Continuous Increasing Number and Incidence of Fall-Induced, Fracture-Associated, Spinal Cord Injuries in Elderly Persons

Pekka Kannus, MD, PhD; Seppo Niemi; Mika Palvanen, MD; Jari Parkkari, MD, PhD

Background: Although osteoporosis, falls, and fractures among older adults are said to be a continuously increasing public health problem, reliable epidemiological information on their secular trends is very limited.

Objective: To determine the current trend in the number and incidence of fall-induced, fracture-associated, spinal cord injuries in a typical white population (Finland, a country with about 5 million inhabitants).

Methods: All Finns aged 50 years or older who were admitted to hospitals from January 1, 1970, through December 31, 1995, for primary treatment of an acute fall-induced, fracture-associated, spinal cord injury were selected from the National Hospital Discharge Register. Similar patients aged 20 through 39 years served as a reference group. In each year of the study, the number and the age-specific and age-adjusted incidences of injuries were expressed as the number of patients per 100,000 persons.

Results: The total number of fall-induced, fracture-associated, spinal cord injuries of Finnish older adults increased considerably during the study period, from 60 in 1970 to 419 in 1995 (an average increase of 24% annually). The corresponding injury incidence was 5 in 1970 and 27 in 1995. The age-adjusted incidence of these injuries also increased from 1970 to 1995: in women, from 5 to 29, and in men, from 7 to 17 (relative increases were 480% and 143%, respectively). In the reference group, no trend changes by time were observed.

Conclusions: In Finnish persons aged 50 years or older, the number of fall-induced, fracture-associated, spinal cord injuries shows a rise with a rate that cannot be explained merely by demographic changes. The finding shows an increasing influence of osteoporosis and falls on health and well-being of our older adults, and therefore, vigorous preventive measures are needed to control this development.

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Falls and fall-induced injuries of older adults are a major public health problem in modern societies with aging populations.1-12 Because the number of older persons in these populations continues to increase, the number of falls and injuries is likely to increase as well.4,6,7,11 Approximately 30% of the older persons living in the community and more than 50% of those living in geriatric long-stay facilities fall every year, and about 50% of those who fall do so repeatedly.2,4 Not all falls of older adults result in injury, but 4% to 5% of the falls cause a fracture, and an additional 5% to 11% of falls cause other serious injuries, eg, serious soft tissue contusions, joint distortions and dislocations, severe wounds and lacerations, and head injuries.2,4,6

Of the injury categories noted earlier, a fall-induced vertebral fracture is one of the most severe conditions, especially when the fracture is accompanied by an acute spinal cord injury. Despite this, very little epidemiological information on fall-induced vertebral fractures and fracture-associated spinal cord injuries in older persons is available, especially concerning their secular trends.13-15 In fact, to our knowledge, no nationwide study investigating the number, incidence, and secular trends of these injuries has been published. Therefore, we determined trends in the absolute number and incidence of fall-induced, fracture-associated, spinal cord injuries, and the age-specific and age-adjusted incidence rates of these injuries in the 50-year-old and older population in Finland between 1970 (4.6 million inhabitants) and 1995 (5.1 million inhabitants). We also studied the same figures in a younger reference group (patients aged 20-39 years) to determine whether the possible epidemiological changes in the study group were specific for the older population or just more general time trends in all adult age groups. Our hypothesis was that the number of fall-induced, fracture-associated, spinal cord injuries among older persons is rising at a rate that cannot be explained merely by demographic changes.
SUBJECTS AND METHODS

DATABASE FOR THE FALL-INDUCED, FRACTURE-ASSOCIATED, SPINAL CORD INJURIES

This epidemiological study defined a fall-induced, fracture-associated, spinal cord injury of an older adult to be an injury that occurred in a person aged 50 years or older as a consequence of a fall from a 1-m or less standing height that resulted in hospitalization of the victim. Similar criteria have been used in previous epidemiological studies of injuries of elderly people.\(^1\)\(^{10}\)\(^{16}\)\(^{17}\) Thus, all patients aged 50 years or older, and for a younger reference group all patients aged between 20 and 39 years, who were admitted to hospitals in Finland for primary treatment of an acute fall-induced, fracture-associated, spinal cord injury between January 1, 1970, through December 31, 1995, were selected from the National Hospital Discharge Register (NHDR). The date of the injury and the unique personal identification number system of the Finnish citizens allowed the study to focus the analysis on each patient’s first recorded hospital admission. Injuries caused by a vehicular accident or other high-energy trauma were excluded.

