

Fall-Induced Injuries and Deaths Among Older Adults

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FALL-INDUCED INJURIES AND deaths among older adults are a major public health problem, especially in developed societies that have aging populations.¹⁻⁵ As the number of older adults in these populations continues to increase, the number of fall-related injuries and resulting deaths is also likely to increase.

About one third of 65-year-old or older persons living in the community and more than half of those living in institutions fall every year, and about half of those who fall do so repeatedly.^{1,2} Both the incidence of falls and the severity of complications increase with age and increased disability and functional impairment.^{2,3} Not all falls of older persons are injurious and life-threatening, but about 5% of them result in a fracture, and other serious injuries occur in 5% to 11% of falls.¹⁻⁵ Injury is the fifth leading cause of death in older adults, and most of these fatal injuries are related to falls.¹⁻⁵ In the United States, falls, occurring primarily among older adults, were the second leading cause of deaths due to unintentional injuries in 1994.⁵

Despite these facts, to our knowledge, no epidemiologic study on the secular trends of fall-induced injuries and

Context Although various fall-induced injuries and deaths among older adults are increasing, little is known about the epidemiology of these events.

Objective To determine the trends in the number and incidence of fall-induced injuries and deaths of older adults in a well-defined white population.

Design and Setting Secular trend analysis of the population of Finland, using the Finnish National Hospital Discharge Register and the Official Cause-of-Death Statistics of Finland.

Participants All persons aged 50 years or older who were admitted to hospitals in Finland for primary treatment of a first fall-induced injury from the years of 1970 to 1995, and for comparison, all fall-induced deaths in the same age group from the years 1971 to 1995.

Main Outcome Measure The number and the age-specific and age-adjusted incidence rate (per 100 000 persons) of fall-induced injuries and deaths in each year of the study.

Results For the study period, both the total and population-adjusted number (per 100 000 persons) of Finns aged 50 years or older with fall-induced injury increased substantially. Total fall-induced injuries increased from 5622 in 1970 to 21 574 in 1995, a 284% increase, and the rate increased from 494 to 1398 per 100 000 persons, a 183% increase. The age-adjusted incidence also increased in both women (from 648 in 1970 to 1469 in 1995, a 127% increase) and men (from 434 in 1970 to 972 in 1995, a 124% increase). Moreover, the number of deaths due to falls in the overall population increased from 441 in 1971 to 793 in 1995, an 80% increase, and the rate increased from 38 in 1971 to 51 in 1995, a 34% increase. However, after age adjustment the incidence of fall-induced death did not show a clear upward trend.

Conclusions In a well-defined white population, the number of older persons with fall-induced injuries is increasing at a rate that cannot be explained simply by demographic changes. Preventive measures should be adopted to control the increasing burden of these injuries. Fortunately, the age-adjusted incidence of the fall-induced deaths shows no increasing trend over time.

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deaths of older adults has been conducted. Therefore, we determined the secular trends in the absolute number and age-specific and age-adjusted incidence rates of fall-induced injuries and deaths among persons aged 50 years or older in Finland, a country with approximately 5 million inhabitants between the years of 1970 and 1995 (deaths were included beginning in 1971).

METHODS

Fall-Induced Injuries

Data for the fall-induced injuries were obtained from the National Hospital

Discharge Register (NHDR) of Finland. This statutory register contains data on age, sex, place of residence, hospital number and department, place and cause of injury, diagnosis, day of ad-

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mission and discharge, and place of further treatment. The register has been operating since 1967 and is updated and monitored for quality by the Department of Registers and Statistics, National Research and Development Center for Welfare and Health, Helsinki, Finland.

In this study, we defined fall-induced injuries as having been incurred by adults aged 50 years or older who as a consequence of a fall (ie, an unexpected, sudden descent from an upright, sitting, or horizontal position, the descent height being ≤ 1 m) were hospitalized (emergency department visits not requiring hospitalization were not included). Similar criteria have been used in epidemiological studies of osteoporotic fractures of the elderly.⁶⁻⁸ Thus, all Finns aged 50 years or older who were admitted to hospitals for primary treatment of a fall-induced injury in the years between 1970 and 1995 were selected from the NHDR. The date of the injury and unique personal identification number system of Finnish citizens allowed us to focus our analysis on each subject's first recorded admission. The fall-induced injuries were classified as bone fractures, soft tissue bruises and contusions, head injuries other than fractures, joint distortions and dislocations, soft tissue wounds and lacerations, and other injuries.

