

# Sports activities related to injuries? A survey among 9–19 year olds in Switzerland

P-A Michaud, A Renaud, F Narring

## Abstract

**Background**—Most data on sports injuries are gathered in clinical settings so that their epidemiology in the general population is not well known.

**Objective**—To explore the link between sports injuries with the type and the amount of sports activity and biological factors.

**Methods**—In 1996, 3609 in-school adolescents 10–19 years (1847 girls and 1762 boys) participated in a regional survey. This included anthropometric measurements and a self administered questionnaire.

**Results**—Altogether 28.2% of girls and 35.9% of boys reported one or more sports injuries during the previous year and 2.1% of girls and 6.5% of boys reported at least one hospitalization due to a sports injury. Using the mean rate of injuries as reference level, some sports are highly related to injury occurrence: body building (relative risk (RR) 1.7, 95% confidence interval (CI) 1.5 to 1.9), skateboarding and roller-skating (RR 1.6, 1.4 to 1.8), athletics (RR 1.5, 1.3 to 1.7), snowboarding (RR 1.5, 1.4 to 1.6), basketball (RR 1.3, 1.2 to 1.4), soccer (RR 1.3, 1.2 to 1.4), and ice hockey (RR 1.2, 1.1 to 1.3). Using a logistic regression, several variables associated with a higher risk of injury were identified: the amount of physical activity, high risk sports, and Tanner pubertal stages.

**Conclusion**—The risk of sports injury increases not so much with age but with exposure to specific sports and with pubertal development.

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In most industrialized countries and increasingly in developing countries, injuries represent a leading cause of death and a substantial source of disability and distress.<sup>1,2</sup> Whereas most of the deaths are linked with traffic accidents, sports represent, beyond the age of 10, an important source of non-fatal injuries<sup>3–5</sup> and as such, often lead to impairment in physical and social activities.

Epidemiological data related to injuries can be gathered in different ways:

- Many reports are provided by hospitals and emergency facilities<sup>6–8</sup> and as such do not include injuries treated by pediatricians or general practitioners.
- To refine the quality of the data and focus on the circumstances of the injury, some researches have looked prospectively at the

occurrence of sports injuries within defined populations.<sup>9–11</sup> These studies bring interesting clues as to the underlying mechanisms of injury, but do not allow for estimates of incidence rates in the general population

- To address the issue of injury incidence in large populations, several surveys have relied on self report by parents<sup>12</sup> or by the adolescents themselves.<sup>13–15</sup> Such inquiries can be made by phone interviews<sup>12,15</sup> or self administered questionnaire.<sup>13,14</sup>

During 1997 and 1998, we conducted a regional survey involving about 4000 children and adolescents, 9–19 years old, focusing on physical activity and fitness.<sup>16</sup> The survey included two items related to injuries in general, including sports. The use of this database allowed for a population based estimates. Specifically, the objectives of this survey were:

- To assess the rate of reported injuries and reported hospitalizations due to sports activities in a population of 9–19 year old children.
- To investigate whether injuries are linked with the practice of different types of sports.
- To address the relationship between sports injuries and the amount of sports activity, as well as some biometric factors.

## Methods

The study was conducted between September 1996 and March 1997 in primary and secondary schools and vocational centers in the canton of Vaud, Switzerland (around 600 000 inhabitants). Two step cluster sampling was used to select classes from 4th, 6th, 8th, 10th, and 11th grades and stratification was used to assure representation of the different parts of the canton and various educational curricula. From the reference population of 30 700 students, 3754 were selected. Of these, 3.8% were absent or refused to participate. In the final sample (n=3609), 4% answered a self administered questionnaire but did not participate in fitness testing and biometric measurements because they were absent or exempted from sport classes. Thus, complete data were obtained from 3516 children and adolescents 9–19 years old. The main characteristics of the sample are shown in table 1; elementary school is grades 1 to 5, secondary school grades 6 to grade 9; both high school and professional centers include pupils 16–19 years.

