Population-based Study of Unintentional Injuries in the Home

Branko Kopjar and Thomas M. Wickizer

There is little current understanding of the risk for occurrence of unintentional injury in the home. The authors estimated the incidence of unintentional home injuries for an entire community, adjusting for actual time spent awake in the home and, in addition, analyzed the costs of these injuries. Cases of unintentional home injuries occurring from 1990 to 1993 among the residents of Stavanger, Norway (approximately 100,000 population) were identified through a prospective, ongoing injury registration system. Age- and sex-specific per-population incidence and incidence per time spent awake at home were estimated. Time exposure data for adults were obtained from the Norwegian Time Budget Survey and were estimated directly for children. The cost of injuries was estimated based on a random sample of 289 patients. A total of 8,580 persons received medical treatment for unintentional injuries in the home (22.0 per 1,000 population annually, 71.9 per 10 million hours awake at home). The per-population incidence was highest among children age 6 years or younger and among people aged 65 or older (51.0 and 32.7, respectively, per 1,000 population annually). The high population incidence for children was not accounted for by time spent awake at home. For people aged 65–74 years, however, increased incidence was primarily a function of greater time spent awake at home. For persons aged 75 years or older, the high population incidence was due to both high exposure-adjusted incidence and greater time spent awake at home. The male-female ratio of age-standardized per-population incidence was 1.07 (95% confidence interval 1.04–1.10), and the ratio of age-standardized exposure-adjusted incidence was 1.22 (95% confidence interval 1.17–1.28). The estimated cost (direct and indirect) per injury was $1,300 during the first year after injury. Persons aged 75 years or older accounted for 12% of the injuries but 50% of the total medical costs. Am J Epidemiol 1996;144:456–62.

Home is where people of all ages spend most of their time and is also the place where many injuries occur. Injuries in the home are the most common source of trauma in the population (1) and occur among people of all ages. However, the highest incidence is among children and elderly persons (2). While information exists about the occurrence of specific types of home injuries, e.g., burns (3) and poisoning (4), and about home injuries in selected population subgroups, such as the elderly (5), there is little understanding about the occurrence of home injuries in the general population. Apart from one study conducted in 1978 in Sweden (2), we were unable to locate any studies describing the incidence of unintentional home injuries in the general population. Incidence of home injury is a function of time spent in the home environment. Yet, exposure-adjusted incidence of unintentional home injuries has never been investigated; therefore, it is unclear whether differences in per-population incidence of injuries among people of various age-sex groups results from differences in the exposure time-adjusted incidence of injury or from those in the amount of time spent in the home environment. Further, little is known about the consequences and economic burden of unintentional home injuries. We estimated the incidence of unintentional home injuries for an entire community, adjusting for actual time spent awake in the home and, in addition, analyzed the costs of these injuries.

MATERIALS AND METHODS

Study population

The study population consisted of all people residing in Stavanger, Norway, from 1990 to 1993. Stavanger is a coastal town located in the southwestern part of the country. The average population in the town during the study period was 98,397. Because of its location, Stavanger enjoys a mild climate compared...
with the rest of the country. As an important center for
the oil industry administration, Stavanger has a popu-
lation that consists largely of middle-class people.

**Cases**

We identified cases for this study through a prospec-
tive, ongoing registration system run by the Central
Hospital and the Emergency Clinic in Stavanger,
which operates as a part of the Norwegian Injury
Registration System. These two institutions provide
inpatient and outpatient medical care to the total pop-
ulation of Stavanger. No other medical facilities that
routinely treat acute injuries exist in the town. Data
recently collected as part of the ongoing quality-
assurance activities performed for the registration sys-
tem indicate that a small percentage (approximately 10
percent) of cases, primarily minor injuries, are treated
by general practitioners and go unreported. The regis-
tration, described in detail elsewhere (6, 7), includes
all inpatients and outpatients treated for injuries and is
performed according to the common classification (8)
of and protocol for registration of injuries in the Nor-
dic countries. It includes extensive, structured infor-
mation about the circumstances in which the injury
occurred.

Cases of unintentional home injuries occurring dur-
ing the 4-year period of January 1, 1990 through
December 31, 1993, were selected for study. A small
number of injuries occurred among children younger
than 6 months and were excluded. All injuries that
occurred in private residences or on the premises of
private residences, regardless of whether the actual
place of injury was the individual’s own home or
someone else’s home (e.g., injuries during visits to
friends) were included as cases. Injuries resulting from
occupational services provided in the home (e.g.,
plumber repairing water pipes) were excluded from
the study. Also excluded were injuries that occurred
among institutionalized elderly people (those in nurs-
ing homes and homes for elderly) and injuries among
children in day-care centers. The case selection in-
cluded only unintentional injuries; cases stemming
from domestic or other violence and cases of inten-
tionally self-inflicted injuries were excluded. The fol-
lowing information was obtained for all cases: age and
sex of the injured, mechanism of the injury occur-
rence, whether hospitalization occurred, and Maxi-
imum Abbreviated Injury Severity (MAIS) score (9). If
an injured person had multiple visits to the hospital or
clinic for the same injury, only the first visit was
included in the analysis.

