Unintentional Injuries in the Home in the United States
Part I: Mortality

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Background: Unintentional injuries are a leading cause of death in the United States. It is unclear, however, what proportion of these injuries occur in the home. The purpose of this paper is to quantify and describe fatal unintentional injuries that take place in the home environment.

Methods: Data from the National Vital Statistics System (NVSS) were used to calculate average annual rates for unintentional home injury deaths, with 95% confidence intervals from 1992 to 1999 for the United States overall, and by mechanism of injury, gender, and age group.

Results: From 1992 to 1999, an average of 18,048 unintentional home injury deaths occurred annually in the United States (6.83 deaths per 100,000). Home injury deaths varied by age and gender, with males having higher rates of home injury death than females (8.78 vs 4.97 per 100,000), and older adults (≥70 years) having higher rates than all other age groups. Falls (2.25 per 100,000), poisoning (1.83 per 100,000), and fire/burn injuries (1.29 per 100,000) were the leading causes of home injury death. Rates of fall death were highest for older adults, poisoning deaths were highest among middle-aged adults, and fire/burn death rates were highest among children. Inhalation/suffocation and drowning deaths were important injury issues for young children.

Conclusions: Unintentional injury in the home is a significant problem. Specific home injury issues include falls among older adults, poisonings among middle-aged adults, fire/burn injuries among older adults and children, and inhalation/suffocation and drowning among young children. In addition, recommendations are presented for improvements to the NVSS.

Introduction

Unintentional injury was the leading cause of death for people aged 1 to 34 years, and the fifth leading cause of death for all ages combined in the United States from 1992 to 1999.1 In this same time period, unintentional injuries were the leading cause of years of potential life lost before age 65, accounting for 2 million years of life lost annually.1 Motor vehicle crashes accounted for nearly half (47.5%) of all unintentional injury deaths.1 Following motor vehicle crashes, falls and poisoning were responsible for the largest proportions of unintentional injury deaths.

A substantial proportion of unintentional injuries are transportation related, taking place primarily on roadways. Few studies have focused on the location of unintentional injury occurrence. However, homes also represent an important setting for unintentional injuries, the national prevalence of which is largely unknown.2-4 Specific characteristics of the home environment may contribute to the likelihood that an injurious event will occur; for example, the presence of unsecured poisonous substances in the home or the absence of railings on stairways. Characteristics of the home environment may also increase the severity of injury events. For example, the flammability of mobile homes or the absence of adequate exits may increase the lethality of a fire in that environment.5

The objectives in this study were to estimate the prevalence of fatal unintentional injury in the home...
environment in the United States, and to describe the circumstances surrounding these injury events. Additionally, information gaps were identified in available data to inform surveillance systems. The ultimate goal was to identify high-risk populations that can be targeted for prevention.

Methods

Data came from the National Center for Health Statistics’ National Vital Statistics System (NVSS).6 The NVSS mortality data set contains information from death certificates compiled in each state and combined nationally. Data were used from 1992 to 1999 to calculate average annual counts and rates of unintentional home injury death. Injury incidents were classified from NVSS as occurring in the home, in a location other than the home, or in an unknown location. The home environment was defined as areas inside of the home dwelling, as well as outside areas that are part of the home, including yards, gardens, or driveways. A classification of “unknown” refers to an incident where the location of the injury was recorded as “location unknown” in the NVSS.

To classify injuries by mechanism and intent, a recommended framework developed by the National Center for Health Statistics in collaboration with the National Center for Injury Prevention and Control was adapted.7 The framework groups external cause of injury and poisoning codes (E-codes) into a matrix of mechanism and intent for purposes of standardizing the presentation of injury mortality data (Table 1). The E-codes are based on the International Classification of Diseases, Ninth Revision (ICD-9).8

Average annual counts and age-adjusted rates of unintentional injury in the home are presented from 1992 to 1999 overall, and by mechanism, gender, and age group. To quantify the random error associated with the rate estimates, 95% confidence intervals were calculated using the Wilson score method.9 Denominator data for rate estimates came from the postcensal data set for the civilian noninstitutionalized population,10 and accounted for an under-enumeration correction for the 1990 census.11 Analyses were performed using the SAS software (SAS Institute, Cary NC, 2002).

