1

General introduction

Physical activity and health in children

The health risk associated with physical inactivity across the lifespan has been recognized by international public health and health promotion organizations[1]. In their 2002 report, the World Health Organization (WHO) estimated that 1.9 million deaths throughout the world were attributable to physical inactivity[2]. More recent estimates, however, calculated that physical inactivity caused 9% of premature mortality, or more than 5.3% of the 57 million deaths in 2008[3]. In addition, Lee et al. (2012)[3] estimated that physical inactivity causes 6-10% of the major non-communicable diseases of coronary heart disease, type 2 diabetes, and breast and colon cancers. This is, according to Lee et al. (2012)[3], comparable with figures reported for smoking or obesity.

In children, appropriate levels of physical activity have reported to positively affect physical fitness[4], bone health[5], obesity risk[6], risk of type 2 diabetes[7], and mental health[8]. Not surprisingly, physical activity promotion has moved up the health agenda[9]. This made the WHO to decide to develop global physical activity recommendations that link frequency, duration, intensity, type and the total amount of physical activity necessary to maintain or increase health. For children, this guideline states[10]:

1. Children and youth aged 5 to 17 should accumulate at least 60 minutes of moderate- to vigorous intensity, physical activity daily.
2. Amounts of physical activity greater than 60 minutes provide additional health benefits.
3. Most of the daily physical activity should be aerobic. Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.

Unfortunately, many children fail to reach the prescribed 60 minutes of daily physical activity. Data from the 2009-2010 Health Behaviour in School Children survey show that only one-in-five children in European Union member states undertook moderate-to-vigorous exercise on a regular basis[11]. Of further concern is that there is evidence that physical activity levels track from childhood through to adolescence[12;13]. As a consequence, many initiatives have been developed to promote physical activity in children. The most promising effects were reported in school-based, multi-component interventions[1;14;15]. The effectiveness of community and family-based interventions remains unclear[16]. Although some interventions are effective in increasing physical activity in children, there is strong evidence that the actual increase in physical activity minutes is only small[17].

Injury risk in children

Beside the many health-enhancing aspects of physical activity, participating in physical activity also has negative consequences. In the Netherlands, an average of 3.7 million individuals sustain a sport-related injury each year; of these, 1.5 million are treated by a medical professional[18]. The direct costs of sport-related injuries, treated at an emergency department, have been calculated to be as high as 1,100 euro per injury[18] (Table 1.1).

In the Netherlands, over half of the individuals that is treated for a sport-related injury is below the age of 20 years (Figure 1.1). One could argue that this is logical, while participation in sport in general is highest in children and adolescents. However, when injury numbers are corrected for actual exposure to participation (i.e. injury incidence density) this figure remains highest in children and adolescents; 1.3 injuries per 1,000 hours sports participation[19]. These numbers even exclude any injuries sustained during non-sports related physical activities like free-play. Although sport and physical activity related injuries are usually not life threatening[18], they do cause pain, short-term disability, school-absence and in the long-term possibly even osteoarthritis[20;21]. More importantly, an injured child may complain of losing enthusiasm for sports or physical activity participation[22] and consequently drop out.

Table 1.1: Costs associated with the most common injuries at Dutch emergency departments.

	Number of injuries	%	Average medical costs
Hand/fingers	29,000	18	€800.00
Ankle	25,000	16	€930.00
Wrist	19,000	12	€910.00
Foot/toes	16,000	10	€610.00
Head/neck/throat	15,000	9	€990.00
Forearm/elbow	13,000	8	€1,100.00
Shoulder/collarbone/AC-joint	12,000	8	€1,200.00
Knee	10,000	7	€980.00
Total	160,000	100	€1,100.00

Average direct medical costs of treatment at an emergency department and/or hospitalization.

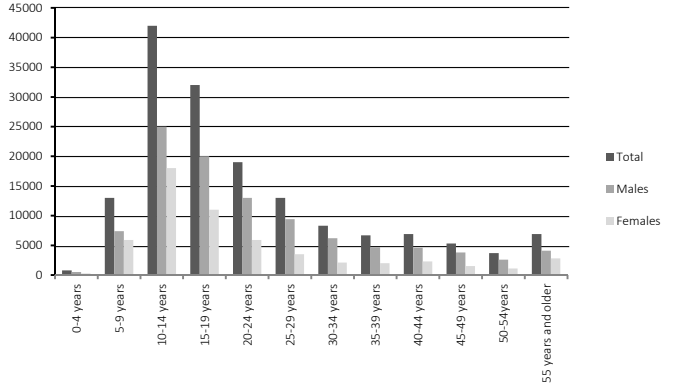
Source: Letsel informatie system 2011, VeiligheidNL[18]

Injury prevention in children

Research in child injury prevention is limited, and the available studies are usually focused on sports injuries alone[20;23-25]. Children, however, do partake in a substantial amount of unorganised leisure time physical activity; over half of their physically active time is estimated to be spend in leisure time physical

