

## Chapter 4

# **A prospective cohort study on physical activity-related injuries in 10-12 year old children**

*Verhagen EALM, Collard DCM, Chin A Paw MJM, van Mechelen W. A prospective cohort study on physical activity and sports related injuries in 10-12 year old children. British Journal of Sports Medicine. 2009; 43(13);1031-1035.*

**Abstract**

**Objectives:** To describe the incidence and severity of injuries resulting from physical education, sports, and leisure time physical activity in 10-12 year old children.

**Design:** This was a prospective cohort study conducted in primary schools with 996 children aged 12-12 years old as participants. Individual weekly exposure was estimated from baseline and follow-up questionnaires. Exposure to physical education (PE) classes was equal in all schools. An injury was recorded if it occurred during PE class, leisure time physical activities, or sports, and caused the child to at least stop the current activity. Injuries were reported within one week of injury onset. Main outcome measures was injury incidence density

**Results:** During the school year a total of 119 injuries were reported by 104 children, resulting in an overall injury incidence density (ID) of 0.48 per 1,000 hours of exposure (95%CI: 0.38-0.57). Injury ID was lowest for leisure time physical activity, followed by PE and sports respectively. Of all injuries, 40% required medical treatment and 14% resulted in one or more days of absence from regular school activities. In general for girls a higher injury ID was reported than for boys, mainly caused by a twofold higher risk during leisure time physical activities.

**Conclusions:** Next to specific areas of preventive interest it was found that in this specific age group, girls require special attention as they seem to be at higher injury risk than boys.

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## Introduction

The numerous health benefits of regular physical activity in children are well described in the literature<sup>1,2</sup>. With the subsequent focus on a physically active lifestyle, an increasing number of sports and physical activity-related injuries can be expected<sup>3,4</sup>. These injuries lead to high direct and indirect costs<sup>5</sup>. More importantly, children may lose their enthusiasm for physical activities and sports through negative associations with injuries<sup>6</sup>. Consequently, the successful prevention of physical activity-related injuries in youth has great potential health gain<sup>7</sup>. In the short-term, the absolute number of injuries will fall and, in the longer term, the risk of injury recurrences and prolonged periods of impairment will be prevented. Prevention may also promote a physically active lifestyle from childhood into adulthood. An important purpose of injury epidemiology is to supply knowledge on injuries that occur frequently and have serious consequences, and to describe their aetiology in order to provide a basis for preventive measures<sup>8</sup>. A recent review on the risk of sports injuries in children revealed that epidemiological data on this topic is scarce<sup>9</sup>. Moreover, it was concluded that there is a great need for more insight into injuries during unorganised activities and for younger age groups. Especially the combination of unorganised activities in younger age groups requires attention. An active child is growing, learning and developing its skills. During this process the younger child 'evolves' from a participant in joyful physical activities to a participant in sports<sup>7</sup>. Therefore, the purpose of this prospective cohort study was to describe the incidence and severity of injuries resulting from physical education (PE), sports, and leisure time physical activities in 10-12 year old Dutch children.

## Methods

### Population

This study was part of the iPlay-study, an injury prevention study among 10-12 year old youth that has been carried out in primary schools located throughout the Netherlands<sup>10</sup>. From the 7,000 primary schools throughout the Netherlands, 520 primary schools were randomly selected and invited to partake in the iPlay-study. A total of 40 primary schools (consisting of 2,210 10-12 year old children) were eligible for participation, and were randomised to an intervention group or a control group. All 20 schools assigned to the control group formed the prospective cohort described in the present study, resulting in a cohort of 1,091 10-12 year old children. The study was approved by the Medical Ethics Committee of the VU University Medical Center, Amsterdam, the Netherlands. Informed consent was given by each child's parent or guardian by means of a passive informed consent.

### Design and measurements

At the start of the school year (September 2006) all children completed a questionnaire in the classroom under the supervision of the researchers. The questionnaire collected information on demographic variables, as well as current sports and leisure time participation.

This questionnaire was repeated at the end of the school year (May 2007). Exposure to PE classes was equal in all schools, i.e. twice a week for 45 minutes. The weekly individual exposure of 90 minutes was multiplied by the number of weeks between baseline and follow-up, taking the regular school holidays into account. Individual exposure to sports and leisure time physical activities was derived from the baseline and follow-up questionnaires. Both questionnaires contained questions on the weekly frequency and duration of sports and leisure time physical activities, from which weekly exposure was estimated. Baseline or follow-up data required to calculate weekly leisure time exposure was missing for 35 children. These children were excluded from further analyses concerning overall, as well as leisure time physical activity-related injuries. There were no missing data regarding exposure to sports participation.