There is no standard to measure physical or sports activity.<sup>17–19</sup> Physical activity includes on the one hand “habitual physical activity”, for example walking, climbing a staircase, etc and on the other hand “moderate to vigorous activities” inducing sweating, a rise in heart rate, often related to formal and informal

Groupe de recherche sur la santé des adolescents, Institut universitaire de médecine sociale et préventive, Bugnon 17, CH 1005 Lausanne, Switzerland  
P-A Michaud  
A Renaud  
F Narring

Correspondence to:  
Dr Michaud  
Pierre-Andre.Michaud@inst.hospvd.ch

Table 1 Sociodemographic characteristics (%) of sample of children with school injuries by school grade

	Elementary school (9–11 years)		Secondary school (12–15 years)		High school (16–19 years)		Professional centers (16–19 years)		All (n=3516)
	Girls (n=389)	Boys (n=342)	Girls (n=760)	Boys (n=740)	Girls (n=475)	Boys (n=378)	Girls (n=147)	Boys (n=285)	
Location									
City	20.2	16.8	47.8	41.3	52.0	52.8	55.8	46.8	58.2
Rural areas	79.8	83.2	52.2	58.7	48.0	47.2	44.2	53.2	41.8
Marital status of parents									
Live together	82.6	85.3	80.1	80.5	77.7	80.9	72.6	76.2	80.1
Separated or divorced	16.1	12.4	17.0	17.3	20.0	15.1	21.9	19.6	17.1
Father/mother deceased	1.3	2.3	2.9	2.2	2.3	4.0	5.5	4.2	2.8

sports activities or heavy physical activities (for example using a bicycle to go to school). These components were assessed by a self administered questionnaire:

- Subjects were given a one page diary for them to list the number and types of sports episodes (of at least 15 minutes' duration) in which they had engaged during the last seven days. This made it possible to assess the type of sports practised and the number of episodes of sports over one week.<sup>20</sup>
- The questionnaire also included questions pertaining to formal (membership in sports clubs or teams) compared with recreational sports activities, as well as the general level of physical activity, like walking or riding to school, or time devoted to activities which induce sweating.<sup>17</sup> It also comprised items on health and lifestyles as well as socio-demographic characteristics.
- Finally, the questionnaire included two questions related to injuries from sports and from other causes (fig 1). In this survey an injury (in French, an "accident") was

defined as "any injury having required health care by a nurse or a physician".

Three versions (with simplified, shorter versions for younger subjects) were prepared and pre-tested in different classes and settings. Anthropometric data recorded by trained nurses included blood pressure (mercury sphygmomanometer), height and weight, skin-fold thickness (bicipital, tricipital, scapular and suprailiac). Tanner stages 1 to 5,<sup>21</sup> describing the different phases of pubertal development, were self evaluated from drawings.<sup>22</sup> Chronological age and biological stage were well correlated ( $r=0.82$ ).

The study was submitted to the Ethics Committee of the Faculty of Medicine, Lausanne University.

Data were processed using SPSS. Bivariate analyses were performed using  $\chi^2$  and confidence intervals; relative risks linked with different sports practised were calculated using the mean rate of accidents as the reference level. Multiple regression analysis was performed to disentangle the respective weight of physical activity and biometric variables in the occurrence of a sports injury. All results show 95% confidence intervals. A detailed description of the survey methods as well as the main results are available elsewhere.<sup>16</sup>

## Results

Sports activity, as assessed by the reported number of sports episodes/week,<sup>23</sup> increased from 9 until 12 years of age, remained steady until 14 years, and decreased thereafter. Among boys, it ranged from 6–9 episodes/week, while among girls it ranged from 4–6. Participation in formal sports activity, defined as participation in sports club activities, was higher among boys than girls: from 12 years on, around 65% of boys reported sports club participation during the previous year, whereas among girls it was 40%.

Within the whole sample, 32.1% of participants reported having sustained any kind of injury during the preceding 12 months (girls: 28.2%, boys: 35.9%;  $p<0.001$ ). As shown in table 2, the most frequent cause of injury was

Table 2 Differences in types of injuries reported during the preceding 12 months by sex

	Girls (%)	Boys (%)	$\chi^2$
Sports	22.8	29.8	$p<0.001$
Road traffic	2.6	5.4	$p<0.05$
Occupational	2.6	9.0	$p<0.05$
Other	9.1	10.0	NS

(1) **During the last 12 months, did you sustain an accident/injury which required the intervention of a nurse or physician?**

1 answer per line please

	Yes	No
a. A traffic injury	.....0.....	.....0.....
b. A sports injury	.....0.....	.....0.....
c. Another injury.....	.....0.....	.....0.....

What kind? \_\_\_\_\_

(2) **During the last 12 months, how many times have you been in a hospital (at least 1 overnight)?**

..... time

**If yes, for what reasons?**

several answers possible

0 A sports injury  
0 A traffic injury  
0 Another type of injury  
Which one? \_\_\_\_\_

0 An illness

0 Another reason?  
Which one? \_\_\_\_\_

Figure 1 The two questions relating to accidents/injuries on the self administered questionnaire.