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. This statutory register has been operating since 1967 and is updated and quality-controlled by the Department of Registers and Statistics, National Research and Development Center for Welfare and Health, Helsinki, Finland.

The Finnish NHDR is the oldest nationwide discharge register in the world, and data provided by this register are well suited to epidemiological purposes, ie, the register has been shown to cover the acute injuries of the population adequately (annual coverage of injuries is \(\geq 95\)% and to record them accurately (annual accuracy of the NHDR injury diagnoses is also \(\geq 95\)%), and these percentages are especially good in severe injuries with clear-cut diagnoses, such as fracture-associated spinal cord injuries.\(^{16}\)\(^{21}\)

Fall-induced, fracture-associated, spinal cord 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. The diagnoses were coded with a 5-digit code according to the eighth and ninth revision of the International Classification of Diseases that indicated the type of injury. The eighth revision of International Classification of Diseases and its code-class 806 for fracture-associated spinal cord injury were used in 1970-1986, and the corresponding ninth revision in 1987-1995. Cases with codes identifying trauma sequelae and orthopedic or neurologic after care were excluded.

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, fracture-associated, spinal cord injuries were not cohort-based estimates but complete population results.


Annual midyear population figures for each 5-year age group (50-54, 55-59, ... \(\geq 90\) years) between 1970 and 1995 were taken from The Official Statistics of Finland.\(^{22}\) In this statutory, computer-based register, every Finn is registered by his or her personal identification number, and the register is quality controlled continuously and updated by Statistics Finland, the Central Statistical Office of Finland.

In each age group, the injury incidence was calculated for both sexes and was expressed as the number of cases per 100000 persons per year. In calculation of the age-adjusted injury incidence, age adjustment was done by direct standardization using the mean population between 1970 and 1995 as the standard population.

Finally, the figures of injury incidences observed in the different age groups over the study period (1970-1995) were used to predict the age-specific incidences and the absolute number of these fall-induced, fracture-associated, spinal cord injuries in the population in 2010, 2020, and 2030. The prediction was based on a simple linear trend continuation method using ordinary least squares as the method of regression and \(r^2\) and standard error of the estimate as descriptors of the fitness of the regression line to the data. The prediction was performed by first calculating the incidence regression lines for both sexes and for each age group. These regression lines were then used to determine the age- and sex-specific injury incidences in women and men aged 50 years or older until 2030. Then, within each age and sex group, the predicted absolute number of injuries was obtained by multiplying the aforementioned incidence by the estimate of the number of inhabitants, the latter being obtained from the Finnish Population Projections 1995-2030.\(^{23}\)

RESULTS

NUMBER AND INCIDENCE OF FALL-INDUCED, FRACTURE-ASSOCIATED, SPINAL CORD INJURIES

Older Adults

In persons aged 50 years or older, the annual number of fall-induced, fracture-associated, spinal cord injuries increased considerably during the study period, from 60 in 1970 to 419 in 1995 (Figure 1). The average increase was 24% per year. The incidence curve for injuries also showed a clearly increasing trend, although the Finnish population of persons 50 years or older increased 36% (from 1.1 to 1.5 million) during this 25-year period: the overall incidence (per 100000 persons) of fall-induced, fracture-associated, spinal cord injuries in persons aged 50 years or older was 4 in 1970 and 27 in 1995 (Figure 1).

The mean age of the patients also increased, in women from 66 years (1970) to 78 years (1995), and in men from 62 years (1970) to 69 years (1995). Despite this, the age-adjusted incidence of these fall-induced, fracture-associated, spinal cord injuries also showed an in-
crease from 1970 to 1995; in women, from 5 to 29, and in men, from 7 to 17 (relative increases were 480% and 143%, respectively).

