In-line Skating

An Observational Study of Protective Equipment Used by Skaters

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**Objectives:** To determine the frequency and patterns of use of the various types of protective equipment by in-line skaters and to determine if use of protective equipment was associated with the age, sex, group composition, or expertise of the skater.

**Design:** A total of 1548 in-line skaters were observed during a 3-month period in Milwaukee, Wis. Identification and protective equipment data were recorded and analyzed by χ² tests with Pearson’s correlation coefficient.

**Results:** Overall, 491 skaters (31.7%) wore no protective gear. Wrist guards were worn by 999 skaters (64.5%). Helmets were worn by only 40 skaters (2.6%). Overall, adolescent males, children, and advanced skaters were the least likely to be observed wearing protective equipment.

**Conclusions:** Protective equipment is underused by many in-line skaters. Educating in-line skaters about the value of wearing protective equipment, as recommended by equipment manufacturers, may help reduce the severity or incidence of skating injuries.

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**RESULTS**

A total of 1548 in-line skaters were observed during the 3-month data collection period. The total excludes three skaters who were eliminated as possible duplicate skaters because of identical identification characteristics. Of the total number of skaters, 1361 (87.9%) were observed at the lakefront parks, while 104 (6.7%) were observed on the streets. The remaining 83 skaters (5.4%) were observed at another park or on the multipurpose trails. The 57 total observation periods included 29 at the lakefront parks, 19 at other parks, and nine on the multipurpose pathways.

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**See Subjects and Methods on next page**
SUBJECTS AND METHODS

All observations of in-line skaters were made by a single observer (C.C.Y.) from June 22, 1993, through September 21, 1993, in Milwaukee, Wis. Observations were made primarily at the lakeshore parks, which included an in-line skate rental shop; at nine other county parks; and on local, traffic-free, paved, multipurpose trails. Additional observations were made by random sightings while traveling down the streets. As the time for the average skater to loop around the primary observation site was approximately 40 minutes, observation periods at parks were limited to 30 minutes, to avoid duplicate sightings.

The observer recorded identification and protective equipment data for each skater. Identification data included race, age, helmet, headgear type, and color, glass, shirt color, and style, pants color and style, and size of the group of skaters. Protective gear included helmet, wrist guards, gloves, and elbow and/or knee pads.

The skaters were subjectively divided into the age groups of child, teenager, adult, or older skater. Older skaters were classified as such if they appeared to be aged 60 years or older. The skaters were also subjectively divided into three skill levels: beginner, average, and advanced. Skaters who were identified as beginners were clearly having prolonged difficulty balancing and controlling their skates. Skaters who were identified as advanced skaters included speed skaters (those who were skating for prolonged periods in a racing crouch with one or both hands resting behind the back), freestyle skaters, figure skaters, dancing or jumping skaters, and skaters who were playing hockey or practicing skating. Average skaters maintained balance and control but did not attempt any stylistic variations.

At the end of each observation session, the data were reviewed; any individuals with identical identification characteristics and protective equipment were considered to be the same person, and the duplicate entry was removed from the database.

Significance of the difference in the rates of equipment used by skaters was tested using the χ² test with Pearson's correlation coefficient. For other analyses, observed and expected frequencies of equipment used by skaters were tested for significance using the χ² test with Pearson's correlation coefficient.

DEMOGRAPHICS

The number of skaters was almost evenly divided; there were 797 males (51.5%) and 751 females (48.5%). The majority of skaters were white (1468 [94.8%]). Thirty (1.9%) skaters were African American, 26 (1.7%) were Asian, 16 (1.0%) were Hispanic, and eight (0.5%) were of other ethnicity. Most of the skaters were adults (1288 [83.2%]). Other age distributions were as follows: children, 135 (8.7%); teenagers, 96 (6.2%); and older skaters, 29 (1.9%).

