Alarming Rise in the Number and Incidence of Fall-Induced Cervical Spine Injuries Among Older Adults

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**Background.** Although fall-induced injuries among older adults are said to be a major public health concern in modern societies with aging populations, reliable epidemiologic information on their secular trends is limited.

**Methods.** We determined the current trend in the number and incidence (per 100,000 persons) of fall-induced severe cervical spine injuries (fracture, cord injury, or both) of older adults in Finland, a European Union country with a well-defined white population of 5.2 million, by taking into account all persons aged 50 years or older who were admitted to all Finnish hospitals for primary treatment of such injury in 1970–2004. Similar patients aged 20–49 years served as a reference group.

**Results.** The number and raw incidence of fall-induced cervical spine injury among Finns aged 50 years or older rose considerably between the years 1970 and 2004, from 59 (number) and 5.2 (incidence) in 1970 to 228 and 12.0 in 2004. The relative increases were 286% and 131%, respectively. Throughout the study period, the age-standardized incidence of injury was higher in men than women, and showed a clear increase in both sexes in 1970–2004 from 8.5 to 17.4 in men (105% increase), and from 2.8 to 6.4 in women (129% increase). A similar finding was observed in the age-specific incidences of the study group. In the reference group, the annual number and incidence of injury decreased slightly over time. Assuming that the observed increase in the age-standardized or age-specific injury incidence continues in Finns aged 50 years or older and the size of this population increases as predicted, the annual number of fall-induced cervical spine injuries in this population will be about 100% higher in the year 2030 (about 400 injuries annually) than it was during 2000–2004 (about 200 injuries annually).

**Conclusions.** In Finnish persons aged 50 years or older, the number of fall-induced severe cervical spine injuries seems to show an alarming rise with a rate that cannot be explained merely by demographic changes. The finding underscores an increasing influence of falls on health and well-being of our older adults; therefore, wide-scale fall-prevention measures should be urgently adopted to control this development.

Falls and fall-induced injuries in elderly people are a serious public health concern in contemporary societies with aging populations (1–5). Approximately one third of community-dwelling persons 65 years old and older, and more than half of those living in residential care facilities or nursing homes, fall every year. Furthermore, about one half of those individuals who fall do so repeatedly (4–7). The rate of falls increases with age, as functional impairment and disability are highest in frail elderly persons aged 90 years and older (1).

Not all falls of older adults result in injury, but about 20% require medical attention, 5% result in a fracture, and 5%–10% lead to other serious injuries, such as severe head and spine injuries, joint distortions and dislocations, and severe soft tissue bruises, contusions, and lacerations (1,8–10). Of these injury categories, a fall-induced cord injury or fracture to the cervical spine, alone or in combination, is one of the most severe conditions for the victim, although at population level these injuries are relatively rare (11–15). Very little epidemiologic information on fall-induced cervical spine injuries in older persons is available, especially concerning their secular trends. In fact, to our knowledge, no nationwide study investigating the number, incidence, and long-term secular trends of these injuries has been published.

We determined trends in the absolute number and incidence of fall-induced cervical spine injuries, and the gender-specific age-standardized and age-specific incidence rates of these injuries, in the 50-year-old or older population in Finland between 1970 (4.6 million inhabitants, of which 1.14 million were aged 50 years or older) and 2004 (5.2 million inhabitants, of which 1.90 million were aged 50 years or older).

**METHODS**

Data on fall-induced cervical spine injuries in Finland during 1970–2004 originated from the National Hospital Discharge Register (NHDR). This statutory, computer-based register is the oldest nationwide discharge register in the world (in operation since 1967), and provides reportedly reliable data for severe injuries and their causes in the Finnish population (1,16–18). The Finnish NHDR contains data on age, sex, place of residence, hospital number and department, place and cause of injury, diagnosis, day of admission and discharge, and place of further treatment. Injury diagnoses at discharge of the patient are based on all the available clinical and radiological information obtained from the patient during the hospital stay. Concerning hospital-treated acute cervical spine injuries, the final diagnosis
is always based on both of these methods. The annual midyear populations were taken from the Official Statistics of Finland, the statutory, computer-based population register of the country (19). The study program was approved by the register holders and an institutional review board.