Mean weekly sports and leisure time physical activity exposure was calculated from the baseline and follow-up weekly exposure values, and multiplied by the number of weeks between the completion of the questionnaires. A correction factor of 0.8 was used in order to account for seasonal effects on physical activity participation throughout the follow-up period. Although chosen arbitrarily, this correctional factor is in line with the decrease in physical activities during winter as found in previous studies<sup>11</sup>. Throughout the follow-up period physical activity-related injuries were continuously monitored by PE-teachers. In case of injury the PE teacher provided the injured child with an injury registration form which had to be completed within seven days of injury onset, preferably with the help from the PE teacher. On this form the child was asked to provide information on the injury location, injury type, injury diagnosis, direct cause of the injury, subsequent medical treatment, and activity performed at time of injury (i.e. PE class, leisure time physical activities, or sports).

#### Injury definition

An injury was recorded if it occurred during either PE class, leisure time physical activity, or sports, and caused the child<sup>8</sup> (i) to stop his/her current activity, and/or (ii) to not (fully) participate in the next planned physical activity (applicable as well to regular leisure time physical activity), and/or (iii) to be unable to go to school the next day, and/or (iv) to seek medical attention (ranging from onsite care by e.g. first aid personnel, to personal care by e.g. physiotherapist or sports physician).

#### Analysis

Injury ID density and corresponding 95% confidence intervals (95% CI) were calculated for all participants, as well as for boys and girls separately, as the number of new injuries reported per 1,000 hours of exposure. Herefore, exposure time of each individual child until the onset of first injury within each specific modality of physical activity was used.

For boys compared to girls, as well as between the different modalities of physical activities, Incidence Density Ratio's (IDR) and corresponding 95% confidence intervals (95% CI) were calculated. Differences in sports and school absence due to injury were analysed using Chi-square statistics.

## Results

### Research population

Of the 20 schools that agreed to participate in the study, all completed the entire follow-up period. One or more questionnaires were missing for 95 individual participating children. Consequently, these children were excluded from the analyses. This resulted in a sample of 996 children (493 boys and 503 girls) (Table 4.1).

### Injury incidence density

During the follow-up period 104 children reported a total of 119 injuries. This resulted in an overall injury ID of 0.48 per 1,000 hours of exposure (95% CI: 0.38-0.57) (Table 4.2). In general the injury ID was lowest for leisure time physical activities (0.39; 95%CI:0.28-0.50),

**Table 4.1:** Subject characteristics. Numbers are given as mean and standard deviation (SD) or percentage of the entire population (%).

|                              | Total population | Boys        | Girls       |
|------------------------------|------------------|-------------|-------------|
| <b>Gender</b>                |                  |             |             |
| Boys                         | 493 (49.5%)      |             |             |
| Girls                        | 503 (50.5%)      |             |             |
| <b>Age</b>                   |                  |             |             |
|                              | 10.7 (0.8)       | 10.7 (0.8)  | 10.6 (0.8)  |
| <b>Height</b>                |                  |             |             |
|                              | 149.1 (7.9)      | 148.7 (7.6) | 149.5 (8.2) |
| <b>Weight</b>                |                  |             |             |
|                              | 40.5 (9.1)       | 40.1 (8.8)  | 40.9 (9.4)  |
| <b>BMI</b>                   |                  |             |             |
|                              | 18.1 (3.1)       | 18.0 (3.0)  | 18.1 (3.1)  |
| <b>Ethnicity</b>             |                  |             |             |
| Western                      | 727 (76.0%)      | 356 (75.1%) | 371 (77.0%) |
| Non-western                  | 229 (24.0%)      | 118 (24.9%) | 111 (23.0%) |
| Missing                      | 40               | 19          | 21          |
| <b>Geographical location</b> |                  |             |             |
| City                         | 560 (56.2%)      | 212 (43.0%) | 224 (44.5%) |
| Village                      | 436 (43.8%)      | 281 (57.0%) | 279 (55.5%) |
| <b>Socioeconomic status</b>  |                  |             |             |
| Low                          | 152 (20.3%)      | 79 (21.8%)  | 73 (18.9%)  |
| Middle                       | 234 (31.2%)      | 124 (34.2%) | 110 (28.4%) |
| High                         | 364 (48.5%)      | 160 (44.1%) | 204 (52.7%) |
| Missing                      | 246              | 130         | 116         |

