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Seasonal variations in incidence of fractures among elderly people

Marija Bulajic-Kopjar

Abstract

***Objective*—To investigate seasonal variations in the incidence of fall related fractures among people 65 years and older.**

***Population and methods*—A prospective, population based cohort study was performed on people aged 65 years and older followed up from 1990 to 1997, a total of 459 904 person years. Cases were identified through a prospective registration system.**

***Results*—There were 10 992 (2390 per 100 000 person years) fall related fractures. The risk was higher in the colder seasons (October through March) among people aged 65–79 years (relative risk (RR) = 1.39, 95% confidence interval (CI) 1.32 to 1.47) and in people aged 80 years and older (RR = 1.17, 95% CI 1.09 to 1.22). For arm fractures, the RR was 1.69 (95% CI 1.56 to 1.83) among people aged 65–79 years and 1.30 (95% CI 1.13 to 1.43) among those aged 80 years and older. The RR for hip fractures was 1.27 (95% CI 1.15 to 1.37) among people aged 65–79 years and 1.08 (95% CI 1.00 to 1.15) for people aged 80 years and older. Slipping on ice and snow seems to entirely explain the excessive incidence of hip and arm fractures during winter months.**

***Conclusion*—Season affects the incidence of all types of fractures in elderly people. Slipping on ice and snow seems to be a causal mechanism behind the seasonal effect. Preventive measures targeting this causal mechanism are likely to reduce the risk of fracture, but the size of the effect is difficult to estimate with certainty.**

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Keywords: elderly; fractures; seasonal variations

Falls are a main cause of injury among elderly people and a major public health problem. The most serious common fall injury is a hip fracture. Numerous studies have investigated risk factors for hip fractures, including the effect of seasonal changes. Findings are contradictory. Studies from Sweden,[1 2] United Kingdom,[3 4] Australia,[5] Italy,[6] and United States[7 8] report seasonal variations, whereas others did not.[9–13]

Various hypothetical causal mechanisms for these seasonal variations have been offered. Differences in exposure to sunlight in winter and summer have been suggested as one possible explanation.[1 7 14] Reduced sunlight may result in poor visual acuity because of shorter daylight periods, low sun on the horizon, reduced synthesis of vitamin D and consequent osteomalacia. Cold weather may also result in decreased activity and concomitant increased bone loss.[15] Freezing temperatures may increase risk of slipping.[16–18] In one study, the risk of hip fracture was related to icy and slippery winter weather conditions among women aged 45–75 years, but not among women aged 75 years and older.[8]

It is unclear which of the proposed pathways accounts for the seasonal variations in hip fracture. Also unknown is whether similar variations occur for other types of fractures among elderly people.

The current study investigates seasonal variations in the incidence of different types of fractures among the elderly, and estimates the contribution of slipping on ice and snow to the pattern of these injuries.

Population and methods

We conducted a prospective observational population based cohort study in a defined population aged 65 years and older in three urban areas in Norway (Stavanger, Trondheim, and Harstad) and their surrounding communities. The study lasted from 1 January 1990 to 31 December 1997 and involved 459 904 person years of observation. The average population during the study period was 57 488. The total number of person years of follow up was divided into exposure during the eight colder seasons (from 1 October through 31 March), and during the eight milder seasons (from 1 April through 30 September). The same subjects served both as the exposed population (exposure time during the colder seasons) and the control population (exposure time during the milder seasons). New subjects entered the population by reaching the age inclusion limit (65 years) or by moving into the study area. The subjects left the study population by emigrating or by dying. The information on population changes has been obtained from the Central Population Register of Norway that prospectively records individual information and is highly accurate.