SKATING CHARACTERISTICS

Most of the skaters (1368 [88.4%]) were classified as average, with 64 skaters (4.1%) classified as beginners and 116 skaters (7.5%) classified as advanced. The advanced group consisted of 82 speed skaters, 24 freestyle or figure skaters, six hockey players, and four skiers. The majority of the skaters were alone (568 [36.7%]) or in groups of two (604 [39.0%]). One hundred ninety-five skaters (12.6%) were in groups of three, 124 (8.0%) were in groups of four, and 30 (1.9%) were in groups of five. There were two groups of six (0.8%) and one group each of seven and eight skaters (0.5% each).

PROTECTIVE GEAR

Figure 1 and Figure 2 display the distribution of protective gear use. Of the 1548 skaters, 491 (31.7%) wore no protective gear, while 1057 (68.3%) wore at least one type of protective equipment. Six hundred fourteen skaters (39.7%) were one piece of protective gear, 224 (14.5%) wore two pieces, 201 (13.0%) wore three pieces, and 18 (1.2%) wore all the protective gear, including all three protective pads and a helmet. Wrist guards were worn by 999 (64.5%). Knee pads were worn by 464 (30.0%). Elbow pads were worn by 234 (15.1%). All three types of protective pads—wrist guards and knee and elbow pads—were worn by 213 skaters (13.8%). Only 40 skaters (2.6%) wore helmets.

Comparison by Sex

Females were more likely to be wearing some protective gear than were males (72.0% vs 64.9%) (P<.002) (Figure 3). More females wore wrist guards compared with males (68.8% vs 60.5%) (P<.001). Females were more likely than males to wear knee (36.9% vs 23.5%) (P<.0005) or elbow pads (18.2% vs 12.2%) (P<.001). Females were more likely to be wearing all three protective pad types than were males (16.5% vs 11.2%) (P<.002). Females and males wore helmets equally infrequently (2.3% and 2.9%, respectively) (P was not statistically significant).

Comparison by Skill Level

Beginners (93.6%) were more likely to be wearing some protective gear than were average (73.3%) or advanced skaters (66.9%) (P<.0005) (Figure 4). Beginners were the most likely to wear wrist guards (87.5%) compared with average (63.3%) or advanced skaters (66.4%) (P<.0005). Beginners were more likely to wear knee pads (73.4%) compared with average (28.2%) or advanced skaters (26.7%) (P<.005). Beginners were also more likely to wear elbow pads (48.4%) compared with average (13.4%) or advanced skaters (17.2%) (P<.005). Beginners were more likely to wear all three types of protective pads (43.8%) compared with average (12.2%) or advanced skaters (15.5%) (P<.0005). Advanced and beginner skaters were much more likely to wear hel-
skaters (11.2% and 7.8%, respectively) than were average skaters (1.6%) (P<.0005).

Comparison by Age

Teenagers were the least likely to wear protective equipment (51.0%) compared with children and adults (60.7% and 69.7%, respectively) (P<.005) (Figure 5). All older skaters wore at least one piece of protective equipment. Children were the least likely to wear wrist guards (33.3%) compared with teenagers, adults, and older skaters (49.0%, 68.4%, and 89.7%, respectively) (P<.0005). However, children and older skaters (47.4% and 48.3%, respectively) were the most likely to wear knee pads, followed by adults and teenagers (28.5% and 19.8%, respectively) (P<.0005). The difference between the groups for wearing elbow pads and wearing all three types of protective pads was not significant: 14.1% of children wore elbow pads and 12.6% wore all protective pads; 12.5% of teenagers wore elbow pads and 19.4% wore all protective pads; 15.4% of adults wore elbow pads and 14.1% wore all protective pads; and 17.2% of older skaters wore elbow pads and 10.3% wore all protective pads. Helmets were worn by 10.3% of older skaters, 8.1% of children, 0.0% of teenagers, and 2.0% of adults (P<.0005). The children's age group was also analyzed by location. At the lakefront parks, 33 (32%) of 103 children wore no protective equipment, whereas 17 (63%) of 27 children observed on the streets wore no protective equipment (P<.01).