## 4 Physical activity-related injuries in 10-12 year old children

followed subsequently by PE (0.50; 95%CI:0.29-0.71), and sports (0.66; 95%CI:0.46-0.87). Injury ID did not differ significantly between the different modalities of physical activity. A similar distribution was found for boys and girls separately. However, for boys the injury ID due to sports was significantly higher than for leisure time physical activities (IDR=2.61; 95%CI:1.39-4.95). In general for girls a higher injury ID was reported than for boys (IDR=1.62; 95%CI:1.10-2.39), mainly due to girls having a more than twofold higher injury ID resulting from leisure time physical activities (IDR=2.13; 95%CI:1.18-3.84).

Of all injuries 40% required medical treatment, resulting in an incidence of 0.19 medically treated injuries per 1,000 hours of exposure (95%CI:0.13-0.25). The incidence of medically treated injuries was divided equally between the different modalities of physical activities, as well as between genders.

### Nature and cause of injuries

Figure 4.1 depicts the anatomical location of injuries divided across the different modalities of physical activities. In general most injuries were to the lower extremities (68%), of which the majority (42%) were to the lower leg or ankle. Injuries to the lower leg or ankle were predominantly reported resulting from sports, while injuries to the lower arm, hand or wrist were mostly reported to be due to leisure time physical activity.

Bruises were most commonly reported (43%), mainly occurring during leisure time physical activity (figure 4.2). The second most frequent occurring injury was a ligament sprain, most commonly resulting from participation in sports.

Falling or stumbling as well as missteps were most common, each accounting for 28% of all injuries (figure 4.3). Collisions with materials (e.g. a ball, playground obstacle, etc) accounted for a substantial amount of injury causes as well, 22% of all injuries. During leisure time physical activity falling or stumbling and collision with materials accounted for most injuries, 45% and 29% of all leisure time physical activities respectively. In sports most injuries were caused by a misstep or twisting motion, 41% of all sports injuries.

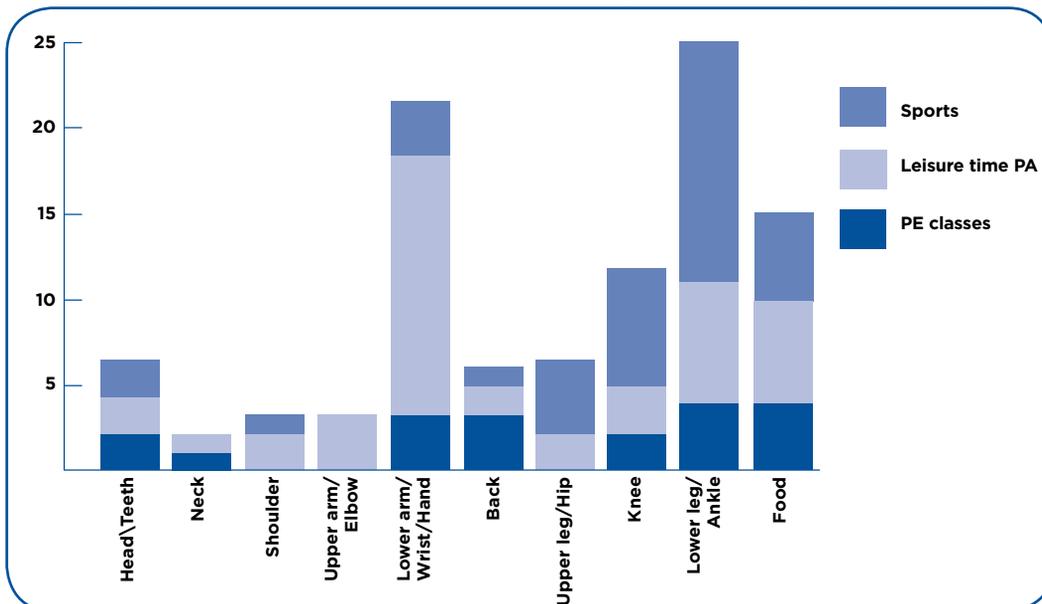
### Sports and school absence

Within the injuries sustained by children who reported to participate in organised sports, 70 injuries (68%) resulted in absence from sports participation due to the injury. For boys (n=37; 79%) the number of injuries resulting in absence from sports was, although not significant, higher than for girls (n=33; 59%). A sports absence of 1 week was reported in 45% of all cases of injury, 29% resulted in a absence of 2 weeks, and 26% resulted in an absence of 3 weeks or more. The duration of absence was similarly divided between boys and girls.

