Chapter 5

Economic burden of physical activity-related injuries among Dutch children aged 10-12 years.

Collard DCM, Verhagen EALM, van Mechelen W, Heymans M, Chin A Paw MJM. Economic burden of sports and physical activity-related injuries in Dutch children aged 10-12 years. Submitted for publication

Abstract

Background: **Injuries among children occurred most often in physical activity-related activities. A lot of these injuries result in direct and indirect costs. A detailed overview of the economic burden of those injuries among children is missing.**

Method: **To describe the economical burden of injuries that occurred during organized sports, leisure time and physical education class activities a prospective cohort study was conducted in Dutch primary schools including 1,091 children. Injuries were continuously monitored by physical education teachers during the school year 2006-2007. An injury was recorded if it occurred during physical education class, leisure time or organized sports activity and caused the child to at least stop the current activity. The parents of the injured child reported associated direct and indirect costs in a cost-diary.**

Results: **During one school year a total of 119 injuries were reported by 104 children. The mean total costs as a result of an injury were 188 ± 317€. The mean direct costs as a result of an injury were much higher than the mean indirect costs, respectively 131 ± 213€ and 57 ± 159€. The highest costs were found for upper extremity and leisure time injuries.**

Conclusion: **Physical activity-related injuries are a negative side effect of participating in physical activities and result in medical costs. Injuries in children that lead to the highest costs are injuries that occurred during leisure time activities and upper extremity injuries. Intervention programs for children to prevent upper extremity injuries and leisure time activity injuries may reduce direct (i.e. health care) and indirect costs.**

Introduction

Paediatric injury-related visits to emergency departments are mainly the result of physical activity-related activities[1]. In the Netherlands sports injuries among 5-14 year old children can be considered as a substantial public health problem. Belechri et al. (2001) found that on a yearly basis 42,000 sports and physical activity-related child injuries are seen in Dutch hospitals[2]. Of these, 13,000 injuries occurred in a school setting, 17,000 during organised sports and 12,000 during leisure time activities.

Besides the short and long-term consequences of physical activity-related injuries on physical and mental well-being, these injuries also lead to high direct and indirect costs for society. For instance, in the United States, over one-third of the school-aged children sustain an injury severe enough to be treated by a doctor or nurse. The associated annual medical costs have been estimated to be about 1.8 billion US dollars[3].

The costs of injuries can be used to determine the severity of injuries[4]. A cost analysis can also identify the injuries that are most "expensive" for the society and allows the development and evaluation of interventions aimed at reducing particularly high cost injuries.

Most studies that report on costs of injuries include only sport-related injuries. During childhood, children participate not only in organized sport activities but also in leisure time activities. In Dutch children aged 10-12 years old, the mean hours of leisure time activities per week is two times higher than of organized sports activities[5]. The use of health care and the associated yearly costs as a result of injuries occurring during physical activities (organised sport, leisure time and physical education (PE) class activities) in children are unknown. Furthermore, most studies are based on recorded injuries through medical channels only. As a consequence, a large percentage of serious injuries is recorded, whereas less serious injuries are not recorded and are lacking.
In this manuscript we report on the economical burden of injuries that occurred during organized sports, leisure time and PE class activities in children. The analyses include the volume for health care use and associated costs, and the mean total direct and indirect costs in general and by gender (boys/girls), type of physical activity (organised sport activity, leisure time activity and PE class) and location of injury (upper or lower extremities).

Methods

Population

This study was part of the iPlay-study, an injury prevention study in 10-12 year old youth that has been carried out in primary schools[6]. A total of 40 primary schools including 2,210 children were willing to participate, and were randomized to an intervention or con-

trol group. The 20 schools assigned to the control group formed the cohort described in the present study, resulting in a sample of 1,091 children. The study was approved by the Medical Ethics Committee. Informed consent was given by each child's parent or guardian by means of a passive informed consent.

Data collection

At the start of the school year (September 2006), all children completed a questionnaire that collected information on demographic variables including age, gender, participation in organized sport and leisure time activities.

Physical activity-related injuries were continuously monitored by PE-teachers during one school year. In case of an injury, an injury registration form was completed. This registration form provided information on the injury location, injury type, injury diagnosis, direct cause of the injury, and activity performed at time of injury.
An injury was recorded when it occurred during either PE class, leisure time or sports activity and caused the child: (i) to stop his/her current activity, and/or (ii) to be unable to (fully) participate in the next planned physical activity, and/or (iii) to be unable to go to school the next day, and/or (iv) to seek medical attention[7].

