Original Article

Trends and epidemiology of spine fractures in the super-elderly population in the United States

ABSTRACT

Introduction: Spine fractures occur commonly in the geriatric population. Super-elderly individuals (i.e., those 80 years of age and older) represent a growing segment of the population and are especially prone to these fractures. The contemporary epidemiology of spine fractures in the super-elderly population is incompletely described in the literature.

Materials and Methods: This descriptive epidemiology study used the National Electronic Injury Surveillance System to examine the incidence and recent trends of spine fractures occurring among super-elderly individuals in the United States (US) from 2011 to 2020. Annual, overall, and age-/sex-specific incidence rates (IRs) were analyzed. Average annual percent change (AAPC) estimates were calculated to indicate the magnitude/direction of trends in annual injury rates.

Results: An estimated n = 385,375 super-elderly patients sustained spine fractures over the 10-year study period for an overall IR of 31.5 per 10,000 person-years at-risk. Lumbar fractures (IR = 16.3) were the most common, followed by thoracic (IR = 9.4) and cervical (IR = 6.9) fractures. Incidence was significantly higher in super-elderly females (IR = 35.6) than in males (IR = 24.8). Incidence was significantly higher in nonagenarians (IR = 50.7) and centenarians (IR = 42.6) than in octogenarians (IR = 26.8). Accounting for population growth yielded a significantly increasing incidence over the study period from 20.8 in 2011 to 40.3 in 2020 (AAPC = 8, $P < 0.0001$).

Conclusions: This study suggests that the annual incidence of spine fractures in the oldest cohort of patients in the US (80 + years of age) increased significantly during the recent decade from 2011 to 2020. Increased IRs highlight the need for future research aimed at optimizing outcomes and quality of life in this frail and ever-growing segment of the population.

Keywords: Elderly, epidemiology, fracture, geriatric, incidence, spine, trauma

INTRODUCTION

Spinal fractures in the elderly are a major public health issue worldwide. The global burden of spinal fractures in this population is substantial, accounting for millions of disability-adjusted life years lost each year.[1] With an aging population, these fractures are becoming more prevalent and more expensive to treat.[2] Furthermore, improved life expectancy has changed the epidemiology of fractures considerably, with an increasing number of fractures occurring among older age groups. It has been estimated that the probability of patients aged 65 years and older suffering a fracture during the rest of their lifetime is about 19% for men and 52% for women.[3] For individuals over the age of 80 years, approximately 13% of men and 35% of women will sustain a fracture during the remainder of his or her lifetime.[3]

The super-elderly population, defined here as individuals aged 80 years and older, is one of the fastest-growing segments

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Submitted: 26-May-24 **Accepted:** 30-Jun-24
Published: 12-Sep-24

Access this article online	
Website: www.jcvjs.com	Quick Response Code
DOI: 10.4103/jcvjs.jcvjs_85_24	

How to cite this article: Cush CT, Stefko JM, Jaworski HM, Lyons JG. Trends and epidemiology of spine fractures in the super-elderly population in the United States. J Craniovert Jun Spine 2024;15:290-7.

of the United States (US) population, and these patients are especially prone to spinal fractures.[4] As the super-elderly population continues to grow, this cohort will likely be impacted significantly by an increasing number of fractures. However, there are few contemporary, population-based epidemiological studies describing the incidence of spinal fractures among super-elderly patients.

Previous research has demonstrated an increasing incidence of cervical spine fractures within the US population as a whole in recent years,[5,6] and an increased incidence of spinal fractures has also been documented in other large nations worldwide.[7,8] However, little is known regarding the contemporary epidemiology of spinal fractures among super-elderly individuals in the US. Spinal fractures in the elderly are a significant economic burden for health systems,[9,10] and advanced age has been shown to be a predictor of mortality and complications after spinal trauma.[11-13] Given the substantial morbidity and costs associated with spine fractures in the elderly, a description of the recent incidence and trends of these fractures is warranted to inform resource allocation and preventive interventions as the elderly population continues to grow. The aim of this descriptive epidemiology study, therefore, was to investigate the incidence and recent trends of spine fractures among the super-elderly population (age 80+ years) in the US using a nationally representative sample.