Results

Fatal Unintentional Injuries in the Home

From 1992 to 1999, there was an average of 146,970 injury-related deaths annually in the United States, with an average annual injury death rate of 54.90 per 100,000 persons. Injury deaths represented nearly 4% of all U.S. deaths, and nearly two thirds (61.8%) were classified as unintentional.

Information on the location of injury was available for 33% (home 20%; location other than home 13%) of all fatal unintentional injuries (Table 2). Of those...
with known location, an average of 18,048 unintentional injury deaths occurring in the home environment were reported annually in the United States from 1992 to 1999. This represents an annual rate of 6.83 deaths per 100,000. Although location was not recorded (i.e., the item was left blank) for the 44,830 transportation-related injury deaths, some proportion of those deaths may have occurred in the home environment, such as in driveways or yards.

### Gender and Age Group Comparisons

The average annual unintentional home injury death rate was higher for males (8.78 deaths per 100,000, 95% CI = 8.61–8.94) than for females (4.97 deaths per 100,000, 95% CI = 4.85–5.08) (Table 3). This increased rate among males was apparent across all age groups, with male-to-female rate ratios ranging from 1.3:1 in the <1-year-old age group to 3.5:1 in the 15- to 19-year-old group. Male and female death rates varied considerably by age group. The highest death rates were among people aged ≥80 years (47.91 deaths per 100,000, 95% CI = 46.41–49.40), followed by those aged 70 to 79 (14.57 per 100,000 deaths, 95% CI = 13.97–15.61) and children aged <1 year (12.19 per 100,000 deaths, 95% CI = 11.08–13.29). Among adults aged ≥80, there was an average of 57.37 deaths annually per 100,000 males (95% CI = 54.57–60.31) and 39.80 deaths annually per 100,000 females (95% CI = 38.13–41.46).

### Leading Causes of Death

Falls, poisonings, and fire and burn injuries were the leading causes of injury death occurring in the home environment (Table 4). Combined, they accounted for 78.6% of all fatal unintentional home injuries. Inhalation/suffocation and drowning were the fourth and fifth leading causes of unintentional home injury deaths, respectively, accounting for an additional 10.7% of all fatal home injuries.

### Fall Deaths

More than half (53.7%) of all unintentional fall deaths occurred in the home (Table 4). Another 35% occurred in a location other than the home, and the remaining (11.0%) occurred in an unknown location. From 1992 to 1999, an average of 5,961 falls occurred in the home each year, accounting for one third of all home injury deaths.

Death rates associated with falls increased substantially with age (Figure 1). Very few deaths occurred among people aged <20 years. Rates of fall deaths were highest among adults aged ≥60, specifically those aged ≥70. Home fall death rates were higher for males than females in all age groups.

The circumstances surrounding the majority (63.0%) of fall deaths occurring in the home defied classification or were recorded as “unknown” in the National Vital Statistics System. Falling on or from steps or stairs was the second leading cause of home fall fatalities, accounting for 17.4% of all falls, followed by falls from slipping, tripping, or stumbling (5.8%). Although males experienced a higher percentage of fatal falls from steps and stairs compared with females (56.3% vs 43.7%), they experienced far more fatalities than females as a result of falling from a ladder (92.8% vs 72.0%) or falling from or out of a building (79.5% vs 20.5%). Females, however, experienced a larger percentage of fatalities from slipping, tripping, or stumbling (55.5%), compared to males (44.5%).

**Table 3.** Average annual numbers, percentages, and rates of fatal unintentional injuries in the home, United States, 1992–1999