Outcome was defined as a fall related fracture. Cases were identified through an ongoing prospective registration of all injuries performed by the National Injury Sample Register for Norway. The system registers injuries according to adapted classification and protocol for registration of injuries in the Nordic countries.[19] The registration covers all medical facilities able to treat fractures in the study population. All fractures are registered,

Department of Population Health Sciences, National Institute of Public Health, PO Box 4404 Torshov, 0403 Oslo, Norway

Correspondence to:
Dr Bulajic-Kopjar (e-mail: marija.bulajic-kopjar@folkehelsa.no)

Table 1 Incidence of fractures among elderly people by nature of injury, age, sex, and season of the year

	Women				*Men*				*Both sexes*	
	Incidence/ 100 000 person years				*Incidence/ 100 000 person years*					
	Winter	*Summer*	*Incidence rate ratio (95% CI)*	*PAR (%)*	*Winter*	*Summer*	*Incidence rate ratio (95% CI)*	*PAR (%)*	*Incidence rate ratio (95% CI)*	*PAR (%)*
65–79 years										
Hip	820	684	1.20 (1.08 to 1.33)	9	418	293	1.42 (1.20 to 1.70)	18	1.27 (1.15 to 1.37)	12
Arm	1473	872	1.69 (1.55 to 1.84)	26	357	211	1.69 (1.39 to 2.05)	26	1.69 (1.56 to 1.83)	26
Other	560	478	1.17 (1.04 to 1.33)	8	270	262	1.03 (0.85 to 1.25)	1	1.12 (1.02 to 1.25)	6
Any	2853	2035	1.40 (1.32 to 1.49)	17	1044	766	1.36 (1.22 to 1.52)	15	1.39 (1.32 to 1.47)	16
⩾80 years										
Hip	3235	3056	1.06 (0.98 to 1.15)	3	1769	1571	1.13 (0.96 to 1.32)	6	1.08 (1.00 to 1.15)	4
Arm	1544	1247	1.24 (1.10 to 1.40)	11	527	346	1.52 (1.10 to 2.09)	21	1.30 (1.13 to 1.43)	13
Other	813	618	1.31 (1.11 to 1.56)	14	522	379	1.38 (1.01 to 1.88)	16	1.34 (1.14 to 1.54)	14
Any	5592	4922	1.14 (1.07 to 1.21)	6	2819	2297	1.23 (1.08 to 1.40)	10	1.17 (1.09 to 1.22)	8

CI = confidence interval; PAR = population attributable risk.
Summer: 1 April through 30 September; winter: 1 October through 31 March.

including those occurring among the institutionalized elderly people. Fractures caused by motor vehicle crashes and occupational injuries are excluded. Multiple fractures from the same injury event were calculated as a single case. Repeated fractures to the same person on different occasions were calculated as separate cases.

We stratified the analysis by age (65–79 years and 80 years and older), sex, and nature of injury. For nature of injury, cases were grouped as follows: hip fracture (*International Classification of Diseases*, ninth revision (ICD-9) code 820), arm fracture (ICD-9 codes 812–817), other fracture (ICD-9 codes 800–829 excluding hip and arm fractures). In the case of multiple fractures occurring in a single injury event, the following order of preference was followed: hip fracture, arm fracture, other fracture. The seasonal pattern was analyzed by calculating the relative risk for injury during the exposure to colder seasons compared with the exposure to the milder seasons. We also analyzed month-by-month changes in incidence rates, but that did not help to better clarify the seasonal patterns, due to smaller samples and larger random variations. Relative risk (RR) was calculated as the incidence rate ratio. Confidence intervals (95% CI) for the RR were calculated for each age, sex, and nature of injury subgroup by applying estimation method used for the person time denominator.[20] The joint incidence rate for both sexes within the same age and nature of injury subgroup was estimated by the Mantel-Haenszel procedure using the relative size of the groups as the weighting factors.[20]

The contribution of icy and slippery conditions to the incidence of injuries was analyzed by classifying cases in those caused by slipping on ice and snow and those due to all other mechanisms. We calculated incidence rates stratified by each age, sex, and nature of injury.

Results

From 1990–97, 10 992 (2390 per 100 000 person years) fall related fractures occurred among people aged 65 years and older in the study population. Of these, 75% were caused by falls on the same level, 14% caused by falls from a level less than 1.5 m high, and fewer than 1% caused by falls from a level higher than 1.5 m. For 8% of the cases this information was missing.

Table 1 shows the incidence rate of injuries by nature of injury, season of the year, age, and sex.