MATERIALS AND METHODS

Data source

The National Electronic Injury Surveillance System (NEISS) is a public health database operated by the US Consumer Product Safety Commission to collect product-related injury data from approximately 100 hospital emergency departments (EDs) selected as a probability sample of all EDs in the US.[14,15] The NEISS database is a nationally representative sample of US EDs, from which nationwide estimates of the number of injuries associated with (but not necessarily caused by) specific consumer products can be made.[16] Trained coders at each participating facility collect data variables including demographic information, injury diagnoses, and a brief narrative description of each injury incident.[14,16] Each NEISS database record carries a weighting factor for the conversion of cases (unweighted records, n) to national injury estimates (weighted estimates, N) by accounting for the NEISS stratified probability sampling design. This allows the total number of ED visits nationwide (related to a certain product/activity) to be estimated from the sample of cases which are reported in the NEISS dataset. The NEISS database has been widely used to analyze various injuries and is an established model for epidemiological surveillance of musculoskeletal injuries.[17-22] The NEISS dataset is de-identified and publicly available and thus this study was deemed exempt from institutional review board approval.

Case selection

Each case in the NEISS database includes a "diagnosis" code (e.g., fracture, dislocation, sprain/strain, concussion, and laceration) and a "body part" code which can be used to identify the specific type and the anatomic location of the injury. Anatomic specificity in the NEISS database is limited as the categories of "body part" are somewhat broad. For example, the thoracic spine does not have its own "body part" code but rather is included in the "upper trunk" code, which also includes all other structures comprising the chest/thorax (e.g., ribs and sternum). Similarly, injuries to the lumbar spine are coded with the "lower trunk" body part code, which also includes injuries to the hip and pelvic girdle. Identification of spine injuries from the NEISS database, therefore, required a manual review of each case's text narrative.

Cases from the years 2011 to 2020 were considered for selection. To identify all potential spine fractures in super-elderly individuals, the NEISS database was queried for all neck (code 89), upper trunk (code 31), and lower trunk (code 79) injuries diagnosed as a fracture (code 57) in patients aged 80 years and older. Each case narrative was then manually reviewed to select only those cases with a clear diagnosis of an acute spine fracture. Cases without a clear diagnosis (including any "possible" or "suspected" diagnosis) and cases describing an alternate diagnosis were excluded. Three major categories of spine fractures were identified based on anatomic location – cervical, thoracic, and lumbosacral. Lumbosacral fractures (hereafter referred to as lumbar fractures) included lumbar spine fractures as well as sacral fractures not associated with a pelvic ring injury.

Case narratives were also reviewed for the presence of any additional injury diagnoses other than the primary spine fracture diagnosis. Vague symptoms (such as pain), noninjury diagnoses (such as unrelated illness or preexisting conditions), and minor injuries (such as strains/sprains and abrasions) were not included. Associated injuries which were recorded were head injuries (including closed head injury, concussion, traumatic brain injury, and intracranial hemorrhage), chest injuries (including rib and/or sternal fracture, pulmonary and/or cardiac contusion, hemothorax, and pneumothorax), internal organ injuries (including solid intra-abdominal organ injury), major arterial or nerve injuries, joint dislocations, and fractures. Associated fractures were further categorized into appendicular fractures (including upper extremity/shoulder girdle, lower extremity, and hip/

pelvic girdle fractures) and nonspine axial fractures (including rib/sternal fractures and skull/facial fractures).