The Finnish NHDR is the oldest established nationwide discharge register in the world, and the data provided by this register are well suited to epidemiologic purposes: the register has been shown to cover the acute injuries of the population adequately (annual coverage of injuries is 95%-100%) and record them accurately (annual accuracy of the NHDR injury diagnoses is higher than 95%).⁹⁻¹²

The injury data were drawn from the entire population of Finland. In other words, the absolute and relative numbers of Finns aged 50 years or older with fall-induced injuries were not cohort-based estimates but complete population results, and, therefore, statistical analyses were not used.

Fall-Induced Deaths

Data were obtained from the Official Cause-of-Death Statistics (OCDS) of Finland.¹³ This statutory register has been computer-based since 1971, and from the beginning, the Cause-of-Death Bureau at the Central Statistical Office of Finland (currently Statistics Finland) has updated it and has maintained quality control.

The Finnish OCDS contains data on age, sex, marital status, place of residence, and place, cause, and time of death of the deceased. In the Finnish system of death certification, the basic reason for the death is clarified by the physician who certified the death and who wrote the official death certificate. In injury-related deaths, an autopsy is required and performed almost without exception in 94% to 97% of these deaths to verify that the death was indeed injury induced.^{13,14}

The main OCDS categories for unintentional injuries are those caused by road traffic and water traffic collisions, falls, drownings, and poisonings.¹³ For the current study, all Finns aged 50 years or older whose deaths were due to a fall-induced injury from 1971 through 1995 were selected.

In practice, the Finnish OCDS reviews 100% of Finnish deaths, since each death certificate and the corresponding decedant information in the population register are cross-checked.¹³ For example, in 1994 only 4 death certificates of the 47 938 deceased were not issued before the deadline and publication of the 1994 statistics.^{13,15}

The accuracy of the data of the OCDS is maximized by triple-checking each code of the death certificate issued by the physician who certified the death.¹³ The first check is made by the local population authority for accuracy of the population data of the deceased, the second by the legal medical officer at the county administration for accuracy and to ensure that the cause-of-death codes and the original death certificate are consistent, and the third by Statistics Finland, a computer-driven check of the logic of the entire database through a cross-tabulation of statistical variables. The accuracy of our death certificates for deaths

due to injuries and their cause-of-death codes are verified further by autopsies performed in 94% to 97% of these cases.^{13,14} The death data for this study were drawn from the entire population of Finland.

Age-Specific and Age-Adjusted Incidence

Annual mid year population figures for each 5-year age group, ranging from 50 to more than 90 years during the years from 1970 through 1995 were taken from the Official Statistics of Finland.¹⁶ In each age group, the fall-induced injury and death incidences were calculated for both sexes and expressed as the number of cases per 100 000 persons each year. In calculating the age-adjusted incidences, age adjustment was performed separately for women and men by means of direct standardization using the mean population between 1970 and 1995 as the standard population.

RESULTS

Fall-Induced Injuries

Numbers and Incidences. The number of older persons with fall-induced injury increased considerably between the years 1970 and 1995: from 5622 to 21 574 overall (a 284% increase) and from 3659 to 14 764 in women and from 1963 to 6810 in men (FIGURE 1, A). The average annual increases for women and men were 12.1% and 9.9%, respectively. In both sexes, the overall incidence curve also showed a clearly increasing trend, although the Finnish population of persons aged 50 years or older increased 36% (from 1.1 million to 1.5 million) during this 25-year period (Figure 1, B). Incidence increased from 494 to 1398 per 100 000 persons, a 183% increase. Even after age-adjustment, the incidence curves showed a clear increase in the number of women injured, increasing from 648 in 1970 to 1469 in 1995, a 127% increase, and the number of men injured, increasing from 434 in 1970 to 972 in 1995, a 124% increase (Figure 1, C). A more detailed examination of these curves showed that the injury development actually consisted of 2 phases: the number and incidence of injuries slightly

decreased between 1970 and 1977 and sharply and steadily increased thereafter.

Comparing the secular changes of the older adults' fall-induced injuries with those of people younger than 50 years or with those whose injuries were induced by means other than falling reveals that the trends are greatest among falls in older adults. For all injuries in Finland (ie, all age groups and all causes for injuries included), the proportion of the study group's injuries increased from 12% in 1970 to 26% in 1995. Within the study group population, this proportion rose from 36% to 56%. Of all persons treated in hospitals for fall-induced injuries, the proportion of older adults increased steadily from 46% in 1970 to 59% in 1995.

