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Dental injuries with kick-scooters in 6- to 12-year-old children

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Abstract – Background/Aim: The objective of this study was to investigate the occurrence of injuries, especially dental trauma, in scooter-related accidents. In addition, children's habits of wearing protective gear were assessed. Material and Methods: The study was conducted in primary schools in three neighboring towns near Basel, Switzerland, using anonymous multiple-choice questionnaires completed by parents of schoolchildren. Results: A total of 953 scooter riders were included in the study. The average age was 9.1 years (range 6–12 years). Of riders, 58.3% wore no protective gear, 39.6% wore a helmet, and 2% wore other protective equipment. Twenty-nine percentage of the children have sustained an accident while riding the scooter, of those injuries, 41.4% affected the lower extremities, 37.0% the upper extremities, 21.6% the head, and 11.2% dental injuries; 20.3% of accidents required medical treatment. Conclusions: Parents, teachers, and doctors should be aware of the dangers involved in scooter riding. Educational measures, especially concerning use of protective gear, should be implemented to reduce the number and severity of injuries caused by this popular recreational activity.

Kick scooters have become very popular vehicles for recreation as well as transportation purposes over the last 10 years. They are made of lightweight aluminum and fold for easy portability. They have two low-friction wheels – the same type as are used in inline skates – between 100 mm (small) and 200 mm (large) in diameter. Steering is performed via height adjustable T-handlebars, they are propelled by the rider's foot, and braking is achieved by applying foot pressure to the rear wheel arch. They have a narrow base and a high center of gravity (1–6).

With the increasing use of kick scooters among children comes considerable increase in the rate of associated accidents. Kick scooters deceive by their apparent simplicity and ease of use. Children, however, are overly susceptible to accidents owing to their poor coordination and balance, undeveloped motor strength, and lack of judgment and cognitive skills. Owing to the underdeveloped neuromuscular system, they are not sufficiently able to protect themselves from injury in case of an accident (2–4).

As scooters became increasingly popular after the year 2000, interest in this area of research also increased. Between 2000 and 2005, many studies were conducted reporting presentation to emergency departments after scooter-related accidents and use of protective gear (7–11). Recommendations from 2002, issued by The American Academy of Pediatrics Committee on Injury Prevention, were that children under the age of 8 should not ride scooters without close adult supervision, children should not ride scooters on streets, near traffic, or in

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the dark, and children should wear helmets, knee pads, and elbow pads riding a scooter (6, 8). Ten years later, scooters are still popular, yet the initial interest has faded and few new medical publications exist regarding scooter injuries in children, especially in Switzerland. Although these injuries cannot be eliminated entirely, it has been suggested that they can be reduced in severity or prevented by use of protective gear such as helmets, knee and elbow pads, and wrist guards or gloves (12, 13). Legislators in Switzerland have not brought forth restrictions for scooter riding yet, although currently authorities are discussing rules for scooter riding on streets and sidewalks for young children. The aim of this study was to assess scooter-riding habits and use of protective gear as well as the occurrence of accidents, especially dental trauma, 10 years after the initial boom, so that recommendations and restrictions can be modified or reinforced.

Material and methods

A total of 1700 multiple-choice questionnaires were distributed at primary schools in three neighboring towns near Basel, Switzerland, to be completed by the parents of children in first to fifth grade in November and December 2010. The questionnaire contained questions about scooter-riding habits, experience in scooter riding, number and dimensions of wheels on the scooter, protection habits, injuries from scooter riding, weather conditions at the time of injury, and the need for medical aid after injury (Table 1).

