

## Low injury rates in elite athletes

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### Abstract

A group of 453 elite young athletes (231 boys, 222 girls) in five two year age groups from 8-16 years of age was followed up for two years in order to identify self reported injuries over that period. Four sports were studied, namely football (soccer), gymnastics, tennis, and swimming. The injury rate was low with just over half the children suffering one or more injuries per year, with the majority of those injured sustaining one injury only. Over the two year period of intensive sporting activity this amounted to less than one injury per 1000 hours of training. The highest risk of injuries was in football (67%) and the lowest in swimming (37%). Most injuries (70%) were acute and of a minor nature, although overuse injuries did require longer periods off training and competition than acute injuries (20 v 13 days). Footballers appeared to sustain more significant injuries than other sports as judged by the time required to resume training and/or competition (16 days after acute and 57 after overuse). No significant associations were found between injury rate, injury severity, sex, and pubertal status with the single exception of female gymnasts in whom more injuries occurred in the latter stages of puberty. Only four of the 453 athletes reported injury as a reason for retiring from their chosen sports. Most injuries in elite young athletes are minor, their prevalence is low and, at least in the short to medium term, do not constitute a significant health problem.

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Considerable concern has been expressed in recent years over the growing number of children undergoing treatment for sports related injuries.<sup>1</sup> This concern has not, however, been substantiated by population based surveys when comparing rate of injuries in sports to the rate in free play activities.<sup>2</sup> Sports activities impose forces of a higher intensity and frequency than those associated with normal life and in the past decade there has been an apparent increase in the number of exercise related injuries.<sup>3</sup> Not only have numbers of children involved increased but competition at international level in sports such as tennis, gymnastics, and swimming is now taking place at a relatively young age.<sup>4</sup> The fact that children in their early teens may have already undergone intensive training and high level competition for several years<sup>1 4</sup> is due to the 'catch them young' philosophy and the widespread belief that in order to achieve

international success at senior level it is necessary to start intensive training before puberty.<sup>1</sup> This increase in the number of children taking part in organised competitive sport has resulted in the drafting of clear guidelines designed to reduce injury rates.<sup>5 6</sup> Concern has been expressed over a potential epidemic of both acute and overuse sports injuries as children make the transition from a variety of free play movements to the specialised pattern of movements imposed by a single competitive sport.<sup>7 8</sup>

During the period of rapid growth, adolescents have been reported to be particularly vulnerable to injuries, at least partially due to an imbalance between strength and flexibility.<sup>7</sup> Sports injuries may adversely affect both growing bone and soft tissues,<sup>9 10</sup> and could result in disturbance to growth and long term damage.<sup>11</sup> Boys have been reported as being twice as vulnerable as girls as a consequence of their preference for high risk contact sports and their higher level of sports activity.<sup>12 13</sup> We therefore set out to establish the frequency and pattern of injuries in a large group of children and adolescents who were training intensively and who were considered by their coaches to be an elite group for their chosen sport.

### Patients and methods

The training of young athletes study (TOYA) set out to establish the positive and negative effects of intensive training in four sports, namely gymnastics, football (soccer), swimming, and tennis. The study was of a mixed longitudinal design and ran over a three year period from 1987 through to the end of 1990. A total of 453 children (231 boys, 222 girls) were recruited. Details of sport and age cohorts are shown in table 1. In years one and two of the study, subjects were medically examined and subjected to a medical interview in order to identify injuries that resulted in discontinuation of training and/or medical treatment in the previous year. The causes of sports injuries were classified as acute (onset from a single clearly remembered event) or overuse (no clear onset could be

Table 1 Number of children recruited by birth year and sport (total sample=453)

Birth year	Football	Gymnastics	Swimming	Tennis
1971	12	20	24	26
1973	25	28	30	32
1975	27	28	30	38
1977		21	30	39
1979		22		21
Total	64	119	114	156

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identified). A sports injury was defined as one which occurred as a result of participation in sport which had one or both of the following consequences: (1) a reduction in the amount or level of sports activity or (2) need for treatment or advice. Injuries were grouped according to the number of days lost to training. Injuries were further classified as occurring during training and in competition and/or outside the chosen sport. Sexual maturity was visually assessed using the indices developed by Tanner.<sup>14</sup> Possible associations of injury with pubertal stage, chosen sport, and sex were examined using contingency tables and  $\chi^2$  tests taking a level of 3% as significant.