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
<th>Rate ratio males: females</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1</td>
<td>268 (2.4)</td>
<td>201 (3.0)</td>
<td>469 (2.6)</td>
<td>1.3:1</td>
</tr>
<tr>
<td>1–4</td>
<td>616 (5.4)</td>
<td>382 (5.7)</td>
<td>998 (5.5)</td>
<td>1.4:1</td>
</tr>
<tr>
<td>5–9</td>
<td>215 (1.9)</td>
<td>139 (2.1)</td>
<td>354 (2.0)</td>
<td>1.5:1</td>
</tr>
<tr>
<td>10–14</td>
<td>194 (1.7)</td>
<td>81 (1.2)</td>
<td>275 (1.5)</td>
<td>1.4:1</td>
</tr>
<tr>
<td>15–19</td>
<td>327 (2.9)</td>
<td>81 (1.2)</td>
<td>408 (2.3)</td>
<td>1.5:1</td>
</tr>
<tr>
<td>20–29</td>
<td>1010 (8.9)</td>
<td>302 (4.5)</td>
<td>1312 (7.3)</td>
<td>2.1:1</td>
</tr>
<tr>
<td>30–39</td>
<td>1896 (16.7)</td>
<td>657 (9.8)</td>
<td>2553 (14.1)</td>
<td>2.1:1</td>
</tr>
<tr>
<td>40–49</td>
<td>1965 (17.3)</td>
<td>672 (10.0)</td>
<td>2637 (14.6)</td>
<td>2.1:1</td>
</tr>
<tr>
<td>50–59</td>
<td>941 (8.3)</td>
<td>428 (6.4)</td>
<td>1369 (7.6)</td>
<td>2.1:1</td>
</tr>
<tr>
<td>60–69</td>
<td>931 (8.2)</td>
<td>513 (7.6)</td>
<td>1444 (8.0)</td>
<td>2.1:1</td>
</tr>
<tr>
<td>70–79</td>
<td>1253 (11.1)</td>
<td>1017 (15.1)</td>
<td>2270 (12.6)</td>
<td>2.1:1</td>
</tr>
<tr>
<td>≥80</td>
<td>1715 (15.1)</td>
<td>2245 (33.4)</td>
<td>3960 (21.9)</td>
<td>2.1:1</td>
</tr>
<tr>
<td>All</td>
<td>11,331 (100.0)</td>
<td>6718 (100.0)</td>
<td>18,048 (100.0)</td>
<td>2.1:1</td>
</tr>
</tbody>
</table>

Note: Rates are per 100,000 persons, and are based on the average annual 1992–1999 postcensal civilian noninstitutional U.S. population.

Source: National Center for Health Statistics.
deaths occurring at home were due to exhaust gas from sants. Three percent of the unintentional poisoning Parkinsonism drugs, and central nervous system depres- anesthetics, including cocaine, anticonvulsant and anti- the central nervous system. These drugs were local
of poisoning deaths were the result of drugs acting on antidepressants, and alcohol (21.2%). Another 12.3% were due to unintentional overdoses of three sub- across all age groups (Figure 1).

Males had higher rates of poisoning death than females had rates that exceeded female rates over threefold. occurred among adults aged 30 to 49 years, where males 100,000). Over two thirds of all poisoning deaths oc- 40 to 49 (4.14 per 100,000) and 30 to 39 (3.85 per 100,000). Total poisoning deaths occurred in a location other than the home. Most home injury deaths due to fires were the result of inhaling smoke, fumes, or carbon monoxide from uncontrolled residential fires (68.7%), followed by burns from uncontrolled residential fires (15.2%). Two percent of fire-related injury deaths were due to the ignition of clothing from a controlled residential fire, such as from a stove or other heating source.

Rates of death for fire-related home injuries were high for young children, decreased among adolescents, and increased again for adults aged ≥20 (Figure 1). Rates significantly increased for adults aged ≥70, surpassing the rates of young children. Across all age groups, males had higher fire- or burn-related death rates than females (Figure 1). However, a higher percentage of deaths occurring among females, compared

Poisoning Deaths

An annual average of 4833 unintentional home injury deaths due to poisonings were reported from 1992 to 1999, accounting for over one fourth (26.8%) of all home injury deaths (Table 4). Across all poisoning deaths, over 50% occurred in the home and 15.7% occurred in a location other than the home. Over one third of all poisoning deaths were classified as location unknown in the National Vital Statistics System.

Rates of fatal poisonings were highest among adults aged 20 to 59 years (Figure 1), specifically adults aged 40 to 49 (4.14 per 100,000) and 30 to 39 (3.85 per 100,000). Over two thirds of all poisoning deaths occurred among adults aged 30 to 49 years, where males had rates that exceeded female rates over threefold. Males had higher rates of poisoning death than females across all age groups (Figure 1).