When comparing the epidemiological development of the older adults’ fall-induced, fracture-associated, spinal cord injuries with that of other age groups or with the fracture-associated spinal cord injuries induced by mechanisms other than falling, the continuously increasing importance of the former received additional evidence. For all fracture-associated spinal cord injuries in Finland (ie, all age groups and all causes for these injuries included), the proportion of the 50-year-old or older persons’ fall-induced, fracture-associated, spinal cord injuries showed a steady increase, from 24% in 1970 to 58% in 1995. In the population aged 30 years or older, the proportion of fall-induced, fracture-associated, spinal cord injuries (of all fracture-associated spinal cord injuries in this age group) rose from 72% to 84%.

Younger Adults

In patients aged 20 through 39 years, the annual number and incidence of fall-induced, fracture-associated, spinal cord injuries did not show increasing trend by time: in 1970, this number and incidence (per 100,000 persons) were 60 and 4.5, respectively, while 67 and 4.7 in 1995 respectively, (Figure 1).

AGE-SPECIFIC INCIDENCE OF FALL-INDUCED, FRACTURE-ASSOCIATED, SPINAL CORD INJURIES IN OLDER ADULTS

In the youngest age groups of the elderly women and men (aged 50-69 years), the incidence of fall-induced, fracture-associated, spinal cord injuries did not show clear trend changes over time, while in the older age groups, especially in those aged 80 years or older, the injury incidence clearly increased (Figure 2).

FALL-INDUCED, FRACTURE-ASSOCIATED, SPINAL CORD INJURIES IN OLDER ADULTS IN THE FUTURE

If the aforementioned increase in the age-specific injury incidence continues, the overall incidence of older persons’ fall-induced, fracture-associated, spinal cord injuries (per 100,000 Finns aged ≥50 years) can be calculated to be 32, 42, and 57 in 2010, 2020, and 2030, respectively. Together with the predicted increase in the size of the population, these incidences mean that in 2010 the total number of older persons with a fall-induced, fracture-associated, spinal cord injury in Finland (5 million population) will be approximately 660, and correspondingly, 900 and 1200 in 2020 and 2030 (Figure 3). Thus, the current number of injuries may treble by 2030.

In this epidemiological study we used the entire Finnish population aged 50 years or older to describe the trends over time for the absolute number and incidence of fall-induced, fracture-associated, spinal cord injuries. No such study has been published previously, to our knowledge. We found that the overall number and incidence (per 100,000 persons) of these injuries rose considerably from 60 and 3, respectively, in 1970, to 419 and 27 in 1995 (Figure 1). In both sexes the increase in injury incidence was most pronounced in the oldest age groups, especially in persons aged 80 years and older (Figure 2).

A clear strength of our study was that data were taken from the Finnish NHDR, with proven high accuracy and excellent coverage of injuries, and that the registration of injuries included the entire population of Finland; ie, absolute numbers and incidences of fall-induced, fracture-associated, spinal cord injuries were not cohort-based estimates but complete population results. With the NHDR and the unique personal identification number system of the Finns, we were able to eliminate multiple admissions caused by transfers between hospitals and hospital departments and readmissions due to complications and other treatment problems. Our results also represent practically all incidents of fall-induced, fracture-associated, spinal cord injuries in this country, because all patients with an acute, fracture-associated, spinal cord injury are admitted to a hospital department.

An additional strength of the study was that our older patients had a younger reference group (persons aged 20-39 years with similar injury diagnoses) in which no increasing number and incidence of injuries were seen during 1970 through 1995 (Figure 1). In other words, the behavior of the reference group over time provided rather convincing additional evidence that our NHDR-based observations on the steeply increasing number and incidence of fall-induced, fracture-associated, spinal cord injuries among older Finns were real and not caused by defects, inaccuracies, or changes in the system of injury registration. The steady increase in the proportional figures of the older adults’ fall-induced, fracture-associated, spinal cord injuries (compared with those of other age groups and with the fracture-associated spinal
cord injuries induced by mechanisms other than falling) also supported our conclusions (see “Results” section).