**Table 4.2:** Number of incident injuries (N), mean exposure in minutes per week (SD), and corresponding injury incidence (95% confidence interval).

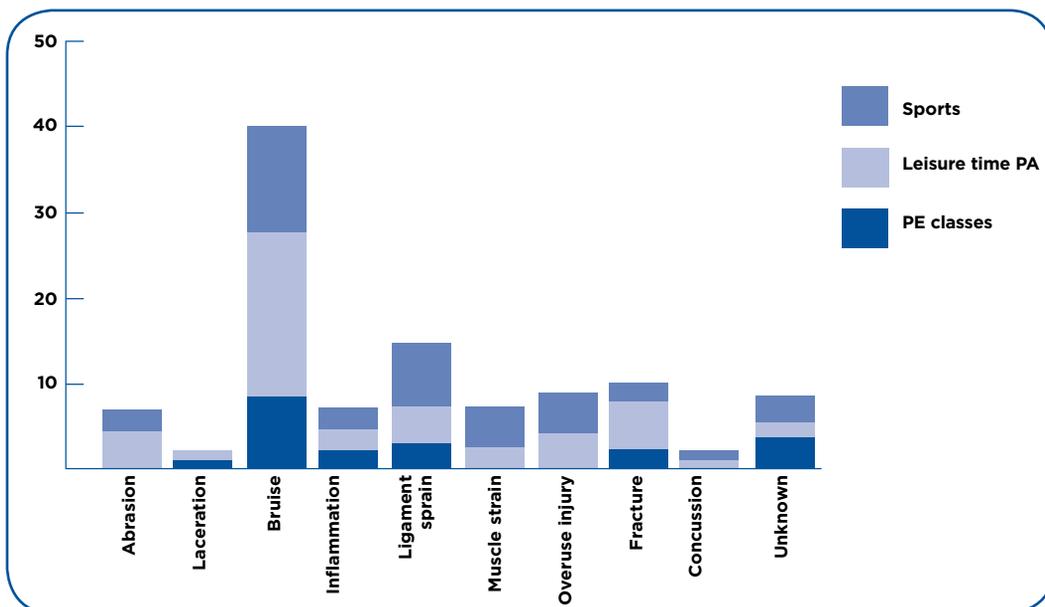
|                                   | All injuries |                       |                          | PE classes |                       |                          | Leisur time PA |                       |                          | Sports |                       |                          |
|-----------------------------------|--------------|-----------------------|--------------------------|------------|-----------------------|--------------------------|----------------|-----------------------|--------------------------|--------|-----------------------|--------------------------|
|                                   | N            | Mean xp (SD) min/week | Injury incidence (95%CI) | N          | Mean xp (SD) min/week | Injury incidence (95%CI) | N              | Mean xp (SD) min/week | Injury incidence (95%CI) | N      | Mean xp (SD) min/week | Injury incidence (95%CI) |
| <b>All injuries</b>               |              |                       |                          |            |                       |                          |                |                       |                          |        |                       |                          |
| <b>Total population</b>           | 104          | 423.8 (169.7)         | 0.47 (0.38-0.56)         | 22         | 76.0 (7.2)            | 0.50 (0.29-0.71)         | 48             | 225.1 (124.2)         | 0.38 (0.27-0.49)         | 40     | 108.7 (96.4)          | 0.66 (0.46-0.87)         |
| <b>Boys</b>                       | 44           | 458.5 (178.8)         | 0.36 (0.26-0.47)         | 9          | 76.2 (6.5)            | 0.41 (0.14-0.68)         | 17             | 242.2 (123.6)         | 0.25 (0.13-0.37)         | 23     | 126.2 (102.8)         | 0.66 (0.39-0.93)         |
| <b>Girls</b>                      | 60           | 389.8 (153.0)         | 0.59 (0.44-0.74)         | 13         | 75.8 (7.9)            | 0.59 (0.27-0.91)         | 31             | 208.3 (122.7)         | 0.53 (0.35-0.72)         | 17     | 91.5 (86.3)           | 0.66 (0.35-0.97)         |
| <b>Medically treated injuries</b> |              |                       |                          |            |                       |                          |                |                       |                          |        |                       |                          |
| <b>Total population</b>           | 41           | 455.5 (158.5)         | 0.18 (0.13-0.24)         | 9          | 71.0 (17.0)           | 0.21 (0.07-0.34)         | 21             | 230.8 (120.4)         | 0.17 (0.10-0.24)         | 13     | 134.7 (81.9)          | 0.22 (0.10-0.33)         |
| <b>Boys</b>                       | 16           | 485.8 (156.0)         | 0.13 (0.07-0.20)         | 4          | 70.8 (17.2)           | 0.18 (0.00-0.36)         | 5              | 243.0 (118.8)         | 0.07 (0.01-0.14)         | 9      | 152.8 (156.0)         | 0.26 (0.09-0.43)         |
| <b>Girls</b>                      | 25           | 436.1 (160.2)         | 0.25 (0.15-0.34)         | 5          | 71.1 (17.2)           | 0.23 (0.03-0.43)         | 16             | 222.9 (123.2)         | 0.28 (0.14-0.41)         | 4      | 123.1 (84.1)          | 0.16 (0.00-0.31)         |