There was a statistically significant difference in incidence rate of injuries occurring during the colder seasons for each sex and age subgroup. The difference was larger among people aged 65–79 years (RR = 1.39) than among people aged 80 years and older (RR = 1.17). It was similar for both men and women in the respective age subgroups. Approximately 16% of the cases in the age group 65–79 years and 8% of the cases in the older age group could be attributed to effects associated with colder season.

The difference in incidence rate of fractures between the colder and warmer seasons is most pronounced for arm fractures. Among people aged 65–79 years, the incidence rate of arm fractures was 69% (95% CI = 56% to 83%) higher during the colder season compared with milder season. The pattern was similar for women and men. Among people aged 80 years and older, the incidence rate of arm fractures was 30% (95% CI = 13% to 43%) higher during the colder compared with the milder season. The effect was higher among men (RR = 1.52) than women (RR = 1.24).

Twenty seven per cent (95% CI 15% to 37%) more hip fractures occurred during the colder than the milder season among people aged 65–79 years. The effect was somewhat higher among men (RR = 1.42) than women (RR = 1.20). Twelve per cent of all hip fractures occurring among people aged 65–79 years were attributed to the season effect. Among people aged 80 years and older, the seasonal pattern in occurrence of hip fractures was moderate (RR = 1.08, 95% CI 1.00 to 1.15). Only 4% of hip fractures were attributed to the effect of season.

Other fractures also showed statistically significant seasonal variation. Among people aged 65–79 years, the effect was smaller (RR = 1.12) than among people aged 80 years and older (RR = 1.34).

Table 2 shows the incidence rate of injuries by age, sex, nature of injury, season, and cause of accident. The excess incidence of hip

Table 2 Incidence rate (per 100 000 person years) of fall fractures by age, sex, nature, season and cause of the accident

	Hip fracture		*Arm fracture*		*Other fracture*	
	Snow/ice	*Other*	*Snow/ice*	*Other*	*Snow/ice*	*Other*
Men						
65–79 years						
Summer	1	292	4	207	1	261
Winter	112	306	147	210	88	182
⩾80 years						
Summer	16	1555	0	346	0	379
Winter	220	1549	143	385	93	429
Women						
65–79 years						
Summer	6	678	12	860	9	469
Winter	142	677	612	862	155	406
⩾80 years						
Summer	3	3054	8	1239	5	613
Winter	194	3040	254	1291	119	694

Summer: 1 April through 30 September; winter: 1 October through 31 March.

fractures is entirely due to the fractures occurring by slipping on ice and snow. A similar finding is suggested for arm fractures. For other fractures, the excess risk is less clearly related to slipping on ice and snow.

Discussion

Studies investigating seasonal pattern in the incidence of hip fracture are contradictory.[1–13] In the current study, a seasonal variation in incidence of fall related fractures among elderly people exists for all types of fractures and in all age and sex groups. The seasonal pattern is most pronounced for arm fractures, and in the younger age group. Our study strongly suggests that the seasonal effect on the incidence of hip and arm fractures occurs entirely due to slipping on ice and snow. Seasonal effects are less likely to occur in areas with mild winter temperatures. This may explain the lack of seasonal variations in some studies. A seasonal effect on hip fractures among the oldest old is small and unlikely to be observed in studies performed on small samples.

Our study suggests that preventive measures should be targeted to icy and slippery surface conditions. Removing ice and snow and increasing friction of the icy surfaces with friction increasing materials are preventive measures that are centuries old. Such measures have, in various extents, been applied in our population during the study period. Population attributable fractions suggest a substantial prevention potential from a more intensive use of these measures. However, caution is required before translating the population attributable fractions calculated in this study into risk reduction estimates. The population attributable fraction is not the same as the preventable fraction.[21] The fact that a proportion of injuries can be attributed to slipping on ice and snow does not imply that the same proportion of injuries would be avoided if all exposure to slipping on ice and snow was removed. An unknown number of injuries caused by slipping on ice would still occur because of competing risks. Removing ice and snow, or increasing stepping surface friction, could increase the exposure time for walking outdoors, as more people might feel safe to do so. Also, other mechanisms may play a part. From our data it is difficult to estimate how large the injury prevention effect of the improved ice and snow removal and the application of friction increasing materials would be. Intervention studies are required to answer that question.