Costs

The parents of the injured child reported the costs. In case of an injury, teachers handed a cost-diary to the child who delivered the diary to his/her parents. All direct and indirect costs from the moment of injury onwards, until full recovery, were registered in the diary. After completion of the diary, the parents were asked to forward the cost-diary to the investigators. If a cost-diary was not returned after 5 weeks of injury onset, parents were contacted per mail, telephone or school.

Costs were collected from a societal perspective. Table 5.1 provides an overview of the costs [8,9,10]. Direct health care costs included costs as a result of an appointment with a general practitioner; visits to a sport physician, physical therapist, sports masseur or dentist; visits to emergency department, outpatient clinic, day care admission or hospital admission; and diagnostic interventions such as X-ray. Costs of medication and medical devices (e.g. crutches) were also included. Indirect costs included costs as a result of absenteeism of parents from paid work, the presence of a caretaker, and transportation to and from daily activities in a different way than usual as a result of the injury.
Dutch guideline prices were used to value resource use [10]. The direct costs of the treatments in the hospital (e.g X-ray) were estimated on the basis of prices from the Health Care Insurance Board[8]. Costs of drugs and medical devices were valued using prices of the Royal Dutch Society for Pharmacy[9] or the Health Care Insurance Board[8].

The costs for absenteeism from paid work were calculated based on the average age and wage in The Netherlands[10]. All costs were adjusted to the year 2007 using consumer price indices[11].

Statistical analyses

Means and standard deviations were calculated by using descriptive statistics. Total costs were estimated for each child by multiplying resource data by cost prices. Total, direct and

Table 5.1: *Prices used in the economic evaluation*

	€ (2007)
Direct health care costs	
General practitioner (per visit)	21,36 [a]
General practitioner (phone consult)	10,68 [a]
General practitioner (home visit)	42,73 [a]
Therapists	
Sports physician (per visit)	68,17 [b]
Physical therapist (per visit)	24,06 [a]
Sports masseur (per visit)	36,58 [b]
Dentist (accidental consult not including treatment)	18,69 [d]
Hospital visits	
Emergency department (per visit)	147,01 [a]
Out-patient clinic (per visist)	59,23 [a]
Day care admission (one day)	242,19 [a]
Hospital admission (one day and night)	356,41 [a]
Treatments in hospital	
X-ray (per unit)	43,58 [d]
Plaster (per unit)	63,41 [d]
MRI-scan (per unit)	196,56 [d]
Additional costs	
Medication	- [e]
Medical devices	- [e]
Indirect costs	
Absenteeism parents from paid work (per 8 hours day)	296,08 [c]
Care taker (baby-sitter) (per 8 hours day)	30 [b]
Transportation to and from daily activities (per km)	0,17 [a]

[a] *Oostenbrink (2004) [10]*
[b] *mean costs of 4 sport medical centra and care takers*
[c] *Oostenbrink (2004) [10], overall mean costs for paid work*
[d] *Health Care Insurance Board [8] (www.cvz.nl)*
[e] *Royal Dutch Society for Pharmacy [9] (www.z-index.nl)*

indirect costs were calculated by adding costs per category of utilisation of health care resources. Missing cost data were completed by multiple imputation using the Multiple Imputation by Chained Equations (MICE) procedure[12] . We generated 5 multiply imputed datasets.

The mean total, direct and indirect costs and the associated standard deviations were calculated for the complete cases, i.e. by first excluding cases with missing cost infromation, and for the mutliply imputed data. In the latter case cost analysis were first applied in each multiply imputed dataset and subsequently pooled using Rubin's rules[13] .

Furthermore, differences in costs for boys, girls; organized sport activity, leisure time activity and PE class; upper and lower extremities were calculated for the multiply imputed dataset. As costs were not normally distributed, mean costs differences and associated 95% confidence intervals were obtained by bias corrected and accelerated bootstrapping (2,000 replications), which was applied in each imputed dataset and subsequently results were pooled using Rubin's rules[13]. All analyses were performed using SPSS and R statistical software[14].