Table 1. Questionnaire

No.	Question (multiple-choice answers)		
1	Gender (f/m)		
2	Age (5-12)		
3	Does your child ride a scooter? (y/n)		
4	Number of wheels (2/3/4)		
5	Size of wheels (large/small)		
6	How many days per week does		
	your child ride a scooter? (1–7)		
7	How many years has your child		
	been riding a scooter? (1–7)		
8	Does your child wear protective gear? (no/helmet/knee pads/elbow pads/gloves)		
9	Has your child ever had an accident with a scooter? (y/n)		
10	If yes, which body parts were affected?		
	(leg, knee/arm, elbow/hands/head/chin/nose		
	/forehead/cheek/mouth/upper lip/lower lip		
	/teeth/avulsion/fractured/dislocated		
11	/deciduous/permanent)		
11	occur? (dry/rain/wet leaves/snow)		
12	Did your child require medical attention		
	after the accident? (no/yes, physician/yes, dentist)		

The statistical evaluation of the children differentiated between gender (female/male) and age (6-13). Nonriders were excluded. Children who rode a scooter for longer than a year were included. For the comparison of categorical variables, cross-tables are reported as counts and percentages. P-values were calculated by Fisher's exact test. The level of significance was P < 0.05. To study the effect of 'years experience' or 'age' on the behavior wearing a helmet, logistic regression models were performed providing odds ratios (OR) and 95% confidence intervals (CI) with corresponding P-values. The OR is expressed as the ratio of the odds from the 3rd to the 1st quartile, representing a typical aboveaverage to a typical below-average value. All analyses were performed using R version 2.9.2 [R Development Core Team (2009)] (14).

Results

Of 1700 questionnaires distributed, a total of 989 questionnaires were completed, which equals a response rate of 58%. The children were both boys and girls, and all in the range of 6–12 years of age. Of those, 953 children (96.4%) rode a scooter (Table 2), and 496 (52.0%) girls and 457 (48.0%) boys between the age of 6 and 12 years old with an average age of 9.1 years

Table 2. Riders

Age	Female	Male	Total
6	23	13	36
7	56	56	112
8	81	84	165
9	124	102	226
10	129	97	226
11	73	84	157
12	10	21	31
Total	496	457	953

(SD 1.5) used the scooter on an average of 3.5 days of the week (SD 1.8). The children had an average of 4.1 years (SD 1.5) experience, having started scooter riding at an average age of 5.0 years (SD 1.6).

Most popular models of kick scooters had two small wheels (629/970, 64.8%), followed by those with two large wheels (329/970, 33.9%), and 1.2% (12/970) of scooters had three or four wheels. Thirty-eight children (3.9%) rode both scooters with small and large wheels. Scooters with small wheels (185/637, 29%) were involved in slightly more accidents than scooters with large wheels (90/333, 27%).

More boys (285/457, 62.4%) than girls (277/496, 55.8%) wore no protective gear (P = 0.041). Girls (215/496, 43.3%) wore helmets significantly more than boys (167/457, 36.5%, P = 0.034). Overall, helmets were used in 40.1% (382/953). There was a decrease in helmet use with increasing age of the children (OR = 0.8) (Fig. 1). At the age of six, 55.6% (20/36) of the children wore a helmet. This number decreased continuously, with only 25.8% of 12-year-olds (8/31) wearing a helmet. Gender had an effect, with males' use of helmets decreasing more than females'. Knee pads (5/953, 0.5%), elbow pads (4/953, 0.4%), and gloves (11/953, 1.1%) were rarely used. There was no significant difference between genders.