**Figure 4.1:** Injury location within the different modalities of PA, presented as the percentage of all injuries.

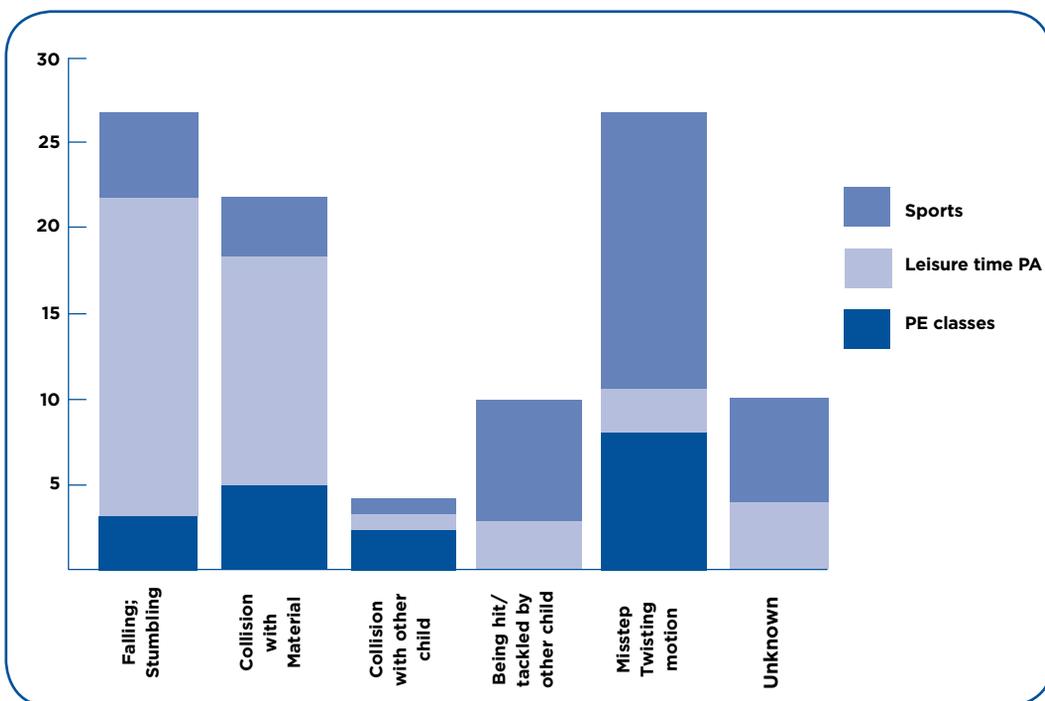


## 4 Physical activity-related injuries in 10-12 year old children

**Figure 4.2:** Injury type within the different modalities of PA, presented as the percentage of all injuries.



**Figure 4.3:** Injury mechanism within the different modalities of PA, presented as the percentage of all injuries.



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Absence from regular school activities was reported in 14% (n=17) of all injuries, with a mean loss of 1.8 school days per injury (SD 1.3). Reported absence from school due to injury and mean loss of school days was similar for boys (14%; 1.7 (SD 1.0) days lost) and girls (15%; 1.9 (SD 1.6) days lost).

## Discussion

This prospective study carried out during one school year showed an overall injury ID of 0.48 injuries per 1,000 hours of physical activity. Injury ID was lowest for leisure time physical activities, followed by PE and sports respectively.

As in most descriptive studies, comparison of incidence figures are hampered by differences in study design, population, and injury definition. When it comes to physical activity-related injuries in children a proper comparison is further complicated by the small number of available studies. As indicated by Spinks and McClure<sup>12</sup>, injury studies in young children focus mostly on sports specific injury risk. Our study specifically dealt with injuries in a relative young age group of 10-12 year old children, and investigated the entire scope of physical activity modalities these children may participate in.