**Results**

All 453 children seen in the first year of the study completed the semistructured interview and in the second year the 406 children remaining in the study were interviewed again. In the first year 222 children were injury free, 148 sustained a single injury, 55 two injuries, and only 28 three or more injuries. The second year results were virtually identical with only a single child sustaining five injuries in that year. The overall incidence of injury was 54 for every 100 athletes; however, 14 of these injuries occurred outside the chosen sport leaving an incidence of 40 injuries per 100 children directly attributable to training and competition. There were differences between sports. The lowest incidence was found in swimmers with 37%; this compared with tennis players 52%, gymnasts 65%, and footballers 67% and these differences were significant ( $\chi^2$  22.3,  $p < 0.001$ ; fig 1). Most injuries occurred in training rather than competition and this was particularly true for gymnastics. However, in footballers, well over half occurred during competition (fig 2). Over half the injuries reported outside training or competition were due to some other sporting activity. In boys these were usually due to participation in contact team sports (rugby and/or football). During each 12 month period, the amount of time spent in training was also noted and it was therefore possible to relate injuries to

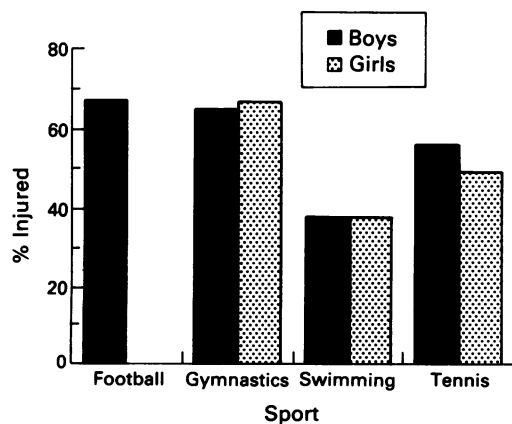


Figure 1 Percentage of subjects injured at least once over the first two years of the study. No female football players were included in the sample. Note the higher rates for football and gymnastics, the similar rates for boys and girls and the lower rates in tennis and swimming. This sports specific trend was highly significant ( $\chi^2$  22.3,  $p < 0.0001$ ).

the number of hours trained. When the rate of injury per 1000 hours trained was calculated, it was found that the overall rate was extremely low with all sports having less than one injury per 1000 hours trained.

There was equal likelihood between the sexes of sustaining an acute or overuse injury. However, there were differences between sports, with swimmers being more likely to sustain overuse injuries (63% of all injuries in this group). In footballers, overuse injuries accounted for only 15% of the total reported whereas in tennis and gymnastics they accounted for approximately one third (fig 3). Of the 492 injuries reported over the two years, just under one third (148) were classified as overuse (table 2).

There was little difference between male and female athletes in the anatomical location of injuries, apart from female gymnasts, who suffered more ankle and foot injuries than male gymnasts. Most football injuries were to the ankle and foot and, as expected, footballers

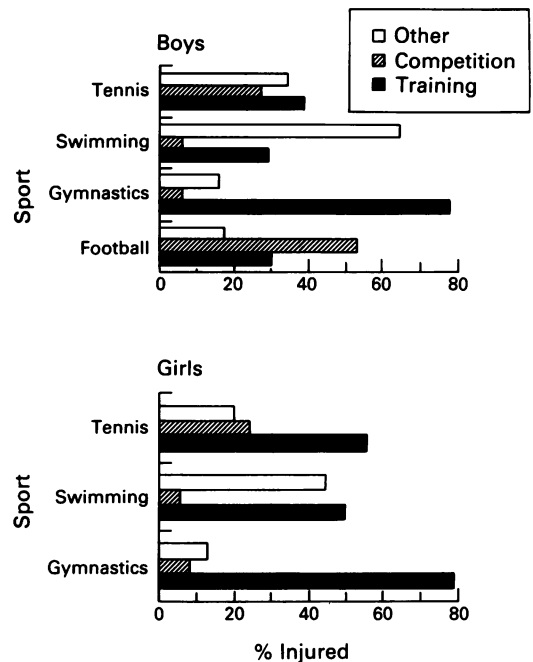


Figure 2 Percentages of injuries occurring during training, competition and outside the athletes' chosen sport. Note the large proportion of injuries during gymnastics training and the relatively low rates attributable to training and competition in swimming. These differences were highly significant ( $\chi^2$ ,  $p < 0.0001$  for boys and 24.9,  $p < 0.0001$  for girls).