Results

Of the 20 schools that participated in the study, all completed the entire follow-up period. Subject characteristics are shown in table 5.2.

Injuries

During one school year in the sample of 996 children a total of 119 injuries was reported by 104 children. Verhagen et al. (2009) reported in a previous paper the injury incidence density (IID) for this population[5]. The overall IID was 0.48 per 1,000 hours of exposure (95% CI: 0.38-0.57). The injury IID was lowest for leisure time activities (0.39; 95%CI:0.28-0.50), followed subsequently by PE (0.50; 95%CI:0.29-0.71), and organized sports activities (0.66; 95%CI:0.46-0.87). More injuries were reported in girls than in boys (58% versus 42%). The lower extremities (68%) were the most injured body parts.

Cost diaries

Complete cost diaries were returned by 73 of the 104 parents (70%). Thus, 31 cost diaries were missing or incomplete (30%). No significant differences were found with respect to gender, ethnicity, socio economical status, and BMI between children of whom the cost-diary was completed or, missing or incomplete. Furthermore, injuries without a cost diary were not significantly different from injuries with a cost diary, regarding variables such as severity, anatomical location and cause of the injuries.

Health care use

Table 5.3 shows the volume of health care use and the associated costs for the complete

Table 5.2: *Subject characteristics*

Characteristics	N=996
Age (year, SD)	10.7 ± 0.8
Gender	
(%boys)	49.5 %
(%girls)	50.5 %
Member sports club	
(%yes)	75.6 %
(%no)	24.4%
Physical activity (min/week, SD)	
PE class	90 [a]
Sport club	131 ± 132
Leisure time	268 ± 181

[a] *SD could not be calculated because exposure to PE classes was equal in all schools, i.e. twice a week for 45 minutes.*

cases (n=73). In addition, volume and associated costs are given for absenteeism of parents from paid work, the presence of a caretaker and transportation to and from daily activities.

Of the 73 parents who completed the cost diary, 43 (58%) reported costs as a result of their child's injury. Of these, 31 parents reported a total of 38 visits to a general practitioner, and 7 parents reported a total of 18 visits to a physical therapist. A total of 43 visits to an emergency department or out-patient clinic was reported by 31 parents. During these visits 28 X-rays were made. In total, 17 children had one X-ray and 4 children had more than one X-ray. Furthermore, 18 plaster bandages were applied and 6 children needed a second plaster bandage.
The highest accumulated costs were found for emergency department and outpatient visits (respectively 3,234€ and 1,244€). Costs as a result of X-ray and plaster bandages were also high (respectively 1,220€ and 1,141€). Visits to a general practitioner and therapists were associated with lower costs. Remarkably high indirect cost for absenteeism of parents from their work as a result of the injury of their child was recorded (5,329€). Eleven parents reported in total 18 days of absenteeism from paid work. The accumulated total direct and indirect costs for the 73 complete cases were 13,716€ (see table 5.3).

Mean direct, indirect and total costs as a result of an injury

Table 5.4 shows the mean direct, indirect and total injury costs (± SD) for the complete cost data (n=73) and the imputed data set (n=104). The results described below are based on the imputed data set.

Table 5.3: *Volume and costs (€) per category of direct, indirect and total costs for the complete cases in the control group (n=73)*

	Volume	Total cost (€)
Direct health care costs		
General practitioner (per visit)	38	812
General practitioner (phone consult)	3	32
General practitioner (home visit)	0	0
SUBTOTAL		844
Therapists		
Sports physician (per visit)	1	68
Physical therapist (per visit)	18	433
Sports masseur (per visit)	1	37
Dentist (accidental consult not including treatment)	1	38
SUBTOTAL		576
Hospital visits		
Emergency department (per visit)	22	3,234
Out-patient clinic (per visist)	21	1,244
Day care admission (one day)	0	0
Hospital admission (one day and night)	0	0
Treatments in hospital		
X-ray (per unit)	28	1,220
Plaster (per unit)	18	1,141
MRI-scan (per unit)	0	0
SUBTOTAL		6,839
TOTAL DIRECT COSTS		8,259
Indirect costs		
Absenteeism parents from paid work (per 8 hours day)	18	5,329
Care taker (baby-sitter) (per 8 hours day)	2	60
Transportation to and from daily activities (per km)	400	68
TOTAL INDIRECT COSTS		5,457
TOTAL COSTS		**13,716**

Total costs

Mean total costs per injury were 188 ± 317€. Mean total costs were calculated from mean direct and indirect costs. Mean direct costs as a result of an injury were two times higher than mean indirect costs (respectively 131 ± 213€ and 57 ± 159€).