Over half of all poisoning deaths occurring at home were due to unintentional overdoses of three substances: heroin (23.8%), appetite depressants (21.9%), and other substances such as amphetamines, caffeine, antidepressants, and alcohol (21.2%). Another 12.3% of poisoning deaths were the result of drugs acting on the central nervous system. These drugs were local anesthetics, including cocaine, anticonvulsant and anti-Parkinsonism drugs, and central nervous system depressants. Three percent of the unintentional poisoning deaths occurring at home were due to exhaust gas from combustion engines, such as from a car not in transit. Males experienced >80% of the poisoning deaths from heroin overdoses and >70% of the overdoses from appetite depressants.

Fire and Burn Deaths

From 1992 to 1999, an average of 3402 individuals died each year as a result of a fire or burn injury that occurred in the home, for an annual rate of 1.29 per 100,000 (95% CI = 1.24–1.33) (Table 4). Nearly 90% of all fatalities due to a fire or burn injury occurred in the home, while 6.5% occurred in a location other than the home. Most home injury deaths due to fires were the result of inhaling smoke, fumes, or carbon monoxide from uncontrolled residential fires (68.7%), followed by burns from uncontrolled residential fires (15.2%). Two percent of fire-related injury deaths were due to the ignition of clothing from a controlled residential fire, such as from a stove or other heating source.

Rates of death for fire-related home injuries were high for young children, decreased among adolescents, and increased again for adults aged ≥20 (Figure 1). Rates significantly increased for adults aged ≥70, surpassing the rates of young children. Across all age groups, males had higher fire- or burn-related death rates than females (Figure 1). However, a higher percentage of deaths occurring among females, compared

### Table 4. Average annual numbers and rates of unintentional injury deaths, by location and type of injury, United States, 1992–1999

<table>
<thead>
<tr>
<th>Mechanism/cause of injury</th>
<th>Home</th>
<th>Location other than home</th>
<th>Unknown location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>Rateb (95% CI)</td>
</tr>
<tr>
<td>Total</td>
<td>18,048</td>
<td>100.0</td>
<td>6.83 (6.73–6.93)</td>
</tr>
<tr>
<td>Falls</td>
<td>5,961</td>
<td>33.0</td>
<td>2.25 (2.19–2.31)</td>
</tr>
<tr>
<td>Struck by/against</td>
<td>285</td>
<td>1.6</td>
<td>0.11 (0.09–0.12)</td>
</tr>
<tr>
<td>Overexertion</td>
<td>&lt;0.1</td>
<td>&lt;0.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cut/pierce</td>
<td>60</td>
<td>0.3</td>
<td>0.02 (0.01–0.03)</td>
</tr>
<tr>
<td>Natural environmental</td>
<td>427</td>
<td>2.4</td>
<td>0.16 (0.14–0.18)</td>
</tr>
<tr>
<td>Poisoning</td>
<td>4,833</td>
<td>26.8</td>
<td>1.83 (1.77–1.88)</td>
</tr>
<tr>
<td>Fire/burns</td>
<td>3,402</td>
<td>18.8</td>
<td>1.29 (1.24–1.33)</td>
</tr>
<tr>
<td>Machinery</td>
<td>127</td>
<td>0.7</td>
<td>0.05 (0.04–0.06)</td>
</tr>
<tr>
<td>Inhalation/suffocation</td>
<td>1,092</td>
<td>6.1</td>
<td>0.41 (0.38–0.43)</td>
</tr>
<tr>
<td>Firearm</td>
<td>590</td>
<td>3.3</td>
<td>0.22 (0.20–0.24)</td>
</tr>
<tr>
<td>Drowning/submersion</td>
<td>823</td>
<td>4.6</td>
<td>0.31 (0.29–0.33)</td>
</tr>
<tr>
<td>Other specified</td>
<td>230</td>
<td>1.3</td>
<td>0.09 (0.07–0.10)</td>
</tr>
<tr>
<td>Unspecified</td>
<td>215</td>
<td>1.2</td>
<td>0.08 (0.07–0.09)</td>
</tr>
</tbody>
</table>