Of 949 children, 276 (29.1%) have sustained an accident while riding a scooter. Female (155/494, 31.4%) and male (120/455, 26.4%) riders were equally prone to accidents, and there was no difference between the two groups. There was a steady increase in reported accidents with increasing experience (Fig. 2), which shows that accidents occur irrespective of years of experience. Most often the lower extremities were affected (186/449, 41.4%) followed by the upper extremities (166/449, 37.0%) (Fig. 3). Leg injuries were more frequent in girls (112/155, 72.3%) than in boys (72/120, 60%, P = 0.039). Head injuries (including teeth) occurred in 21.6% (97/449) of cases, affecting the chin (26/82, 31.7%), lower lip and nose (both 16/82, 19.5%), upper lip (15/82, 18.3%), forehead (13/82, 15.9%), and cheeks (11/82, 13.4%). Teeth were damaged in 31 (11.2%) of 276 scooter accidents (Fig. 4). Of those, 10 affected deciduous teeth and 13 affected the permanent dentition, and eight could not remember which dentition was affected. Of those remembered and described, deciduous teeth were avulsed in three cases, two were fractured and two were dislocated. One permanent tooth was avulsed, eight fractured and one dislocated. Of 276 accidents, 219 (79.3%) occurred in dry weather, 44 (15.9%) during rain, 32 (11.6%) on wet leaves, and 6 (2.0%) on snow. Of all accidents, 79.7% (220/276) required no medical aid. In 31 cases of accidents excluding teeth (6.5%), a physician was consulted, and in 21 of 31 tooth accidents, a dentist was consulted. Accidents occurred equally often in children wearing protective gear (112/389, 28.8%) as in those without protective gear (163/560, 29.1%).

Discussion

Scooters have become a common sight in the streets. They are mainly used by children, but also by adults, for



Fig. 1. Helmet use in different age groups in female and male riders in %.



Fig. 2. Number of accidents at different levels of experience (absolute count).



Fig. 3. Anatomical distribution of injuries (absolute count, multiple answers possible).

recreation as well as transportation purposes. This study focused on the occurrence of scooter-related injuries in children, especially dental injuries, as well as assessing the use of protective gear. The interviews were not conducted directly but as a questionnaire on paper, and the amount of additional comments of parents show that this is an adversely discussed topic and many parents are insecure regarding safety issues. Swiss authorities are



Fig. 4. Affected dentition and mechanism of injury to teeth (absolute count).

currently debating restrictions for scooter riding on streets and sidewalks for young children.

Of 1700 questionnaires distributed, a total of 989 questionnaires were completed, which equals a response rate of 58%. Of those, 953 children (96.4%) rode a scooter. Presumably, many non-scooter-riders did not take the time to complete the questionnaire after realizing it did not concern them. Because the questionnaire was not mandatory, the exact prevalence of scooter riding in the children is not known, but even if there were no scooter riders who did not complete the questionnaire, the prevalence would be 56% (953/1700).

Kick scooters with two small wheels were most popular (64.8%), followed by those with two large wheels (33.9%). Scooters with small wheels were involved in only slightly more accidents (29%) than scooters with large wheels (27.0%), which shows that wheel size influences handling of the scooter only little.

Although 29.1% had sustained an injury while riding a scooter, 62.4% of boys and 55.8% of girls wore no protective gear. According to a Center for Disease Control and Prevention (CDC) report from 2002, scooter riding is among the seven most common recreation activities that lead to emergency department visits in age groups 0-14 years (15). Although most of the reported injuries were minor, the occurrence is alarmingly high. Of the 39.6% of children who wore a helmet, girls (43.3%) wore helmets significantly more than boys (36.5%). These numbers are slightly higher than in studies from 2001 to 2004 (4-12.7%) (3, 5, 9, 12), and similar to findings in 2009 (33.7%) (16), implying that awareness is slowly rising. Obviously, there is much need for more public awareness for the possible outcomes of accidents, especially to the head. Between January 1995 and June 2001, 15 deaths resulting from scooter-related injuries were reported to the Consumer Product Safety Commission (CPSC), nine of those caused by head trauma, and none of these riders were noted to be wearing a helmet at the time of injury (17). In a report from CDC, traumatic brain injuries were diagnosed in 5.8% of all scooter-related emergency department visits in the United States between 2001 and 2005 (18).

There was a significant decrease in helmet use with increasing age of the children (Fig. 2). More than half (55.6%) of 6-year-olds wore a helmet, whereas only one-fourth (25.8%) of 12-year-olds did. The level of social acceptance of helmets is a widespread problem in different sports. The older the child, the more important this factor becomes, and less regard is paid to safety. A study conducted in Iowa in 2001 found the same tendencies (11). Forjuoh et al. (9) found in 2002 that of four common childhood leisure activities (bicycle riding, in-line skating, skateboarding, and scooter riding), the prevalence for helmet use was lowest in scooter riders (11.5%). Knee pads, elbow pads, and gloves were rarely used. A study by Cassell et al. (19) in 2005 found that wearing wrist guards for scooter riding did not appear to adversely affect steering of the scooter while providing protection for the wrists and lower arms.