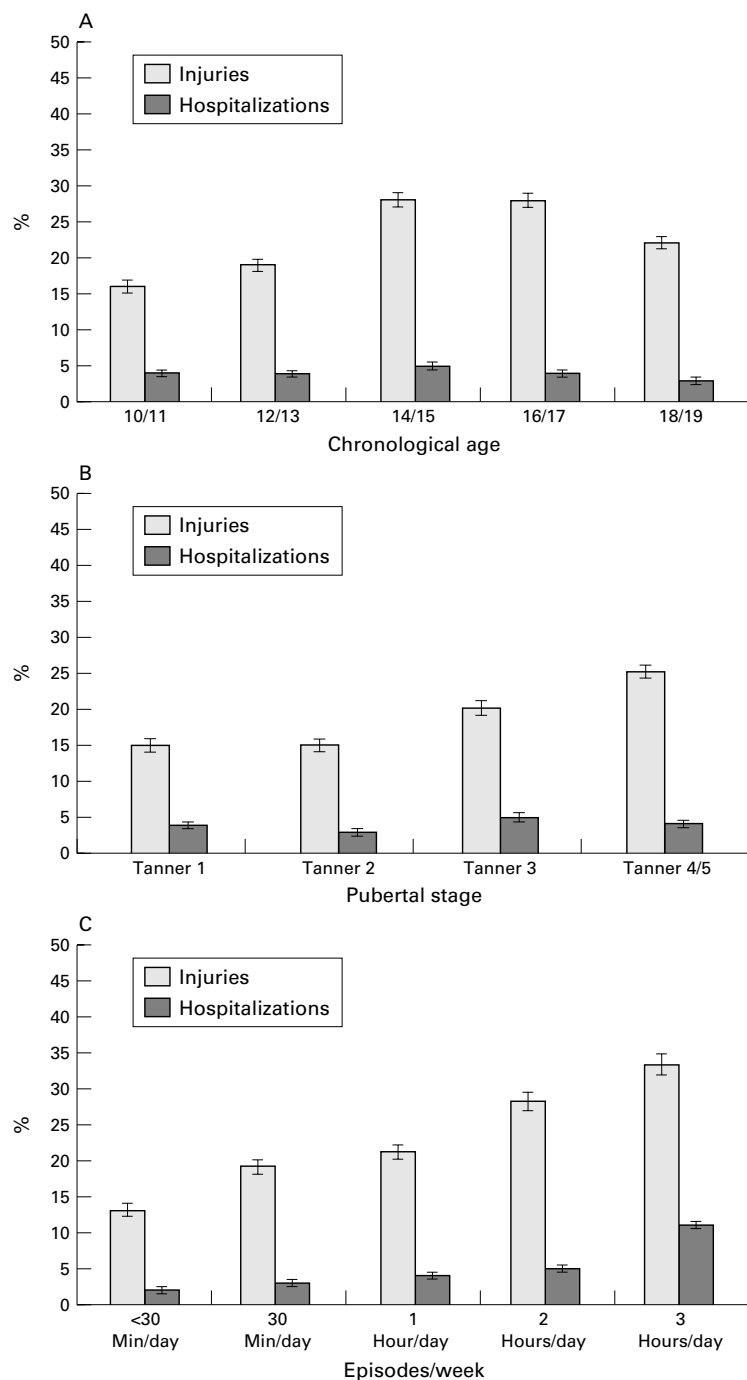


Figure 2 Per cent of respondents (with 95% confidence intervals) treated or hospitalized for a sports injury during the preceding 12 months (A) by chronological age, (B) by pubertal stage (= biological age or Tanner stages), and (C) by reported amount of weekly physical activity (defined as activities leading to sweating).

sports activity, which accounts for more than half of the total. Moreover, 2.1% of the girls and 6.5% of the boys were hospitalized for a sports injury during the preceding 12 months. The frequency of injury increased with age until 16 years of age and then decreased (fig 2A), that is, the same pattern as the sports activity. It also increased with pubertal stages (fig 2B). Finally, the occurrence of sports injury and of hospitalization was closely linked with the amount of vigorous physical activity, when defined as weekly episodes of activities leading to sweating (fig 2C).