Analysis

Statistical analysis was performed using the survey data commands (svyset) in Stata/IC, version 17.0 (StataCorp, College Station, TX, US), accounting for sample weights and the complex survey design. Results are reported as numbers of unweighted cases (n) and/or as weighted national estimates (N) with corresponding 95% confidence intervals (CIs). Each unweighted case (n) in the NEISS represents a single patient ED encounter and has a sample weight which represents the inverse of the probability of selection of the case. Sample weights are summed to provide national estimates (N). The US Census Bureau population estimates for the years 2011 to 2020 were used to calculate at-risk person-years during the study period.[4] Thus, the population at risk was defined as the entire super-elderly US population to derive national incidence estimates. Incidence rates (IRs) are expressed as the number of injuries per 10,000 person-years at-risk (PYR) and are calculated as the number of estimated injuries (N) divided by PYR. IR ratios (IRRs) are reported and represent unitless expressions of risk used for the comparison of IRs between two distinct subgroups, with the IR of an identified referent subgroup serving as the denominator. IRRs among sex and age groups are reported. Patients were split into three different age groups for comparisons (octogenarians, 80–89 years; nonagenarians, 90–99 years; and centenarians, 100+ years). Chi-square tests were used to compare estimated IRs between groups. Student's *t*-test/analysis of variance and design-adjusted Rao–Scott Chi-square analysis were used for direct comparisons of means for continuous variables and proportions for categorical variables, respectively.[23,24] Temporal trends in annual IRs over the course of the study period were assessed with regression analyses (Joinpoint Regression Program, Version 4.9.1.0– April 2022; Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute).[25] Average annual percent change (AAPC) estimates are presented to indicate the magnitude and direction of trends in injury rates over the study period (2011–2020) as determined by joinpoint regressions. $P < 0.05$ was the threshold for statistical significance.

RESULTS

A total of $n = 8574$ unweighted cases were identified over the course of the 10-year study period from 2011 to 2020, corresponding to a national estimate of $n = 385,375$ super-elderly patients (95% CI = 298,584–472,165) presenting to US EDs with a spine fracture. Overall IR was 31.5 PYR (95% CI = 24.4–38.6; total population at-risk = 122,318,155 person-years).

Overall national injury estimates/IRs and patient demographic/incident characteristics for each type of spine fracture are presented in Tables 1 and 2. Approximately 10% (9.9%) of patients presented with fractures involving multiple spinal levels. In 3.6% of cases, patients presented with fractures involving multiple spinal regions (i.e., cervical, thoracic, and lumbar). Of all the cases of fracture(s) involving a single spinal region, 50.6% were in the lumbar spine, 27.6% were in the thoracic spine, and 21.8% were in the cervical spine. An estimated $n = 84,701$ (95% CI = 64,470–104,932) super-elderly patients presented with cervical spine fractures, $n = 115,367$ (95% CI = 92,874–137,861) presented with thoracic spine fractures, and $n = 199,341$ (95% CI = 145,709–252,973) presented with lumbar spine fractures, for overall IRs of 6.9 PYR (95% CI = 5.3–8.6), 9.4 PYR (95% CI = 7.6–11.3), and 16.3 PYR (95% CI = 11.9–20.7), respectively. The incidence

Table 1: Spine fracture estimates, incidence rates, and patient characteristics, 2011-2020, by spinal region

	All Spine Fractures	Cervical Fractures	Thoracic Fractures	Lumbar Fractures	*P*
Unweighted Cases (*n*)	8,574	2,249	2,532	4,139	
National Estimate (*n*)	385,375	84,701	115,367	199,341	
[95% CI]	[298,584-472,165]	[64,470-104,932]	[92,874-137,861]	[145,709-252,973]	
Incidence Rate	31.5	6.9	9.4	16.3	<0.05
[95% CI]	[24.4-38.6]	[5.3-8.6]	[7.6-11.3]	[11.9-20.7]	
Sex (%)					<0.0001
Male	30	36.4	25.2	29.9	
Female	70	63.6	74.8	70.1	
Race (%)					0.3531
White	64.3	65.3	67.2	62.2	
Black	2	2	2.1	2	
Other[a]	2.6	1.7	3.1	2.6	
Unspecified	31.1	31	27.6	33.1	

[a]Other Race includes the categories "Other," "Asian," "Native Hawaiian/Pacific Islander," and "American Indian/Alaska Native" from the NEISS database, which were combined into one category due to the small number of cases coded with these categories. Percent totals may not sum to 100.0% due to rounding. All Incidence Rates are expressed per 10,000 person-years at-risk. *P* value indicates the differences between cervical, thoracic, and lumbar spine for each of the listed variables. CI, Confidence Interval.

of lumbar fractures was significantly higher than that of both cervical (lumbar: cervical IRR = 2.35, 95% CI = 1.54–3.59; $P < 0.05$) and thoracic fractures (lumbar: thoracic IRR = 1.73, 95% CI = 1.19–2.51; $P < 0.05$) among super-elderly individuals, and the incidence of thoracic fractures was significantly higher than that of cervical fractures (thoracic: cervical IRR = 1.36, 95% CI = 1.01–1.84; $P < 0.05$).