**Calculation of exposure time**

The amount of time spent at home differs among
age-sex groups, requiring adjustment in injury inci-
dence for differences in exposure time. The effective
exposure to home environment was defined in this
study as time people spend at home. Analysis of the
cases revealed that the risk of injury during sleeping
was minimal, and we adjusted the exposure estimates
accordingly by subtracting sleep time from the base
figures. The effective exposure at home for different
age groups was calculated as follows.

For children aged 6 months to 6 years, we used the
estimates from a previous study of day-care center
injuries (6). In brief, we calculated exposure time at
home by subtracting sleep time, time spent in day-care
centers, and other time spent outside the home from
the overall daily exposure (24 hours).

For people aged 15–79 years, we used information
from the Norwegian Time Budget Survey, 1990–
1991, which provides information about the amount of
time spent at home for a nationally representative
sample of the Norwegian population (10). Separate
exposure estimates were calculated for males and fe-
males in 10-year age groups. For persons over age 79
years, exposure information was unavailable, and we
estimated it as follows. We assumed that the effective
exposure among people aged 80–84 years was similar
to the exposure of people aged 75–79. Exposure
among people aged 85 years and older was assumed to
be somewhat higher (13 hours per day) than that
among people aged 75–84.

Exposure data were also unavailable for children
aged 7–14 years. Children this age attend school, and
we therefore assumed that their exposure was some-
what lower than that of children aged 6 months to 6
years. In particular, we assumed that children in this
age group had 6.5 hours of home exposure per day
(compared with 7.03 hours for children aged 6 months
to 6 years).

**TABLE 1. Estimated average daily hours of awake exposure
to home environment in Stavanger, Norway, 1990–1993**

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5–6</td>
<td>7.03</td>
<td>7.03</td>
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<tr>
<td>7–14</td>
<td>6.50</td>
<td>6.50</td>
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<tr>
<td>15–24</td>
<td>7.55</td>
<td>5.90</td>
</tr>
<tr>
<td>25–44</td>
<td>9.73</td>
<td>7.15</td>
</tr>
<tr>
<td>45–64</td>
<td>10.03</td>
<td>7.45</td>
</tr>
<tr>
<td>65–74</td>
<td>12.15</td>
<td>10.38</td>
</tr>
<tr>
<td>75–84</td>
<td>12.53</td>
<td>11.33</td>
</tr>
<tr>
<td>≥85</td>
<td>13.00</td>
<td>13.00</td>
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<tr>
<td><strong>All ages</strong></td>
<td>9.35</td>
<td>7.35</td>
</tr>
</tbody>
</table>
The average per-day exposure time estimates used for this study are shown in table 1. Estimates of the total number of person-hours of exposure for each age-sex group were calculated by multiplying the respective daily exposure estimates presented in table 1 by 1,461 days (the number of days from January 1, 1990 to December 31, 1993) and by the number of persons for the respective age- and sex-specific population groups. People living in long-term care institutions were excluded from the calculation. Per-population incidence of injuries was calculated as the number of cases per 1,000 population. The exposure-adjusted incidence of injuries was calculated as the number of injuries per 10 million person-hours of awake time at home.

Utilization of health services and cost calculation

Information about whether an injury resulted in hospitalization was available for all patients. In addition, 300 patients injured in 1992 were selected at random to provide more detailed data on utilization, medical costs, and cost of foregone productivity as part of a larger, ongoing research project. Eleven patients had incomplete data or had medical records that could not be located, reducing the sample size to 289. The methodology used to estimate medical costs has been described elsewhere (11). In brief, utilization and cost determination were based on actual resource use as described in patients' medical records. Costs for inpatient treatment were calculated by the Norwegian Diagnosis Related Groups patient classification system.

Information about the length of sick leave related to the injury was collected through a questionnaire sent to 170 randomly selected people aged 15–74 years. These 170 prospective subjects were chosen from the sample of 289 patients described above. The questionnaires were administrated at the beginning of 1994, between 12 and 24 months after the injury occurred. Two patients died, and 15 could not be sent questionnaires because of unknown addresses. Of the 153 (170 – 17) questionnaires sent, responses were received from 96 patients (63 percent). The indirect costs of injuries associated with reduced productivity due to lost work time were calculated for the 12-month period after the injury by multiplying the (self-reported) duration of absence from work by the average wage rate of persons in the relevant age-sex group for Stavanger in 1992. Wage data were obtained from official government records. All cost data were adjusted to 1994 price levels according to the Norwegian Consumer Price Index.