Source: National Center for Health Statistics. Note: This table excludes 41,692 transportation-related motor vehicle deaths, 125 pedal cycle injury deaths, 984 pedestrian-related motor vehicle deaths, and 2029 deaths due to other transportation injuries where the location of injury field in Yes/No NVSS was left blank. Additionally, 11.4% of drowning and submersion deaths, 51.4% of other specified deaths, and 7.8% of unspecified deaths are omitted from the table due to the location of the injury field in NVSS being left blank. *External cause of injury was determined by E-codes. Rates are per 100,000 persons and are based on the average annual 1992–1999 postcensal civilian noninstitutional U.S. population.
with males, was the result of injury from the ignition of clothing in a controlled residential fire (60.1% vs 39.9%) and from a hot substance or object (54.3% vs 45.7%).

**Injury Fatalities by Selected Age Groups**

**Children.** Fires and burns, inhalation and suffocation, and drowning were the leading causes of unintentional home injury death among children aged <15 years. Fire/burn deaths were the leading cause for children aged 1 to 14 years and the second leading cause for children aged <1 year. Nearly all fire/burn injury deaths among children aged <15 were the result of residential fires. Inhalation/suffocation was the leading cause of home injury death among children aged <1 year, and drowning was the second leading cause among children aged 1 to 9 years. The majority of drowning deaths among infants occurred in bathtubs. Similar to adults, death rates among young males exceeded those of young females (Table 3).

Unintentional home injury death rates among children varied by age, with infants having the highest death rate (12.19 per 100,000 children aged <1 year, 95% CI=11.08–13.29), compared with children aged 1 to 4 years (6.42 per 100,000 1- to 4-year-old children, 95% CI=6.02–6.81), and children aged 5 to 9 years (1.85 per 100,000 5- to 9-year-old children, 95% CI=1.65–2.04) (Table 3). From 1992 to 1999, an average of 469 children aged <1 year died each year in the United States as a result of a home injury (Table 3), the majority of which were due to choking and suffocation incidents (62.8%). Children aged between 1 and 4 years had the second highest rate of home injury death per year, in which nearly 75% of the injuries were the result of residential fires (43.7%) and drownings (29.3%).

**Older adults.** From 1992 to 1999, an average of 7674 adults aged ≥60 years died each year as a result of a home injury. Falls were the leading cause of home injury death, accounting for 48.8% of the deaths for adults aged 60 to 69, and 65.9% of the home injury deaths for adults aged ≥70. Fire injuries were the second leading cause of home injury death across all older adult age groups.

Rates of home injury death increased twofold for adults aged 60 to 69 (7.21 per 100,000, 95% CI=6.83–7.58) and 70 to 79 (14.57 per 100,000, 95% CI=13.97–15.61), and over six-fold for adults aged 60 to 69 and ≥80 (47.91 per 100,000, 95% CI=46.41–49.40) (Table 3). The ratio of home injury deaths for older males versus older females decreased as age increased, from 1.9:1 at 60 to 69 to 1.4:1 at ≥80.

The circumstances surrounding fall deaths among older adults could not be identified in over two thirds of the events reported in the National Vital Statistics System. Of those that were identified, 16.8% were due to falls on or from stairs or steps; 6.6% from slipping, tripping, or stumbling; and 3.3% from falls from a chair or bed.

**Discussion**

Falls, poisonings, and fire/burn injuries were the leading causes of unintentional home injury death in the United States. Older adults and young children experienced the highest rates of home injury death. Their stages of physical development make them vulnerable population groups for fatal injury. Children may become injured while engaging in normal exploratory behaviors, lacking the judgment to avoid dangers. Older adults may experience more injuries as a result of balance or limited mobility. When injured, older adults are often unable to rehabilitate in the same way fully developed and stronger younger people can. In addition, these age groups probably experience greater home injury because they spend more time in the home environment, compared with other age groups who spend a significant amount of time at school.
and/or work. Older adults had the highest rates of falls, and young children had the highest rates of fire/burn and inhalation/suffocation injuries.