Table 5.4: *mean direct, indirect and total costs (€) (standard deviation) for total, boys, girls, sport club, leisure time, PE class, upper and lower extremity injuries.*

		Direct costs (€)		Indirect costs (€)		Total costs (€) [a]	
		Complete data	**Imputed data**	**Complete data**	**Imputed data**	**Complete data**	**Imputed data**
Total injuries		113 ± 178 N=73	131 ± 213 N=104	75 ± 183 N=73	57 ± 159 N=104	188 ± 329 N=73	188 ± 317 N=104
Gender	Boys	91 ± 154 N=33	120 ± 204 N=44	73 ± 181 N=33	66 ± 229 N=44	164 ± 314 N=33	185 ± 304 N=44
	Girls	131 ± 195 N=40	149 ± 239 N=60	76 ± 187 N=40	66 ± 189 N=60	208 ± 343 N=40	226 ± 350 N=60
Type of physical activity	Sport club injuries	59 ± 124 N=24	107 ± 204 N=38	0.36 ± 1.40 N=24	15 ± 68 N=38	59 ± 125 N=24	122 ± 240 N=38
	Leisure time injuries	166 ± 226 N=33	164 ± 235 N=45	127 ± 235 N=33	107 ± 216 N=45	293 ± 427 N=33	271 ± 416 N=45
	PE class injuries	86 ± 91 N=16	108 ± 165 N=21	78 ± 170 N=16	62 ± 162 N=21	164 ± 231 N=16	182 ± 269 N=21
Location of the injury	Upper extremity injuries	218 ± 215 N=28	195 ± 241 N=43	172 ± 247 N=28	122 ± 221 N=43	390 ± 406 N=28	316 ± 401 N=43
	Lower extremity injuries	48 ± 110 N=45	72 ± 158 N=61	14 ± 88 N=45	22 ± 104 N=61	62 ± 183 N=45	75 ± 232 N=61

[a] *Total costs are calculated as the sum of direct and indirect costs.*

Gender

Table 5.4 shows also the mean direct, indirect and total costs for injuries reported by boys and girls. The mean total injury costs were higher among girls (226 ± 350€) than boys (185 ± 304€), mainly as a result of higher direct costs. No significant difference in mean total costs between girls and boys (cost difference = 41€; 95%CI: -126; 198) were found.

Type of physical activity

The mean total costs for injuries that occurred during leisure time activities (271 ± 416€) were higher than the costs for injuries that occurred during PE classes (182 ± 269€). Organized sport activities had the lowest injury costs (122 ± 240€) (table 5.4).

Borderline significant higher total costs were found for leisure time injuries compared to organized sport injuries (cost difference=149€;95%CI:-5; 308). The difference in costs for leisure time injuries and organized sport injuries was mainly caused by the higher in-

direct costs (cost difference=93€;95%CI:30;174). The costs for leisure time injuries were also higher than the costs for PE class injuries, but this difference was not significant (cost difference=89€;95%CI:-75; 265).

Location of the injury

The mean total costs for upper extremity injuries were 316 ± 401€, compared to 75 ± 232€ for lower extremity injuries (table 4). The difference in costs was significantly (-241€; 95%CI: -364; -92).

Discussion

Main findings

The mean total costs as a result of a physical activity-related injury among Dutch children aged 10-12 years were 188 ± 317 €. The mean direct costs were much higher than the mean indirect costs, respectively 131 ± 213 € and 57 ± 159 €. The highest costs were found for upper extremity injuries and for injuries that occurred during leisure time activities.
Fractures were significantly more often reported in upper extremity injuries (n=11) compared to lower extremities (n=2). For the upper extremity injuries 9 of the 11 fractures were fractures to hand/wrist and forearm. Moreover, 24 X-rays and 16 plaster bandages were reported for upper extremity injuries, whereas only 4 X-rays and 2 plaster bandages were reported for lower extremity injuries. The higher costs of upper extremity injuries were mainly due to fractures to hand/wrist and forearm.
Furthermore, upper extremity injuries were significantly more often reported during leisure time activities than during organized sport or PE class activities. It appeared that 8 of the 11 fractures were reported during leisure time activities. The higher costs for injuries occurred during leisure time activities were caused by a higher incidence of fractures to upper extremities.