Statistical methods

Ninety-five percent confidence intervals were calculated for per-population incidence, exposure time-adjusted incidence, incidence ratios, and incidence rate ratios (12). To adjust for variations in the gender distribution among different age groups, we estimated confidence intervals for male-female, exposure-adjusted incidence rate ratios on the basis of age-stratified person-time denominator data. We also performed age standardization of per-population incidence by substituting the age distribution of the total population as the standard population. The 95 percent confidence intervals were also calculated for point estimates of injury costs (13).

RESULTS

Incidence

Over the period of observation (1990–1993), 8,580 persons (22.0 per 1,000 population annually) received medical treatment for an unintentional home injury, 71.9 per 10 million person-hours. Of these, 4,272 (22.2 per 1,000 population, 82.9 per 10 million person-hours) were males, and 4,306 (21.7 per 1,000 population, 63.5 per 10 million person-hours) were females. (Information about gender was missing for two cases.) The male-female incidence ratio was 1.03 (95 percent confidence interval (CI) 0.98–1.07), and the exposure-adjusted incidence ratio was 1.31 (95 percent CI 1.25–1.36). The male-female age-standardized incidence ratio was 1.07 (95 percent CI 1.04–1.10). The age-standardized exposure-adjusted male-female incidence ratio was 1.22 (95 percent CI 1.17–1.28).

Table 2 presents information on the number, per population incidence, and exposure-adjusted incidence of injuries by age. Among children ages 6 months to 6 years and 7–14 years, the per population incidence was, respectively, 3.4 and 1.4 times the corresponding incidence for persons aged 35–44 (the comparison category). The respective ratios of exposure-adjusted incidence were even higher, 4.0 and 1.8. This finding suggests that the high incidence of home injuries among children is entirely due to high risk rather than to high time exposure.

Among people aged 65–74 years, the per-population incidence was 1.6 times higher than the corresponding incidence for the comparison category. The exposure-adjusted incidence for this age group was 1.2 times higher than for the comparison category. Among people aged 75–84 years and those aged 85 years or older, the per-population incidence was, respectively, 2.5 and 6.1 times higher than the incidence for the comparison category. The corresponding ratios for exposure-adjusted incidence were lower, 1.7 and 3.9,
respectively. These ratios indicate that the increase in per-population incidence observed for persons aged 65–74 years was mainly due to higher exposure. Only for ages 75 years and older did the exposure-adjusted incidence of injury increase. This implies that the relatively high per-population incidence of injuries among people aged 75 years or older was due to the combined effect of two factors—high exposure-adjusted incidence and high exposure to the home environment.

Figure 1 shows per-population incidence and exposure-adjusted incidence of injuries by age and sex. Among males, the exposure-adjusted incidence decreased with age until 75 years. After that, the exposure-adjusted incidence increased. In contrast, the exposure-adjusted incidence for females decreased until age 35 years and increased thereafter.

As figure 1 shows, the per-population incidence followed the pattern of exposure-adjusted incidence for females but not for males. For men between ages...
65 and 74 years, per-population incidence increased, while exposure-adjusted incidence continued to decrease.

**Mechanism of occurrence**

Information on the distribution of injuries by mechanism of occurrence is presented in table 3. Injury mechanisms differed substantially among people in various age groups. Falls were by far the most common mechanism of injury, causing 49 percent of the injuries overall. However, the proportion of injuries caused by falls varied by age group. More injuries were caused by falls than for any other reason (57 percent) among preschool children. Among people aged 7-44 years, approximately one third of the injuries were caused by falls. For age 45 and after, the proportion of injuries caused by falls increased with age, reaching 84 percent among people aged 75 years and older. Cuts, stings, and punctures accounted for 22 percent of the cases overall and for approximately 30 percent of the cases among people aged 7-54 years.

The exposure-adjusted incidence of falls showed a U-distribution, with the highest values among children aged 6 months to 6 years (112 per 10 million person-hours) and people aged 75 years and older. In contrast, the exposure-adjusted incidence of injuries for all other injury categories decreased with age.

**Severity and hospitalization rate**

Of the 8,580 persons injured, 1,142 (13 percent) required initial hospitalization (2.9 per 1,000 population). The majority (76 percent) of the cases overall represented injuries of minor severity (MAIS = 1). Injuries of moderate severity (MAIS = 2) accounted for 18 percent of the cases, with severe injuries (MAIS = 3 and more) accounting for 4 percent of the cases. Seven patients sustained a fatal injury (two children, two adults, and three elderly people). The MAIS was not recorded for 2 percent of the cases.