Unusual Patterns of Protective Equipment Use

The use of knee pads as the only piece of protective equipment was predominately seen in children (22.2%), with only 1.0% of the teenagers and 12.0% of the adults wearing protective equipment in this pattern (P<.0005). When comparing skaters who wore some protective equipment but no wrist guards, again, children were predominant (26.7%) compared with teenagers and adults (2.1%
and 1.5%, respectively) (P<.0005). Neither of these equipment patterns was statistically significant when analyzed by sex or skill level.

Protective Equipment Use Within Skating Groups

Among the 302 pairs of skaters, 64 of the pairs consisted of two skaters who wore no protective gear. In 50 pairs, one individual wore at least one piece of protective equipment and one individual wore no protective equipment. In 188 pairs, both skaters wore protective equipment. In the 65 groups of three, 13 groups were observed in which none of the skaters wore any protective equipment. Eleven groups of three had at least one skater who wore no protective equipment and at least one skater who wore at least one piece of protective equipment. All three skaters wore at least one piece of protective equipment in 41 of the groups of three skaters. For the groups of two skaters and of three skaters, the number of groups comprising all individuals with or without protective equipment was significantly higher (P<.0005) than would be expected, based on the random grouping of skaters (Table).

![Figure 5. Protective gear use by age.](image)

<table>
<thead>
<tr>
<th>Gear Use</th>
<th>No. of Pairs Observed</th>
<th>No. of Pairs Expected*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Both skaters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No protective gear</td>
<td>64</td>
<td>29</td>
</tr>
<tr>
<td>Some protective gear</td>
<td>188</td>
<td>143</td>
</tr>
<tr>
<td>Mixed group</td>
<td>At least one with and one without protective gear</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Groups of Three Skaters</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All skaters</td>
<td>No protective gear</td>
<td>13</td>
</tr>
<tr>
<td>Some protective gear</td>
<td>41</td>
<td>23</td>
</tr>
<tr>
<td>Mixed group</td>
<td>At least one with and one without protective gear</td>
<td>11</td>
</tr>
</tbody>
</table>

*Expected pairs are calculated by the probability of two random skaters having a combination of protective gear. If the probability of no protective gear is p, the probability of two skaters having no protective gear is p^2; the probability of two skaters both having protective gear is (1-p)^2; and the probability of mixed group is 1-p^2-(1-p)^2. Expected values for the groups of three were calculated in a similar manner.

Our study found that, as a group, in-line skaters wore insufficient protective equipment. While use of some equipment was common (68.3%), only 10% of skaters wore the majority of available protective equipment as recommended by manufacturers. Helmet use was universally low, found in only 2.6% of skaters. Adolescent males were the least likely to use protective equipment (51.0%), followed by children (60.7%) and advanced skaters of all ages (66.9%). However, certain subgroups were more likely to wear one or more types of protective gear, including all older skaters (100.0%), beginners (93.6%), and females (72.0%).

While little is known about the frequency and types of in-line skating injuries, several case series found that one third of traditional skaters and skateboarders who sought emergency treatment had fractures or dislocations. Review of the US Consumer Product Safety Commission data indicated that there were 35 in-line skating injuries reported to the National Electronic Injury Surveillance System from January 1991 through July 1993. In a 1992 study, seven in-line skaters sustained 10 fractures, five of the radius or ulna or both, and five involving the carpal or metacarpal bones. Anecdotal reports by in-line skaters suggest that most falls are forward falls onto an outstretched hand and arm. Such falls place the skater at risk for wrist fractures, especially scaphoid and Colles’ fractures, which constituted 30% of the roller-skating injuries seen in the study by Nayeem et al. These findings, as well as equipment manufacturer recommendations, point to wrist guards as the most important piece of protective equipment for in-line skaters.

Helms are also recommended by in-line skate manufacturers and have been shown to substantially reduce the risk of injury in bicyclists. Approximately 10% of skaters and skateboarders treated in emergency departments have head or neck injuries, and, according to the data by the US Consumer Product Safety Commission, of the 35 in-line skating injuries, 12 deaths occurred, seven resulting from head injuries. Although these data are scanty, we believe that helmet use by in-line skaters is important for the prevention of serious head injuries, especially as in-line skaters can reach downhill speeds exceeding 65 km/h, and braking on these skates is relatively difficult and inefficient.