Furthermore, the majority of studies report on injuries sustained by a wide age range of children. However, as found by Sorensen et al.(1996)<sup>13</sup> great variations in sports and physical activity-related injury rates exist between different ages, ranging from 20 per 1,000 children at the age of 6, to 120 per 1,000 children at the age of 14. The present study included only a relative small age range of 10-12 year old children, rendering a comparison with other studies unhelpful. The only study comparable in design and methodology is by Spinks et al. (2004)<sup>14</sup>. For the same age group they reported similar overall injury rates of 0.59 injuries per 1,000 hours sports and physical activity participation, as well as 0.69 sports injuries per 1,000 hours of sports participation.

In contrast to what is generally being reported in the literature, we found the overall injury ID of girls to be higher than for boys. Corresponding to our study, Sundblad et al. (2005)<sup>15</sup> reported higher PE injury rates for girls as compared to boys. For other modalities of physical activities no differences between genders were found. This latter contrast to our result, that girls have a twofold injury risk during leisure time physical activity. It may well be that the definition of leisure time physical activity differs between studies. It remains unclear in the study of Sundblad et al. (2005)<sup>15</sup> what was defined as leisure time physical activity. Even though the present study is the first to find these gender differences in such a pronounced way, Sorensen et al. (1996)<sup>13</sup> previously indicated that gender differences in injury risks 'cross over' between the ages 12-14. This is presumably due to the growth spurt appearing earlier in girls. It was only in the older ages that Sorensen et al. (1996)<sup>13</sup> showed injury risk to be substantially higher in boys.

Of all injuries 40.3% required some form of medical attention, and 68% resulted in absence from sports or school. This is a grave amount, especially when one considers the broad

injury definition was used, i.e. any occurrence that led at least to cessation of the current activity. Although this has led to the registration of a substantial amount of relatively 'minor' injuries (e.g. 43% of all reported injuries were bruises), this shows that an important number of injuries in children should be labelled as 'serious' or even 'severe', especially in the light of the young, growing, and playing child. This high percentage of serious injuries warrants a stronger focus on injury preventive efforts in younger children.

Another methodological issue that needs to be addressed is the registration of participation in leisure time physical activity and sports. In contrast to participation in PE classes, individual exposure to sports and leisure time physical activity was estimated from self-reported weekly frequency and duration of sports and leisure time physical activity, in the baseline and follow-up questionnaires. Physical activity and sports participation would have been more accurate when measured objectively and on a more regular basis, e.g. weekly, using structured exposure forms commonly used in sports injury research<sup>16</sup>. However, from a practical perspective this was undoable, and we chose a method that might have resulted in a slight overestimation of actual exposure to leisure time physical activity and sports. Despite this potential bias we were able to calculate injury ID per 1,000 hours of exposure, giving an estimation of actual differences in injury risk between the different modalities of physical activity.

An important strength of this study was that the PE teacher prospectively registered all physical activity-related injuries of each individual child on a weekly basis. Therefore, we believe that close to all injuries resulting from participation in PE, leisure time physical activity and sports have been reported. In addition, the injury definition used was not limited to injuries resulting in at least absence from school or sports, or injuries requiring medical treatment. Both are injury definitions widely used in (sports) injury research in children<sup>12-15, 16-20</sup>. Such definitions may lead to an underestimation of the actual number of injuries, the so-called 'tip-of-the-iceberg' phenomenon as only more 'severe' injuries are being registered<sup>21</sup>. This showed, for instance, in the high number of bruises found in the present study. Injuries rarely causing time loss from PE classes or sports, but potentially hampering the for the child so important leisure time physical activity.

## Conclusion

An important purpose of descriptive studies like this study is to supply knowledge on the magnitude, severity, and aetiology of injuries in order to provide a basis for preventive measures.

When it concerns 10-12 year old children descriptive information on physical activity-related injuries is lacking, although a substantial physical activity-related injury risk exists for this age group. In general the injury ID was found to be highest for participation in organised sports, where most injuries were caused by missteps or twisting motions leading to ligament injuries to the lower extremities. The most common injuries were bruises, most

frequently leading to upper extremity injuries through falling and stumbling during leisure time physical activity. Next to such specific areas of preventive interest it was found that in this specific age group girls require special attention, as they seem to be at higher injury risk than boys.

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