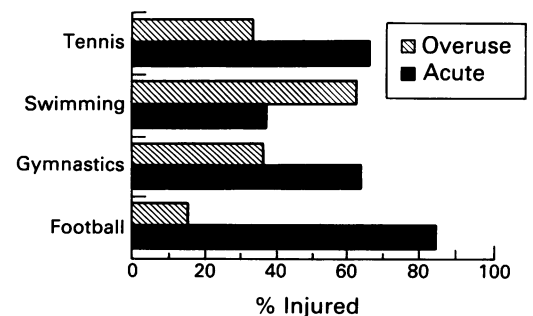


Figure 3 Percentages of acute and overuse injuries by sport for boys and girls combined. Note the high proportion of acute injuries in footballers with the reverse pattern in swimmers ( $\chi^2$ , 35.4,  $p < 0.0001$ ).

Table 2 Overuse injury diagnoses

Diagnosis	No (%) of occurrences
Epiphyseal	1 (0.7)
Osteochondrosis	39 (26.4)
Spondylolysis	1 (0.7)
Stress fracture	5 (3.4)
Low back pain	19 (12.8)
Muscle strain	6 (4.0)
Other/unspecified	77 (52.0)
Total	148 (100)

suffered the largest number of acute injuries to the knees. In swimmers the shoulders were found to be the most vulnerable site (40% of total), and in tennis players there was a fairly even distribution of injuries over the whole body, although a slight preponderance was noted for injuries to the ankle and feet (22%).

Severity was assessed by determining the number of days training missed by the young athletes as a consequence of a given injury. Overuse injuries tended to be more severe with an average lay off time of 20 days compared with 13 days after an acute injury. Not only did swimmers have the lowest injury rate (fig 1) but they also appeared to suffer the least severe acute and overuse injuries as they returned to training after an average of five days. Using this criterion, footballers were the most severely injured athletes as they required an average 16 days to return to active sports training after an acute and 57 days after an overuse injury. Although overuse injuries appeared to be the most severe in footballers, this type of injury accounted for less than 20% of all injuries for this particular sport (fig 3). No significant associations were found between the number and severity of injuries and pubertal status with the exception of female gymnasts in whom significantly more injuries occurred in older athletes in stages 4 and 5 ( $\chi^2$  14.7,  $p < 0.005$ ). Only four of the 453 subjects reported injury as the reason for retiring from their chosen sport.

### Discussion

At the outset of the study it was thought that a large number of overuse injuries would be found in this population. However the results clearly showed that most were due to acute trauma rather than overuse and that annual injury prevalence was low. Our findings agree closely with those of a recent review that concluded that child and youth sports are safe and that most injuries are minor and self limiting<sup>2</sup> (our overall incidence of sports related injury of 40 for every 100 athletes being remarkably similar to the 39 injuries per 100 athletes found in a previous report<sup>15</sup>). Most of the injuries sustained were of a minor nature and, while no confirmatory data exist, would probably not exceed the rates of injury expected in free play activities in the general population. It was also of interest that over half of the injuries reported, outside training or competition, were due to some other sporting activity. Although we did not inquire exactly where

these injuries occurred, it was likely that many of them were related to school sports. Concerns about school sports have been raised in the past including poor quality playing fields, inappropriate protective equipment, and inefficient supervision by well meaning but untrained people with limited knowledge of sports physiology and the treatment of sports injuries.<sup>1,2</sup> It has been suggested that quality as well as the amount of training may influence injury rates,<sup>2</sup> an assertion that the present study would support. Contrary to widely held opinion, elite young athletes undergoing intensive training do not appear to be at increased risk of injury. On the contrary, our data suggest a 'protective' effect of high level organised sporting activity. A small number of high achieving individuals, often well publicised, will suffer as a consequence of their sport. Continual improvement in coaching methods and sports equipment should reduce these already low risks even further.

Although only a small number of overuse injuries were found in our sample, parents and coaches should be aware that this type of injury could be prevented by reducing training intensity. It must also be remembered by coaches and parents that the young athlete may be particularly susceptible to overuse injury during the period of rapid growth.<sup>16</sup>

The results presented here require some qualification as this was a relatively short term study and further research is required to establish whether there are thresholds of training above which the likelihood of injury is increased. The present cohort should also be assessed again in the future in order to establish the occurrence of further overuse injuries and to identify any long term sequelae.

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