According to the United States CPSCs National Electronic Injury Surveillance System, an estimated 37 797 non-motorized-scooter-related injuries in 5- to 12-year-old children were treated at emergency departments across the United States in 2009 (20). In this study, 276 children (29.1%) of 949 had sustained an accident while riding a scooter. Female (31.4%) and male (26.4%) riders were equally prone to accidents. Most often the lower extremities were affected (41.4%)followed by the upper extremities (37.0%). Head injuries (including teeth) occurred in 21.6% of cases. Although injuries to the extremities are more common, the severity of head injuries is much greater. According to a study conducted at a Trauma Program at the Children's Hospital in Pittsburgh in 2000 and 2001, injuries sustained while riding a scooter can be very severe, usually affecting the head, but also the extremities and thorax, with hospital stays for up to 25 days (21). There was a significant and steady increase in reported accidents with increasing experience in the present investigation, which shows that accidents occur irrespective of years of experience.

Teeth were damaged in 31 of 276 scooter accidents. The face in general and the mouth in particular are especially prone to scooter-associated injuries because of the T-handlebar of the device and the fact that the center of gravity is located high and to the front. Wearing a mouthguard is understandably not an option because of the use of scooters in play and on the way to and from school. Again, social acceptance may play a role as well as the fact that mouthguards inhibit verbal communication.

Of 276 accidents, 219 (79.3%) occurred in dry weather, 44 (15.9%) during rain, and 32 (11.6%) on wet leaves. This correlates with a study which shows that occurrence of scooter accidents varies seasonally, with a peak each in spring and early fall (22). The parents' general reaction to the answer option 'snow' were especially forceful, adding quite a few additional comments to the extent that they would never let their children ride the scooter on snow. Nonetheless, six accidents (2.0%) occurred on snow.

Of all accidents, 79.7% required no medical aid, probably resulting in scrapes and bruises, for which parents did not deem professional medical attention necessary, which is consistent with findings from 2006 (23). Nonetheless, in 31 cases of accidents excluding

teeth, a physician was consulted, and in 21 of 31 tooth accidents, a dentist was consulted. Accidents involving teeth seem to be a greater cause of worry to the parents, as teeth do not just heal if broken and need repair to avoid disfigurement.

In this study, accidents occurred equally often in children wearing protective gear (28.8%) as in those without protective gear (29.1%). Findings from other studies show that wearing protective gear cannot prevent but at least reduce severity of injuries sustained, as in similar recreation activities (e.g., in-line skating, skateboarding, and bicycle riding) (1, 4, 5, 7, 13, 16, 18, 21, 23). Therefore, these results should not discourage use of protective gear or cause a decrease in awareness programs for safety measures in scooter riding.

There were some limitations to this study, one being the self-reporting bias. Because the questionnaires were distributed to the children at school, some questionnaires may have been completed by the children themselves and others by the children and their parents jointly. Depending on whether the parents are willing and able to implement wearing protective gear in their children, they may have reported more use of protective gear. Because some of the participating schools have regulations for use of scooters on the way to and from school, parents may have reported less frequent scooter riding. There were no means to indicate occasional vs regular use of protective gear, as well as parents' knowledge of children's use of protective gear while not under supervision. Apart from seeking medical attention or not, the severity of the injuries was not assessed. However, the large response rate and total number of assessed questionnaires give an accurate overview of accessibility of protective gear and occurrence of accidents in scooter riding. Further investigation and continuing awareness programs are needed (21, 24). It is hoped that parent and rider education regarding the importance of protective gear, especially helmets, is implemented, and legislative action is taken, increasing compliance in helmet use.

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