### Key points

- Greater involvement in sports is associated with a greater risk of injury, both among males and females.
- Risk of sports injury increases not so much with age but with exposure to specific sports.
- Risk of injury is also related to pubertal development.
- Coaches and physical education teachers should take account of limitations arising from the adolescent growth spurt.
- Community and legislative interventions targeting healthy sports environments should be encouraged.

Using the mean rate of injuries as reference level, six activities were clearly associated with an excess of injuries (table 3): so called “extreme sports” like skateboarding, rollerblading, and snowboarding, as well as sports like soccer, athletics, and body building. To identify factors most strongly associated with a sports injury, we performed several logistic regression analyses including all variables associated with the occurrence of injury in the bivariate analyses. These were gender, chronological age, pubertal stage, body mass index, amount of physical activity, participation in risky sports, participation in formal and informal sports sessions, and use of television. The final model is shown in table 4. The three factors significantly associated are the amount of physical activity, type of sport practised, and pubertal stage.

### Discussion

In our sample, and using our definition, sports activity is the leading cause of injuries among children and adolescents. These injuries are much more prevalent among males than among females and also more frequent among older adolescents. Greater involvement in physical activity and sports is linked with a greater risk of injury. Specific types of sports

Table 3 Relative risk of injury (95% confidence interval, CI) for selected sports (using the mean rate of injuries as reference level)

Sport	Relative risk	95% CI	p Value
Body building	1.7	1.5 to 1.9	<0.001
Skateboarding/rollerskating	1.6	1.4 to 1.8	<0.001
Athletics	1.5	1.3 to 1.7	<0.001
Snowboarding	1.5	1.4 to 1.6	<0.001
Basketball	1.3	1.2 to 1.4	<0.01
Soccer	1.3	1.2 to 1.4	<0.01
Ice hockey	1.2	1.1 to 1.3	<0.05

Table 4 Logistic regression: variables significantly associated with the occurrence of an injury during the last 12 months

Variable	OR (adjusted)	95% CI	p Value
Amount of physical activity	1.5	1.4 to 1.6	0.01
Engaging in “at risk” sports	1.5	1.3 to 1.7	0.01
Tanner stage 4 or 5	1.3	1.2 to 1.4	0.05

CI = confidence interval; OR = odds ratio.

expose adolescents to different risks of injury. The risk of injury also appears to be linked to biological development (pubertal stage) more than to actual size and weight, body mass index, or chronological age.

Whatever the approach used, the registration of data pertaining to injuries has several methodological problems.<sup>5</sup> First, many surveys do not focus specifically on sports activities and thus do not allow for an understanding of the circumstances linked with injury occurrence. Second, as we lack a universal definition of a sports injury, it is difficult to compare the data cross nationally. The distinction between formal sports and recreational activities is difficult to delineate. Finally, the choice of an adequate denominator is often difficult. Is the sample studied representative of the reference population? Are the incidence rates calculated per period of time (over a few weeks, months, or one year) or based only on the amount of time devoted to sports?

These methodological difficulties explain why, in the published literature, the rate of injuries linked with sports varies so greatly. Most surveys using referral to hospitals or clinics as their source of data report lower rates than those we found. In the health care setting, in the age range from 10–19 years, the annual rate ranges from 10%<sup>4</sup> to 20%.<sup>3</sup> In these surveys, sports injuries account for only 10%–20% of the total number of injuries (that is, 1%–3% of injured adolescents per year). Conversely, in surveys using self report, sports injuries constitute the main source of injuries among children and adolescents.<sup>12 14 15</sup> This difference is probably due to the fact that only more severe injuries requiring in-depth investigation or care are sent to hospital.

In our survey, sports injuries represent 55%–60% of all self reported injuries, a percentage higher than the usual results reported in other surveys, which approximate 20%–40%.<sup>3 4 12 14</sup> The rate of sports injuries we found is higher than the percentage reported by Bijur *et al* in a survey using parent reports.<sup>12</sup> It is lower, however, than the rate found in a Scottish survey also using self administered questionnaires.<sup>14</sup> In a similar survey conducted in the Netherlands, but limited to the preceding six weeks, only 3% of participants sustained an injury.<sup>13</sup> Extrapolating these results to one year (nine times, six weeks), gives 27%, a rate similar to our results. Thus, our figures are comparable to other surveys using similar methods but remain higher than hospital based studies.