This epidemiologic study defined a fall-induced cervical spine injury of an older adult to be an injury (fracture, cord injury, or their combination) that occurred in a person aged 50 years or older as a consequence of a fall from a standing height of 1 m or less (that is, all falls from a raised surface up to 1 m were included) and resulted in hospitalization of the victim. Thus, all patients aged 50 years or older and, for a younger reference group, all patients between 20 and 49 years old (admitted to hospitals in Finland for primary treatment of an acute above-noted injury between January 1, 1970, and December 31, 2004) were selected from the NHDR. Cervical spine injuries caused by vehicular crashes or other high energy traumas were excluded, as were cases with codes identifying sequelae of previous injuries or their orthopedic or neurologic aftercare.

The fall-induced severe cervical spine injuries were recorded from the NHDR by evaluating the primary and secondary diagnoses. According to the directives given by the Finnish National Board of Health, the first diagnosis describes the main reason for the hospital stay. The second, third, and fourth diagnoses indicate other possible diseases or injuries.

In calculating the gender-specific age-standardized injury incidence (per 100,000 persons), the age standardization was done by direct standardization using the mean population of persons aged 50 years or older between 1970 and 2004 as the standard population or reference point (a point for which each annual injury incidence was adjusted). In this way, the population and its injury rates became comparable across the study years and allowed annual assessment of the average individual risk for fall-induced cervical spine injury. The size of the standard population was 572,531 persons in the age group 50–59 years, 453,618 persons in the age group 60–69 years, and 421,543 persons in the age group 70 years or older. The age-specific incidences (per 100,000 persons) were calculated for three 10-year age groups (50–59, 60–69, and 70 years or older, respectively). For data validation and comparison, the incidence rates of injury were also studied in a younger reference group (patients 20–49 years old) to determine whether possible epidemiologic changes in the study groups were specific to the older population or just more general time trends in all adult age groups.

In each of the above-noted study groups, the prediction of future incidence was made with a linear regression model until the year 2030, and then, within each age and sex group, the predicted absolute number of injuries in 2030 was obtained by multiplying the incidence by the estimated number of inhabitants, the latter being obtained from the Finnish Population Projections 2004–2030 (20).

The injury data were drawn from the entire population of Finland, the study thus completely covering the intended study population (Finnish nation). In other words, the absolute numbers and incidences of fall-induced cervical spine injuries were not cohort-based estimates but complete population results; therefore, the study, in full agreement with previous investigations (1,2), did not use statistical analyses with confidence intervals characteristically needed in cohort or sample-based estimations.

RESULTS

The number and raw incidence of a fall-induced cervical spine injury among Finns aged 50 years or older rose considerably between the years 1970 and 2004, from 59 (number) and 5.2 (incidence) in 1970 to 228 and 12.0 in 2004 (Figure 1A). The relative increases were 286% and 131%, respectively.

Throughout the study period, the age-standardized incidence of injury was higher in men than women and showed a clear increase from 1970 to 2004: from 8.5 to 17.4 in men (105% increase), and from 2.8 to 6.4 in women (129% increase) (Figure 1B). A similar finding was observed in age-specific incidences. In men, the injury incidence rates in 1970 were 6.9, 10.0, and 10.5 in the age groups of 50–59, 60–69, and 70 years or older, respectively, versus 10.7, 16.0, and 34.1 in 2004. In women, these incidence rates were 2.6, 2.1, and 3.7 in 1970, versus 3.2, 5.2, and 12.5 in 2004. In the younger (20- to 49-year-old) reference group, the annual number and incidence of injury decreased slightly over time: In 1970, the number and incidence were 85 and 4.5, respectively, and were 75 and 3.6 in 2004. Across the study years, male predominance was clear in this age group, too: 79% and 81% of the patients in 1970 and 2004, respectively, were men.