This study has some limitations. Cases are missed if treated outside the registration system catchment area. This is, however, unlikely to cause major distortion of the findings. People are probably more likely to travel during the warmer season, leading to a differential underestimation of incidence rates for colder and warmer seasons. National hospital discharge statistics show that only about 1%–2% of hip fractures in our study population are treated in hospitals not represented in the injury register. Possible differential underreporting of that size would not significantly influence the estimates. Further, our injury registration system is designed so that people injured and receiving initial treatment at other places, but coming for the follow up visit to a facility involved in the registration, are captured by the system. Information bias may also play a part. People may over-report by wrongly describing injuries as related to slipping on ice and snow, or under-report by failing to describe them correctly. Under-reporting is more likely and cannot be easily ruled out. But it would make our conclusions about the importance of slipping on ice and snow even stronger.

Finally, our findings are only valid for Norway. But weather in Norway is not much different from that of other Scandinavian countries, Central and Mid West states in the US, and many other countries in the world. It makes our findings likely to explain the seasonal variations in fractures that have been reported from many countries.

Implications for prevention

Slipping on ice and snow seems to be the main factor contributing to the excess seasonal risk of hip, arm, and other fractures among elderly people. Preventive measures targeting these causal mechanisms are likely to result in a reduced risk of fracture, but the size of the effect is difficult to estimate with certainty. A variety of preventive measures could be applied—health education, use of safety equipment, removal of ice and snow, or home food delivery services to the elderly during cold periods. Little is known about the costs and effectiveness of such measures, and good evaluation studies are needed to help select them.

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Two snake reports

Assault with a deadly . . . snake??

Sawn-offs, handguns, knives, and the trusty blood filled syringe . . . but for those awkward moments when you get caught without, the resourceful robber can always turn to the reptile world like Oklahoma City resident Lyle Burpo (yes, his real name). Clearly believing it was time someone tried a stick up armed only with a snake, he allegedly walked into a convenience store with a small python that he passed off as a highly venomous copperhead. For his trouble he received some cash and cigarettes and, a short time later, a visit from some not-quite-plussed policemen. The snake made no comment (*The Weekend Australian*, December 1999).

Just when you thought it was safe to visit Australia *or* How to be a sensitive expert

Seven year old Gerard O'Hare was camping with his family near Brisbane, Australia, and thought he was having a bad dream. At 4 am his father woke to his scream and found a 3 metre python wrapped tightly around the boy. "It's head was as big as my hand", Mr O'Hare said, "it had two wraps around his neck and stomach". Gerard was fine after being flown to hospital and treated for about 20 bites and some bruising. A snake expert said this was a rare event. "While the snake could have strangled the boy to death, it would have been unable to eat him. I see no reason to kill the snake", he said "I don't think its going to make the same mistake twice!" (*The Australian*, December 1999).

Martial arts regulation called for

The parents of an 18 year old who suffered a brain haemorrhage, stomach trauma, and vision loss after competing in a martial arts grading session are demanding tougher laws for Victorian martial arts instructors and schools. The man suffered the injuries during a grading for his second dan black belt. While parents had been assured that the session would be non-contact *The Age* says that video evidence shows the youth being struck repeatedly to the head and stomach. After being taken to hospital the next day the man was diagnosed as having substantial bleeding to the left side of the brain. Swelling of the brain and bleeding caused him to be urgently transferred to specialist care and he spent a week in hospital. A month later he is unable to drive, cannot return to work, and his vision is impaired. Doctors have told the family he could take up to two years to recover and some damage may be permanent. The parents are concerned that their 65 kilogram son was challenged by two full grown men, "one of whom was about 140 kg", who were not members of the club and who broke the non-contact rule. They are also concerned that there is no state legislation controlling the activities of martial arts instructors or clubs. While at one stage there was a system of compulsory licensing of all martial arts instructors in Victoria, revisions in 1997 did away with this practice (based on reports in *The Age* (Melbourne), September 1999).