Injuries and hospitalization are much more prevalent among males than among females, but our male to female ratio of 1.3:1 is actually lower than in other reports, where it approximates 1.8:1 or even 2:1.<sup>12 24</sup> The male/female differences are more pronounced for injuries occurring outside the school than during physical education courses.<sup>6</sup> This may be partly due to biological characteristics,<sup>5 25</sup> but is mainly due to more frequent sports involvement as well as greater risk taking<sup>5 23 26 27</sup> among males. Most of the existing literature also show the same increase in the rate of injuries among

older adolescents<sup>6–8 12–14 24</sup> at least until 15–16 years. Thereafter, many studies show a slight decline, mainly attributed to a decrease in exposure to sports activities.

In our study, the risk of injury seemed more closely linked to pubertal stage than to chronological age. Although this result may be artifactually linked with the high correlation ( $r=0.82$ ) between pubertal and chronological age, two hypotheses can explain this finding. First, the pubertal growth spurt is accompanied by a rapid changes in the length of bones. It is only in later years that the bones acquire their final mass.<sup>28</sup> Bonjour *et al* state that “there is an asynchrony between the gain in statural height and bone mass growth. This phenomenon may be responsible for the occurrence of a transient period of a relative increase in bone fragility that may account for the pattern of fracture incidence during adolescence”.<sup>29</sup> Although we do not know of any other study that specifically addresses the relationship between pubertal age and the occurrence of injuries, one study focusing on the relationship between physical fitness, biological and chronological age<sup>30</sup> shows a higher degree of correlation between biological than chronological age or fitness. Another report emphasizes the influence of physical characteristics on sports injury.<sup>31</sup> However, as in our own study, other reports suggest that exposure time is a more important predictor than anthropological factors.<sup>11 32</sup>

The second hypothesis is linked with adolescent neuropsychological development: the rapid modification of the dimensions of the body during puberty can lead to clumsiness because of the time required for the adolescent to integrate his body’s internal scheme. Several factors have been identified to explain why certain sports lead to an excess of certain injuries in comparisons with others<sup>5 7 8 11–13</sup>:

(1) The nature of the sport is obviously a leading factor: some, like rollerskating, expose children and adolescents to falls, while others like football, soccer, or hockey involve participants in close contacts which easily lead to assaults.

(2) As in other similar surveys,<sup>13</sup> our regression analysis shows that both the type of sport and extent of involvement are independently associated with injury risk. Some sports, especially organized sports among teams with heavy schedules or many hours of training, lead to greater exposure. Some authors have shown a direct relationship between the risk of injury and the number of hours of training.<sup>11</sup> In less popular sports, any excess of injury may not be detectable in a population based survey.

(3) Another factor is supervision. Some studies indicate that the occurrence of injury is less probable when there is close supervision by a trained adult.<sup>11 13</sup>

(4) Finally, it may be that some sports attract adolescents who are “risk takers”<sup>27</sup> such as snowboarding.

#### LIMITATIONS

The most important limitation of our study is that injuries and their care, as well as data pertaining to involvement in sports and physical

activities, were self reported. This results in possible recall problems or under or over-reporting<sup>5 12</sup> and the estimation of Tanner stages was self assessed. Although a previous study has shown this to be reasonably reliable,<sup>22</sup> this self assessment is less valid than pubertal status observed directly by trained physicians or nurses. Finally, the incidence of injury might be underestimated, because injured subjects are more likely to be absent from school than those who are not injured. However, only 5% did not participate because of school absence.<sup>16</sup> Another bias, which goes in the opposite direction, is linked with the fact that the injury part of the survey only focused on sports activities. Pupils may have more accurately reported events linked with sports activities than with other situations (for example, road traffic accidents), thus underestimating other sources of injuries.

### Implications for prevention

Given the prominent place of sports in the occurrence of injuries during late childhood and adolescence, health professionals should include in a systematic way a discussion of sports activity and injury prevention.<sup>26 28 33</sup> This should especially be the case when caring for a child or teenager who has sustained repeated injuries. Preparticipation physical examinations are ideal opportunities for such counseling. Coaches and physical education teachers also have an important part to play in taking account the limitations linked with the growth spurt, by insisting on the use of protective equipment<sup>34</sup>, and in promoting warm-up activities. Safety regulations represent yet another way to prevent injuries or their consequences. A recent review underlines the effectiveness of community and legislative interventions like engineering changes to sports environments or mandatory helmet use.<sup>35</sup> Future research targeting adolescents injuries and sports activities should further address the potential role of pubertal status.

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