Males experienced higher rates of unintentional home injury death than females across all age groups. This gender difference is not unlike injury patterns occurring outside the home, but more striking if one considers that females, at least in some subgroups of the population, probably spend more time in the home environment than males. The existing literature does not report clear evidence for why males have higher rates of home injury death than females, although hypotheses for the relationship can be made. For example, males may have riskier behaviors than females, which can expose them to activities that lead to increased injury severity with a greater probability of resulting in death. For instance, males are more likely to climb a ladder and fall from greater heights, fight a fire with a fire extinguisher rather than flee, or use saws for home improvement, compared with females. More research to identify why males have higher home injury death rates than females could help in the development of tailored behavioral and environmental intervention strategies suited to each group.

Although this study was able to advance our understanding of the frequency and mechanisms of injury occurring in the home environment, there are important limitations to the NVSS data that must be noted. For instance, only 33% of the non–transportation-related deaths could be classified as to the location of injury. If an equal proportion of all unknown or blank (i.e., where the location field in NVSS was left blank) nontransportation cases occurred in the home as did those in which the location was known (60.5%), the total number of unintentional home injury deaths could be as high as 27,860, a figure 53% higher than the home injury fatality estimate provided here. Additionally, it is reasonable to assume that a small number of the transportation deaths occurred in the home environment, which would also increase the average annual estimate.

Most data with a blank location were transportation related, as 100% of the transportation data did not distinguish whether the injury occurred in the home or not. Although the vast majority of transportation injuries likely occurred on roadways, it is probable that a small proportion occurred in driveways and garages, which meets the definition of the home environment. Furthermore, unintentional motor vehicle–related fatalities in driveways and garages are probably more likely to involve young children. Therefore, the rates of home injury death among children associated with this means may be somewhat under-estimated in this study.

The percentage of injury deaths with unknown locations ranged from 3.7% for fire/burn injuries to 90.0% for “unspecified” causes of injury. Other types of injury deaths with a large percentage of unknown location data included overexertion injuries (65.2%), inhalations and suffocations (62.2%), injuries associated with the natural environmental (36.9%), and poisonings (33.6%). Some of these injury types undoubtedly occurred in the home, but the magnitude of the under-reporting cannot be determined. In addition, reporting of injury deaths classified with an unknown location varied by state, ranging from 14.9% in South Dakota to 55.3% in Alabama. The magnitude and variation in the percentage of unknown injury locations could influence the ranking of the leading causes of home injury death presented in this study. It is likely that location coding will improve once ICD-10 coding is universally implemented; however, this is expected to take some time to phase in.

This study showed that the magnitude of home injury death in the United States is substantial, and given the considerable gaps in the available data, the problem is even larger than that reported in this study. However, the available data are too limited to make specific recommendations about interventions. What is needed is a data system ensuring that the locations of injury are identified and recorded in a consistent manner and that documents more fully the circumstances of injury events.

**Recommendations**

There are several recommendations derived from this work. First, more careful consideration needs to be given concerning the collection of data, including development of consistent definitions for “home injury,” guidelines for recording this information, better training of medical personnel who complete the death certificates, and modifying the death certificate to make it an option to check off whether the injury occurred at home. Ultimately this will permit more complete assessment of the problem and the ability to compare information across locales and data systems (e.g., deaths and nonfatal injuries and data from inpatient and outpatient care), and before and after hazards are introduced or preventive interventions applied.

This fatality analysis highlights a need to focus attention on prevention of residential fires, falls among older adults, poisonings among all adults, and drowning and suffocation among young children. As with any intervention effort, multiple approaches should be examined, and those with the greatest potential effectiveness considered most carefully. Often, these will be strategies that modify elements of the home environment, such as installation and maintenance of smoke alarms. However, strategies will also need to promote changes in safety practices or behavior. For example, drowning among infants in bathtubs likely requires educational approaches associated with super-
vision practices. Finally, policy change and service provision are also important intervention strategies. The prevention of adult poisonings associated with medications or illicit drugs specifically may require new policies regulating access and distribution of substances. Adult poisoning associated with drug use also begs for closer consideration of the issues associated with accessibility of mental health services.

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