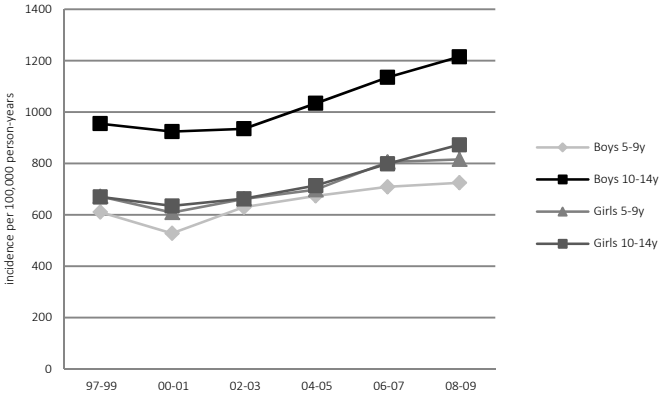
activities[26-28]. Injuries are also sustained during such activities, and while the amount of time spent on these activities is in general higher, the absolute number of injuries sustained during leisure time activities surpasses the number of sport-related injuries in children[28]. Furthermore, research suggests that children with low physical fitness levels are specifically at increased injury risk[29-31]. Since these children are less likely to partake in organised sports, they will not be reached by sport-specific injury prevention programs. Besides, being more prone to sustain an injury, children with low levels of physical activity have reported to benefit most from injury preventive efforts[30]. Thus, to effectively reduce the sport and physical activity related injury burden in young children at risk, physical activity related injury prevention programs should be developed for use outside the organised sports setting.

Figure 1.1: Absolute number of sport-related injuries treated at emergency departments in the Netherlands in 2011.



Source: Letsel Informatie Systeem 2011, VeiligheidNL[18]

Figure 1.2: Incidence of wrist fractures in children per 100,000 person-years summarized in 6 time periods between 1997 and 2009.



Source: de Putter et al., 2011[34]

Of special concern in a younger population are forearm fractures. Not only has this type of fracture been reported to be the most costly injury[32]. Forearm fractures also account for roughly one third of the total number of fractures sustained by children presented at emergency departments[33]. Since the incidence of forearm fractures has steadily increased over the last 30 years[33-35] (Figure 1.2), preventive measures are warranted to decrease the risk of this particular type of fractures in children.

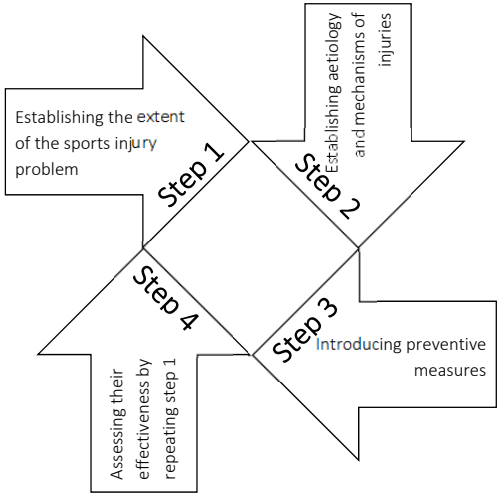
The exact mechanisms of the reported increase in forearm fractures are unclear[33;35;36]. It is, however, known that 80% of forearm fractures are caused by a fall[37]. Since it is arguably impossible to prevent a child from falling[38], an educational program to increase fall skills was developed. This educational program, called 'Vallen is ook een sport', comprised of eight one hour sessions that were designed for use during regular school physical education classes of 8 to 12 year old children. Exercises were derived from martial arts techniques. These techniques have been reported to decrease impact forces of the forearm when falling[39;40]. This thesis describes the evaluation of this educational program

and its effectiveness to reduce the risk of sustaining a forearm fracture in 8 to 12 year old children.

Outline of this thesis

According to the 'sequence of prevention' of sports injuries of van Mechelen et al., 1992[41] (Figure 1.3), epidemiological data should serve as the basis for injury prevention programs. The second and third chapter of this thesis are, therefore, focussed on the actual injury risks of physical activity in children.

Figure 1.3: Sequence of injury prevention.



Source: van Mechelen et al., 1992[41]

Chapter 2 describes a systematic review that was conducted to summarise the evidence for the injury risk of several physical activity behaviours in primary school children. Physical activity promotion in children is usually focussed on one of four modalities of physical activity, i.e. active commuting, leisure time physical activity, physical education and/or sports. Evidence suggests that injury patterns vary between these four physical activity behaviours[28;30]. This information may be helpful to target future injury prevention strategies in children.

Although we know that the number of forearm fractures is increasing, there is limited research available on less severe upper extremity injuries. Chapter 3 provides a more complete picture of the upper extremity injury problem in young children by describing the incidence, aetiology, and mechanisms of upper extremity injuries in a cohort of 6 to 12 year old Danish children.

As reported before, children with low physical fitness levels are at increased injury risk. Injury prevention programs are, thus, best designed for use outside a sports setting. Community- and school-based interventions can offer such a broader approach to reduce injuries. Chapter 4 describes a review that was conducted to assess the current knowledge of the impact of these types of initiatives on physical activity related injuries.

In order to prevent upper extremity injuries in primary school-aged children, the educational program described before was developed and implemented in the Netherlands. The effectiveness of this educational program was assessed using a cluster randomized controlled trial design. In chapter 5, the effect of the educational program to increase fall skills on incidence and severity of fall related injuries is described. The effectiveness of an intervention strongly depends on those executing the program, therefore a process evaluation was conducted. Results of the process evaluation are described in chapter 6. The process evaluation was structured according to the RE-AIM framework, which includes the following domains of research quality: 'Reach', 'Effectiveness', 'Adoption', 'Implementation' and 'Maintenance'.

The last chapter of this thesis, chapter 7, summarizes the main findings and conclusions. Also methodological issues are discussed and recommendations are provided regarding the development and implementation of injury prevention strategies for young children.

Objectives of this thesis

- To describe the magnitude of the injury risk of a physically active lifestyle in young children. More specifically, the risk of upper extremity injuries.
- To review the literature regarding the effectiveness of community- and school-based physical activity related injury prevention programs in children.
- To evaluate the effectiveness and implementation of the Dutch educational program to improve fall skills called 'Vallen is ook een sport'.

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