Unfortunately, protective equipment use patterns of children and adolescents appear to be based on convenience or image, not efficacy. Children were least likely to use wrist guards (33.3%) and were more than teenagers or adults (19.8% and 28.5%, respectively) to use knee pads (47.75%) which offer no protection from the most frequent or serious types of skating injuries. Most of the children's knee
pads were soft, soccer-style pads rather than the more expensive hard-shell pads designed for in-line skating. This suggests that children wear what is available, which in turn suggests that they may not own appropriate gear.

Peer influence appears to be an important factor in protective equipment use. Recreational skaters, especially teenagers, appear to wish to resemble their cohorts. Skaters in groups of two or three had a significantly increased likelihood of all group members either wearing or not wearing equipment (Table). This increased likelihood persisted as a trend in other group sizes. The role of peer influence in protective equipment use has been suggested in several studies of bicycle helmet use.10-14 In these studies, children were receptive to the idea of bicycle helmets and viewed favorably sport bicyclists and racers who wore them. While the children did not wear helmets themselves because they feared disapproval from their peers, they indicated willingness to do so if everyone else wore them.11,12

As well as image, cost is probably a perceived obstacle to wearing protective equipment, as the use by children of inexpensive multipurpose knee pads suggests. Other important barriers to protective equipment use are discomfort and inconvenience. While the cost-effectiveness of protective equipment for in-line skating cannot be calculated, as the injury rate is unknown at this time, we believe that prudence and the desire to avoid pain and suffering, temporary or permanent disability, and the rare but present threat of death are sufficient recommendations for wearing helmets. Further study of the motivations for and obstacles to wearing protective gear is merited.

The design of this study has several inherent limitations. Identification of age group and the other demographic factors was subjective, although the use of a single observer ensured a level of consistency. Skill level identification also was subjective and was influenced by the observation period's time limitations. An advanced skater who was skating casually when observed would be classified as an average skater, as would a beginner skater during a period of heightened confidence. As a result, some beginners and advanced skaters were probably misclassified as average skaters. This averaging effect would cause the comparisons between different levels of skaters to be biased toward no difference among the groups. The subjective division of skaters into groups based on age and skill level is the largest source of bias and error. The strategies used to observe the frequency of protective equipment use could not account for several other possible biases, including counting of the same skaters on different days, the arbitrary periods and places chosen for observation, and assessment of the total time skating. The effect of these problems on our comparisons between groups is difficult to predict. Our results probably overrepresent people who skate more regularly, who may be more or less skilled.

Another source of possible bias is the limited observation of children in local neighborhood streets, where children who own in-line skates may play most often. Although the sample of children observed skating in the streets is small, their use of protective equipment was less than was observed at the lakefront parks, where most of the children were either skating with or brought by parents. This undersampling might result in falsely elevated overall rates of protective equipment use by children. However, the observational study design used has one advantage over survey methods—as people tend to overreport healthy behaviors and underreport unhealthy behaviors, an observational study can provide a more accurate representation of the broad use of protective equipment.

CONCLUSIONS

To our knowledge, this is the first report on the use of protective equipment by in-line skaters. Despite the study limitations and the need for further study, our findings support a number of recommendations. All in-line skaters should wear, at minimum, rigid wrist guards and helmets that pass the American National Standards Institute (New York, NY) Z90.4 helmet standards and Snell Memorial Foundation (St James, NY) B90 helmet standards. Manufacturers of protective equipment should consider style, cost, and safety in equipment design and should use appealing role models in advertising and public-image campaigns to heighten the desirability of wearing protective equipment. Finally, physicians should join others in educating skaters, their parents, and the general public about the importance of safety equipment in this and other sports. Our finding of cohort equipment-wearing similarities suggests that convincing even a few skaters to use helmets or wrist guards regularly might have an exponential effect.

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REFERENCES