Figure 2 shows average MAIS scores and the proportion of hospitalized cases by age and sex. The average MAIS scores and the proportion of cases that required hospitalization increased with age, especially for persons aged 55 years and older. The proportion of hospitalized cases for age groups less than age 55 years was less than 10 percent. Among persons under 45 years, the average MAIS score and the proportion of hospitalized cases were higher for males than for females, but the opposite was true for persons aged 55 and older.

**Costs**

Cost information on injuries is presented in table 4. The average per-injury cost of medical treatment was considerably higher for persons aged 65 years and older than for persons less than 65 years ($2,504

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**TABLE 3. Number and incidence* per 10 million person-hours of unintentional home injuries by mechanism of occurrence, Stavanger, Norway, 1990-1993**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Falls</th>
<th>Collision</th>
<th>Cut, sting, or puncture</th>
<th>Other</th>
<th>Unknown</th>
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<td>19</td>
<td>27</td>
<td>11</td>
<td>6</td>
<td>100</td>
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<tr>
<td></td>
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<td>9</td>
<td>5</td>
<td>88</td>
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<tr>
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<td>45-64</td>
<td>86</td>
<td>882</td>
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<td>882</td>
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<td>5</td>
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<td>65-74</td>
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<td>49</td>
<td>882</td>
<td>1,147</td>
<td>423</td>
<td>8,580</td>
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<td>10</td>
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<td>≥75</td>
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<td>3</td>
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<tr>
<td>All ages</td>
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<td>1,147</td>
<td>423</td>
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<td>5</td>
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* Incidence per 10 million person-hours awake at home.
and $341, respectively). The estimated average (indirect) cost of lost work time per injury in the 12-month period after injury was $1,342 among people aged 25-64 years. The aggregate annual cost (direct and indirect) in the 12 months after injury was approximately $3 million, or $1,300 per case. Injuries among persons aged less than 24 years accounted for 41 percent of all cases but only 10 percent of the costs. In contrast, injuries among persons aged 75 years and older accounted for 12 percent of the cases but for 50 percent of the medical costs.

### DISCUSSION

This study presents a detailed investigation of unintentional home injuries among the general adult population, and to our knowledge, is the first study to present incidence of these injuries adjusted for time spent awake at home. We found that the high population incidence for children was not accounted for by time spent awake at home, suggesting that children have relatively high risk of home injury. For people aged 65-74 years, however, increased per-population incidence was primarily a function of greater time...
spent at home. This finding has important potential implications for injury control efforts. The relatively high per-population incidence of injuries among people aged 75 years and older is due to a combined effect of comparatively higher exposure-adjusted incidence of injury and higher exposure time.

Our findings highlight important gender differences in exposure-adjusted incidence of home injury. For persons aged 0–64 years, the exposure-adjusted incidence of home injury among males is significantly higher than that among females. However, the opposite is true among older people (those over age 65 years).

This study also extends existing knowledge about the occurrence of falls. It shows that the risk of fall-related injury at home begins to increase at about age 45 years, sooner than would be expected judging from current research (5) that has focused on falls among the elderly.

Our analysis suggests that the cost of unintentional home injuries is substantial. We calculated that in the initial year after injury the average cost per injury was approximately $1,300, including both direct and indirect (foregone market productivity) costs. This estimate is conservative in that it includes only first-year costs and does not include other indirect costs arising from pain and suffering or lost leisure time and household services productivity. Extrapolating the incidence and injury cost from our study to the Norwegian and US populations implies costs for the year after injury of approximately $125 million and $7 billion, respectively.

The limitations of our study should be noted. A small percentage of minor injuries are not represented in the study because they went unreported. In addition, for children aged 7–14 years and for persons aged 80 years and older, information on exposure time to the home environment was unavailable, and estimates of time exposure had to be made indirectly. However, these estimates were reasonable and would not significantly alter our findings even if they were somewhat imprecise. For example, if the real exposure among persons 80 years and older was higher than we estimated, as high as the maximum possible exposure (16 hours per day without sleeping), the exposure-adjusted incidence ratio for this age group would still be 3.2 (95 percent CI 2.8–3.7) times higher than that of the comparison category (instead of 3.9 as we estimated), and our findings would remain essentially unchanged. Lastly, the estimation of injury costs are based upon a relatively small sample of cases. The variation in medical costs and length of sick leave was, as expected, fairly large, reducing the precision of our cost estimates. However, our findings regarding the length of sick leave due to home injuries are consistent with data reported by other investigators (1).

The data on time spent awake at home used for this study are specific to Norway. While these data might be considered representative of Scandinavia, home time exposure may differ in other countries. In addition, the occurrence of home injuries might be influenced by many other factors. Further research is needed to clarify the generalizability of the data reported here.

The risk of unintentional injuries in the home for the population has been an unresolved question. As understanding of this risk improves, it should be possible to develop more appropriate preventive strategies to reduce these injuries.

ACKNOWLEDGMENTS

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REFERENCES


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