Age-Specific Incidences. Age-specific incidence curves showed that the incidence of fall-induced injuries, regardless of sex, increased by age and time and that in both absolute and relative numbers, the incidence increases were higher in older age groups than in younger age groups (data not shown). For example, the incidence of fall-induced injuries (per 100 000 persons) experienced by women aged 50 to 54 years increased from 264 in 1970 to 596 in 1995, a 126% increase. Similarly, the incidence of fall-induced injuries experienced by women aged 90 years or older increased from 2760 in 1970 to 7880 in 1995, a 186% increase.

Mean Age. The mean age of older persons with a fall-induced injury also in-

creased during the study period, from 67.3 years in 1970 to 73.0 years in 1995. In women, the mean age increased from 69.2 to 75.3 years; in men, it increased from 63.6 to 68.0 years.

Injury Distribution by Type. Of all injuries, bone fractures represent the largest injury group and their proportion remained constant (68%) over time in both 1970 and 1995. Soft tissue bruises and contusions, the second largest injury group, increased slightly over time, from 9% in 1970 to 11% in 1995. A slight increase also occurred in joint distortions and dislocations (6% to 9%, respectively), soft tissue wounds and lacerations (3.5% to 4%, respectively), and other injuries (0.5% to 1.5%, respectively). The only injury category that decreased over time was head injuries other than fractures, which declined from 13% in 1970 to 7% in 1995.

Fall-Induced Deaths

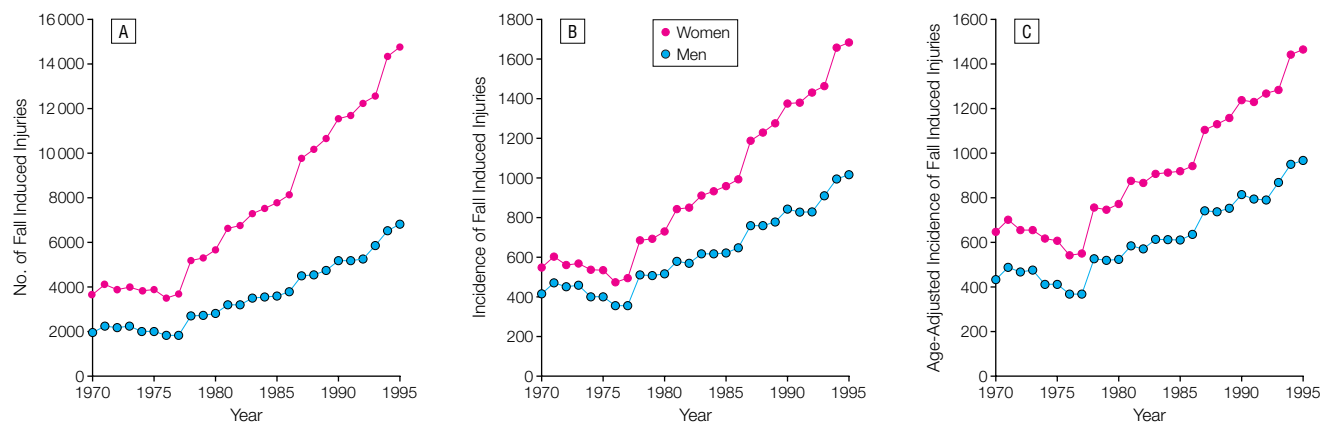
Numbers and Incidences. The number of deaths due to falls in older adults also increased from 441 to 793, an 80% increase overall. The rate increased from 38 in 1971 to 51 in 1995, a 34% increase. Stratified by sex, numbers increased among women from 279 in 1971 to 441 in 1995 and from 162 to 352 in men during the same years (FIGURE 2, A). The average annual increases were 2.4% and 4.9%, respectively. In both sexes, the overall incidence curve also showed an increasing trend, although the Finnish population of persons aged 50 years or

older increased by 36% during this period (Figure 2, B). However, after age-adjustment (Figure 2, C), these incidence curves do not show a clear trend and they show larger annual variation than the corresponding injury curves (see Figure 1, C). In women, the age-adjusted incidence of fall-induced deaths decreased between 1971 and 1975, after which it stayed relatively stable, while in men this incidence rate increased slightly from 1971 to 1995 (Figure 2, C). The number of deaths due to falls decreased in women from 64.9 in 1971 to 37.5 in 1995 and increased in men from 40.5 in 1971 to 47.6 in 1995.