A limitation of our study is that the numbers, incidences, and secular trends of the fall-induced, fracture-associated, spinal cord injuries of the older Finns cannot be directly generalized to other populations. However, the incidence of injuries will probably develop similarly in other developed countries with an aging white population. Further studies are required to show precise results for each population. In addition, our database of injuries excluded information on comorbid illnesses, medications, and lifestyles of the patients. In other words, our finding of an increasing incidence of fall-induced, fracture-associated, spinal cord injuries among older adults in Finland remained without explanatory speculations.

In this context it is also good to remember that we studied a very specific group of patients with a vertebral fracture: it has been estimated that less than half the patients with a vertebral fracture seek medical help (many osteoporotic vertebral fractures are spontaneous and not symptomatic enough to result in medical consultation), that no more than 10% come to inpatient hospital attention, and that no more than 1% have accompanying spinal cord affection. This, however, in no way devalues the observation on the drastically increasing number and age-adjusted incidence of fall-induced, fracture-associated, spinal cord injuries among older Finns: since our database is very accurate and complete, the finding is likely to be a true reflection of a rising problem of vertebral fractures in our aging population.

However, as we have noted earlier, the precise reasons for the increasing age-adjusted and age-specific incidences of fall-induced, fracture-associated, spinal cord injuries in older women and men are unknown. In the fall-related fractures of the hip and proximal humerus, fractures for which a similar secular trend has been reported, deterioration in the age-adjusted bone quality (caused by decreased mineral density and bone strength) and an increase in the age-adjusted incidence of falls in older adults (caused by impaired balance, coordination, proprioception, reaction time, and muscle strength) have been the most commonly offered explanations. In fall-induced, fracture-associated, spinal cord injuries of older adults, both of these explanations are possible.

We believe that, on average, the oldest persons (≥80 years) are less healthy and functionally less capable today than in the past; thus, persons who now survive to old age are, on average, more prone to osteoporosis, falls, and injuries than were persons of the same age in the past. In other words, increased survival of ill and frail older individuals is likely to mean increased average tendency to osteoporosis, falls, and fractures. Reduced bone strength and increased propensity for falls have, in turn, been explained by such factors as increased body height,
greater occurrence of coexisting medical problems, poorer nutrition (calcium, vitamin D), more frequent use of drugs, poorer neuromuscular function (mobility, gait, and balance), less active lifestyles, and greater consumption of tobacco and alcohol and other related substances that increase the risk of bone loss and falling.2,4,6,11,36-41

Our observations on fall-induced, fracture-associated, spinal cord injuries among older persons are alarming. The first concern is that not only is the incidence of these injuries rising, but also the population at risk is constantly expanding and will expand more rapidly in the near future. As a result, the largest age group in Finland (the 15-year cohort born after World War II) will reach the average age of older adults with this injury between 2020 and 2030. Second, the increasing mean age of the patients initially seen with a fall-induced, fracture-associated, spinal cord injury is likely to present more difficulties in the treatment of these injuries (longer time for recovery, longer rehabilitation period, and an increasing number of spinal cord injuries with severe complications such as paraplegia or tetraplegia) and rising rates of general morbidity and death of the patients.

Provided that the observed development in the age-specific injury incidences continues, the annual number of fall-induced, fracture-associated, spinal cord injuries in Finland for persons aged 50 years or older can be estimated to be about 600 and 900 in 2010 and 2020, respectively (Figure 3). However, as described earlier, the largest Finnish age groups will not reach the average age of the patients until 2020, and thus, the number of these injuries is expected to increase especially rapidly then. For this reason, vigorous preventive measures, such as prevention and treatment of osteoporosis and diminution of the number and severity of falls of older persons, should be urgently implemented to control the increasing burden of these age-related injuries.

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Corresponding author: Pekka Kannus, MD, PhD, UKK Institute, Kaupinpuistonkatu 1, FIN-33500 Tampere, Finland (e-mail: klpeka@uta.fi).

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