It must be mentioned that while physical activity-related injuries do have associated costs, there is also a cost to society for physical inactivity[15,16]. It is important to stimulate children to participate in physical activities to enhance health. Because a lot of physical-actvity related injuries are preventible, also costs as a result of those injuries can be reduced.

Strengths and limitations

This prospective study is the first study that describes not only the medical and non-medical costs as a result of sports injuries, but also the medical and non-medical costs as a result of leisure time and PE class activities in children.

Another strength of this study is that costs were measured prospectively by means of cost diaries. Most studies only report costs provided from medical records (f.i. emergency

department records). Such data on costs only take into account injuries severe enough to result in a visit to a hospital. In our study not only injuries severe enough to result in a visit to a hospital but all injuries were taken into account. It is known that minor injuries without medical need for hospitalization account for a substantial part of health care costs[17]. Moreover, our study included also costs of general practitioners; sport physicians, physical therapists, sports masseurs, dentists and indirect costs such as the costs of absenteeism of parents from paid work and the presence of a caretaker.
Furthermore, the study population - children from different primary schools in urban and suburban areas throughout the Netherlands - was a good representation of the Dutch population, consequently, our data can be generalized to injury-related costs in 10-12 years old children in The Netherlands.

Unfortunately our study also has some limitations. The costs were calculated from cost-diaries completed by parents. These data are self-reported and have limitations such as recall bias. Furthermore, during the study period it appeared that not all cost-diaries were returned. Thirty percent of the cost diaries were missing or incomplete. A third limitiation of this study is that the sample size, while larger than previously published studies, is still small and this may be biasing the results. Furthermore, we could not include costs of medication and medical devices in the analysis, because these data were not filled out accurately and there were too many missing values. Finally, we were not able to calculate costs per sport activity, cause of the injury (e.g. falls) or injury diagnosis because the number of injuries per subgroups was too small.

Comparison with the literature

This is to our knowledge the first prospective study that describes medical and non-medical costs of injuries as a result of organized sports, leisure time and PE class activities in children. Very few studies have attempted to quantify the economic burden of physical activity-related injuries in children. Most studies focused only on sports injuries in the total population. De Loës (1990) showed that the medical care and economic costs of medically treated sports injuries in the total population of a municipality in Sweden was 209 ± 348 US dollars[18]. Cumps et al. (2008) assessed costs of sports injuries in the Belgium population from insurance companies[19]. They found that direct medical costs per acute insurance-claimed injury and indirect costs were 180€ and 1.338€ respectively. To our knowledge Knowles et al. (2007) conducted the only study on the costs of injuries specifically in children. They described the costs of medically treated sport injuries in a population of North Carolina high school athletes[20]. Adjusted mean medical costs per injury were 709 US dollars (95%CI 542-917). This study focused only on severe injuries occurring during organized sports activities. Our study investigated the entire scope of physical activity modalities where children participate in i.e. organized sports activities as well as

leisure time and PE class activities. Obviously the mean costs per injury in our study were relatively low as we also included minor (less severe) injuries with little or no costs. Furthermore, comparison of costs as a result of injuries between studies is hampered by differences in injury definition, study design, population, methods and healthcare systems.

A remarkable result in our study was the high costs for upper extremity injuries in children. This finding is consistent with the findings of Meerding et al. (2006)[17]. They found that upper extremity injuries in terms of health care costs are relatively high during childhood. From age 15 onwards injuries to the lower extremities (e.g. knee and lower leg fractures, hip fractures) increasingly dominate health care costs[17].

Practical implications

This study has identified the economical burden of physical activity-related injuries in Dutch children aged 10-12 years. This information can be of great interest for the development of policy for injury prevention programmes. For example, this study has identified leisure time activity-related injuries as a major cause of health care costs. Similarly, the costs of upper extremity injuries (often occurred during leisure time activities) are relatively high. Current injury prevention mainly focus on the prevention of sports injuries. Effective intervention programs to prevent leisure time activity injuries, including upper extremity injuries, may reduce the average costs of injuries in children considerably.

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