When comparing secular trends of fall-induced deaths among persons aged 50 years or older with the other categories of the unintentional injury deaths, the increasing relative importance of the fall-induced deaths is evident. For all unintentional injury deaths among all age groups in Finland, the proportion of deaths due to falls among those aged 50 years or older steadily increased, from 15% in 1971 to 30% in 1995. Within the population aged 50 years or older, this proportion rose from 33% to 47%, respectively.

Age-Specific Incidences. The limited number of fall-induced deaths per year and age group allowed reasonable examination of the age-specific incidence curves of the fall-induced deaths in 4 age groups that span 10 years: 50 to 59, 60 to 69, 70 to 79, and 80 years or

Figure 1. Trends in Fall-Induced Injuries of Older Adults



Data represent Finnish persons aged 50 years or older injured due to falls from 1970 through 1995. Incidences are reported as number of injured patients per 100 000.

older. In both women and men, the age-specific incidence of fall-induced deaths increased by age, being clearly highest in the oldest age group (≥ 80 years), but none of these incidence curves showed a clearly and consistently increasing time trend (data not shown).

COMMENT

Our study showed that the absolute as well as the relative number (patients per 100 000 persons) of older persons with fall-induced injury increased considerably in Finland between 1970 and 1995: from 5622 and 494 in 1970, to 21 574 and 1398 in 1995, respectively. This increase occurred in both women and men and after age adjustment. The trend was greatest in persons aged 80 years or older. The overall number and incidence of fall-induced deaths among this population also increased during the study period, but as in the age-adjusted figures, the incidence curves did not show definite trends over time.

A major strength of this study was that the data of fall-induced injuries and deaths were taken from 2 registers (the Finnish NHDR and OCDS) both of which are with highly accurate and have excellent coverage,⁹⁻¹⁵ and that both registers included the entire population of Finland. On the other hand, these trends of fall-induced injuries and deaths cannot be directly generalized to other populations in the world, although it is likely that trends are similar in other western

countries with predominantly white population.

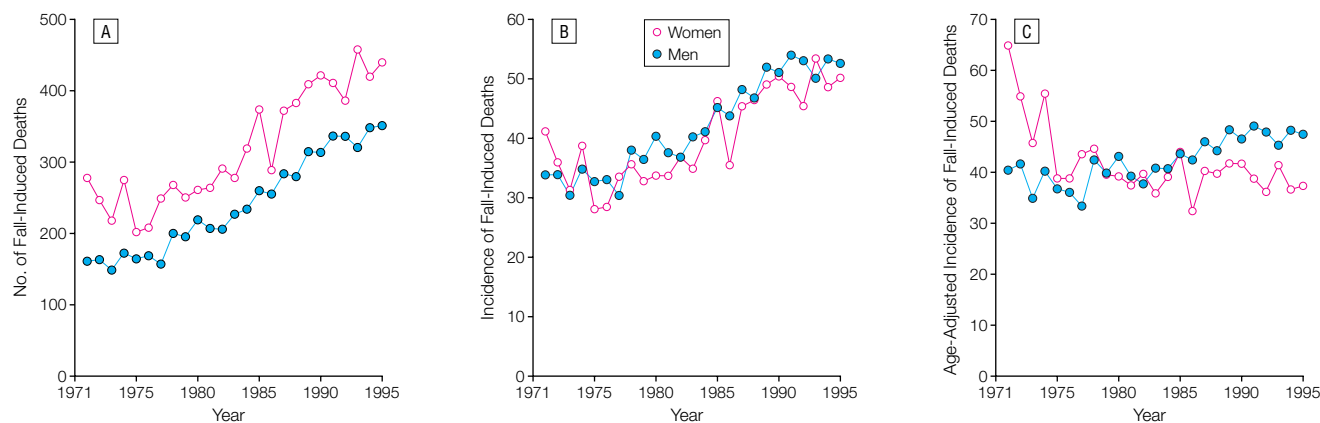
Theoretically, it is possible that the observation that the absolute and relative number of older Finnish persons with fall-induced injuries increased in the years from 1970 to 1995 (Figure 1, panels A, B, and C) is a result of changes in the hospitalization policy of the injured older persons over time rather than a true increase in the number of injured persons in the population. For several reasons, this possibility is, however, very unlikely.

