason conditioning as well as functional training, education, strength and balance programs that are continued throughout the playing season on injuries in adolescent sport. This is only partially backed up by Aaltonen's systematic review where he claims that "the evidence for the effectiveness of injury prevention is based on feeble to moderate evidence" [18].

Referring to the above data, one can conclude, that the preventive approach we used might have led to an initial non significant decrease in overall injuries between 1990 and 1998 followed by a stabilisation. It did not, in any case, fulfil the 75% potential decrease in injuries suggested by some authors [3]. We did however see a significant (RR=2.05) decrease in overuse injuries between 1989 and 2003, which tends to confirm what some authors have found; that prevention might be more effective in preventing overuse injuries than the overall number of injuries in youth [19].

As to sport specific and injury specific interventions, there now is substantial evidence showing the short term effectiveness of proprioceptive exercises for previously injured ankle joints [20,21], preventive exercises for muscle and ligament injuries [22,23], helmets, and eyewear [24], to prevent certain sports related injuries.

Despite some success in short term reduction in injuries, the overall number of injuries on sports practitioners does not seem to decrease as observed in our young sportsmen and in the Swiss National database. This does indeed question the traditional approach to prevention (education, advice, preventive exercises) and encourages us to look more closely at other forms of prevention, like structural prevention (rules, regulations) or better understand why our traditional approach is not as effective as expected.

A number of studies using a more structural approach have shown some success, whether it be in reducing eating disorders in dancers and ski jumpers by setting minimum BMI values, or by limiting the number of throws in youth baseball players [25]. This approach certainly has interesting perspectives, but has the disadvantage of changing rules which isn't always appreciated by sports practitioners.

Our data also suggests that participating in intensive (about 10h a week) sport may not result in more overall injuries than the every day life of a similar age group. It is however probable that because of the amount of time spent doing sports, injuries tend to occur more frequently during sport. This is an important and positive message for the exercise promotion and sports community.

This data also evokes the concept that there might exist a threshold minimum amount of injuries sustainable by youth, whether it be through sports or otherwise, permitting to acquire neuro-motor and cognitive mechanisms to avoid future injuries (learning process).

It is conceptually quasi-impossible to reach maximum performance without taking any risks and a majority of young sportsmen will agree that an injury is part of the learning process of most sportsmen. This underpins the concept of a limit to prevention, the effect of prevention and questions us on where this limit might be situated [26]. It also engages us to think about the potential preventive effect of injuries, in the sense that an injury will lead the athlete to be more careful, act differently, protect himself or be more apt to detect his limits when exposed to future training loads. Some evidence supports this idea. Hasler's paper [27] on the use of Helmets before and after skiing accidents clearly shows a change in behaviour before and after an injury. This, to some extent, is common sense; the human being usually wanting to avoid being exposed to danger or pain repetitively. Let's not forget that common sense also has a strong preventive effect.

"Performance changes", which are generally omitted in injury prevention research, is not accounted for in most studies even if it is generally agreed that prevention contributes to both injury prevention and performance [28]. Van Mechelen's model of prevention becomes more pertinent if performance is accounted for or if the baseline of performance stays constant over time. In the case of our young sportsmen, training hours increased by 2 hours per person per week between 1990 and 2004 and comparative performance was estimated to have increased by about 20% according to some national coaches (unpublished data). One could therefore conclude that our prevention efforts permitted these children to train more and increase their performance without increasing the number of injuries.

It would therefore be of interest to establish some means of evaluating performance, to better understand the effect of prevention, or accept that a certain part of the benefit of prevention goes to performance.

One can but underline the importance of physical activity for health and even for injury prevention. Inactive (clumsy) children seem to be at a higher risk for injury [29] than the average population, whilst competitive young sportsmen do not seem to be at increased overall risk.

Sport must however be played in good conditions, in accord with the children's bill of rights in sport [30] and using the evidence based protective approaches, including changes in rules and regulations.

Performance must be accounted for when looking at the influence of prevention, but more research will be required to better understand the implications.

As to the nature of sport, Chalmers comments; "this is an

aspect of life in which individuals deliberately push their bodies to the threshold of human tolerance. This motto is embodied in the motto of the Olympic Games, the most important sporting event on earth: 'Citius, Altius, Fortius' or 'swifter, higher, stronger'" [15].

Seen this way, prevention may be one of the ways to push the limits of human performance, but not necessarily a way of reducing the number of injuries.

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