If the aforementioned increase in the elderly population’s age-standardized and age-specific injury incidence continues at the same rate as in 1970–2004 and the size of the 50-year-old or older population of Finland increases as predicted (approximately 25% increase during the coming 25 years) (19), the number of fall-induced cervical spine injuries in this population will be about 100% higher in the year 2030 (about 400 injuries annually) than it was at the beginning of the millennium (about 200 injuries annually in 2000–2004) (Figure 1C).

DISCUSSION

In this nationwide epidemiologic study, we used the entire Finnish population 50 years old or older to describe the trends between 1970 and 2004 for the absolute number and incidence of fall-induced severe cervical spine injuries. No such study has been published previously, to our knowledge. Our findings suggest that injury incidence is higher in men than in women, and that overall number as well as age-standardized or age-specific incidence of these injuries clearly rose from 1970 through 2004 without signs of leveling off during the most recent years of observation. Thus, fall-induced cervical spine injuries, among other fall-related traumas, represent an alarming epidemic in our older adults, and the predicted aging of the population will soon accentuate the burden on our health care systems (1,20).

Our results confirm previous observations from Finland and elsewhere that various fall-induced injuries and related deaths of older adults have been a rapidly growing problem during the recent decades (1–11,21–25), and they suggest further that this undesirable trend has not stopped in the new
millennium. Even worse is that the further aging of the population is likely to increase the problem so that by the year 2030 Finland may face more than 400 fall-induced severe injuries of the cervical spine among persons aged 50 years or older each year. This prediction requires, however, that the observed development in the incidence rates of these injuries in 1970–2004 continues between 2005 and 2030. If not, the above noted injury scenario is an overestimation. In contrast, our assumptions on the continuously rising number of elderly adults in Finland during the coming 30 years is very robust and reliable, because all individuals who will be age 50 years or older in the year 2030 have already been born.

In light of these findings, Finland may have great difficulty providing the necessary standard treatments and coping with the financial burden of the fall-induced injuries of elderly adults (7,21). Many other developed countries are likely to face a similar dilemma, although detailed epidemiologic data from other countries are largely lacking.

The exact reasons for the rise in the elderly population’s age-adjusted or age-specific incidence of fall-induced injuries are unknown (1,2,4,7,9). An increase in the average risk of falling caused by impaired muscle strength, balance, and reaction time may partly explain the phenomenon. The decrease in these domains of musculoskeletal performance have been explained by such factors as poorer physical condition, less active lifestyle, poorer nutritional status (vitamin D and calcium), increased consumption of cigarettes and alcohol, greater occurrence of coexisting medical problems, and increased use of balance-affecting drugs (1,9). In addition, today’s older people may have more serious consequences of falling than did their predecessors.

An increasing number of less healthy and functionally less capable elderly people are, among others, now surviving to older ages (e.g., due to more effective health care and life-expanding treatments and medication); and this increase in survival may result in an increase in severe falls (4,7,9).

In this study of fall-induced severe cervical spine injuries, the age-standardized injury incidence was higher in men than in women. Recently we made a similar finding in another group of older adults’ severe falls or fall-induced deaths (21). Because the general incidence of falling is higher in elderly women than in elderly men (1,4,7,9,22), it can be hypothesized that elderly men have an increased risk for severe falls than do their female counterparts. Further studies are, however, needed to confirm these observations and to examine the reasons for this gender difference.

Taken together, as the increased number and incidence of fall-induced severe cervical spine injuries among Finnish persons age 50 years or older between 1970 and 2004 cannot be explained merely by demographic changes,
effective fall-prevention actions are urgently needed to control this development. Multifactor interventions aimed at reducing the number of falls of elderly persons by simultaneously modifying many of the predisposing and situational risk factors for falls have shown promising results (4,5,7,10,26). Also, single-factor interventions such as strength and balance training have clearly reduced the risk of falling (7,27). Now it is time for their wide-scale implementation.

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REFERENCES

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