First, the increases were so large that it is unlikely that they would have occurred as a result of a change in the hospitalization policy of older patients only. Any trends in hospitalization policy would have favored outpatient care because in Finland, as elsewhere, the economic mandate calls for reductions in health care costs.¹⁷ Such a trend would mean that our data would underestimate rather than overestimate the true incidence of fall-induced injuries among older adults. Second, the steady increase in the relative number of fall-induced injuries in older adults compared with younger adults, trends in other mechanisms of injury, and the proportion of fall-induced injuries that occurred in older adults support the view that the number and incidence of fall-induced injuries among the elderly Finns indeed increased between 1970 and 1995. The increase in the pro-

portion of all injuries that were due to falls from 36% in 1970 to 56% in 1995 would not be explained by an increased rate of hospitalization. Third, within specific injury categories, we recently studied severe fall-induced head traumas and found that while the age-adjusted incidence of these injuries has clearly increased among older adults during recent decades, it has remained stable among a randomly selected younger reference group, people aged 30 to 39 years.¹⁸ Finally, a similarly increasing trend has been seen in the number and age-adjusted incidence of hip fractures of Finns aged 50 years or older,¹⁹ and these injuries have always resulted in hospital admission.

Our findings on fall-induced injuries among older persons are alarming for 2 reasons. First, not only is the incidence of these injuries increasing, but the population at risk is constantly expanding and will grow more rapidly in the near future. Second, the increasing mean age of the patients presenting with a fall-induced injury is likely to mean more difficulties in the treatment of these injuries and increasing rates of general morbid conditions and, indirectly, death of the patients. In this respect, it was encouraging that the age-adjusted incidence of fall-induced deaths did not show a clear increase over time (Figure 2, C), which is most likely due to improved treatment, rehabilitation, and average health of injured older adults.^{20,21}

Figure 2. Trends in Fall-Induced Deaths of Older Adults



Data represent Finnish persons aged 50 years or older who died due to a fall between 1971 and 1995. Incidences are reported as deaths per 100 000 persons.

The precise reasons for the increasing age-adjusted incidence of fall-induced injuries in Finnish older adults are not known. In the fall-related fractures of the hip and proximal humerus, fractures for which a similar secular trend has been reported,^{8,19} deterioration in the age-adjusted bone density and strength and an increase in the age-adjusted incidence of falls in the older adults have been the most commonly offered explanations.^{19,22,23} In the fall-induced injuries other than fractures, only the latter explanation is plausible.

Among very old adults (persons aged 80 years or older), the suspected increasing average propensity for falls has been explained by such factors as increased occurrence of coexisting medical problems, poorer mobility and neuromuscular function, and more frequent use of drugs and related substances that increase the risk of falling.^{1-5,19} Also, increased survival of ill and frail older individuals may increase the tendency to falls and injuries in this population. On the other hand, no study has been published to confirm that the age-adjusted incidence of falls of the older

adults has increased during recent decades, and in England, Wales,²⁴ and the United States,²⁵ no deterioration in the average health of these people has been observed.

Older adults who are in the young-old age group (eg, 65-75 years) have improved average health and functional capacity compared with past cohorts,^{24,25} and they may engage in more activities that place them at risk of falls. An increasingly mobile lifestyle may thus predispose these persons to injuries due to falls.^{26,27} In addition, the increased average consumption of alcohol, psychotropic drugs, and related substances among the younger Finnish groups of older adults may have increased the risk of falling.^{26,27}

Assuming that the observed rather linear development in the injury incidence continues (Figure 1, B) and that the size of the population of older persons increases as predicted, the annual number of 50-year-old or older Finns experiencing fall-induced injury can be estimated to increase from 21 600 (1995) to about 25 000 and 36 000 in the years 2000 and 2010. However, the

largest Finnish age groups will not reach the average age of the patients in this study until the year 2020, and thus the number of these injuries would be expected to increase particularly rapidly during that time (about 61 000 patients with fall-induced injury per year by 2030). For this reason, vigorous preventive measures, such as reducing the number and severity of falls of older persons, should be implemented to control the increasing burden of these age-related injuries. Fall-prevention interventions have given convincing evidence that strength and balance training of older adults,^{28,29} as well as more multifactorial preventive programs including simultaneous assessment and reduction of many of the individual's predisposing and situational risk factors for falls,^{30,31} can significantly decrease the risk of falling. Such programs should be implemented on a broader scale to reduce the likelihood of falls in older adults.

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