Approximately two-thirds of all injuries (66.9%) occurred in the patient's home. The vast majority of injuries were the result of low energy mechanisms (97.6%), and approximately two-thirds of all patients (64.7%) required hospital admission. High-energy mechanisms and hospital admission were more frequent among patients who sustained cervical fractures [Table 2]. Overall, 19.5% of patients presented with (at least one) concomitant serious injury, and 16.5% presented with a concomitant fracture (apart from the primary spine fracture diagnosis). Concomitant closed head injuries, face/skull fractures, and upper extremity fractures were more frequent among patients with cervical fractures, whereas chest/internal organ injuries, rib/sternum fractures, and multilevel spinal fractures were more frequent among patients with thoracic fractures [Table 2].

Accounting for population growth yielded a significantly increasing incidence of all spine fractures over the study period from 20.8 PYR in 2011 to 40.3 PYR in 2020 (AAPC = 8, 95% CI = 5.8–10.2; $P = 0.00002$). When looking at specific types of spine fractures, the incidence of cervical spine fractures (AAPC = 6.9, 95% CI = 3.8–10.1, $P = 0.00079$), thoracic spine fractures (AAPC = 9.5, 95% CI = 5.9–13.3, $P = 0.00027$), and lumbar spine fractures (AAPC = 8, 95% CI = 5.7–10.5, $P = 0.00004$) all increased significantly over the course of the study period [Figure 1]. The annual incidence of cervical, thoracic, and lumbar spine fractures increased at similar rates over the study period ($P > 0.2$ for all pairwise comparisons).

Sex

Females accounted for 70% of cases. Overall, an estimated $n = 269{,}663$ cases (95% CI = 210,563–328,764) occurred in female patients for an overall IR of 35.6 PYR (95% CI = 27.8–43.4; total female population at-risk = 75,672,558 person-years). Males accounted for 30% of cases. Overall, an estimated $n = 115{,}711$ cases (95% CI = 87,333–144,090) occurred in male patients for an overall IR of 24.8 PYR (95% CI = 18.7–30.9; total male population at-risk = 46,645,597 person-years). The overall injury rate was significantly higher for females when

Table 2: Spine fracture incident characteristics, 2011–2020, by spinal region

	All spine fractures (%)	Cervical fractures (%)	Thoracic fractures (%)	Lumbar fractures (%)	*P*
Injury location					
Home	66.9	64.9	68.7	66.7	0.1023
Public	19.5	22.9	17.6	19.2	
Recreation	0.7	0.7	0.6	0.7	
Unspecified	12.9	11.4	13.1	13.4	
Mechanism of injury					
Low energy	97.6	95.7	97.3	98.6	<0.0001
High energy	2.4	4.3	2.7	1.4	
ED discharge disposition					
Admitted	64.7	82.8	61.4	58.7	<0.0001
Discharged	35.3	17.2	38.6	41.3	
Any concomitant injury	19.5	27.3	28.5	16.7	<0.0001
Concomitant head injury	3.5	7.1	3.2	2.2	<0.0001
Concomitant chest or internal organ injury	4.3	3.4	7.5	3.6	<0.0001
Any concomitant fracture	16.5	21.3	26.2	14.8	<0.0001
Concomitant spine fracture	9.9	13.7	18	10	<0.0001
Concomitant nonspine axial fracture[a]	4.9	5.7	7.8	3.7	<0.0001
Concomitant face/skull fracture	0.8	2.5	0.7	0.2	<0.0001
Concomitant rib/sternum fracture	4.2	3.2	7.3	3.6	<0.0001
Concomitant pelvic girdle fracture[b]	1.8	1.3	2.7	1.6	0.0547
Concomitant extremity fracture	2.4	4.2	2.4	1.8	0.0001
Concomitant upper extremity fracture	1.9	3.5	1.9	1.4	0.0001
Concomitant lower extremity fracture	0.5	0.7	0.5	0.4	0.537

[a]Head (face/skull) fractures and chest (rib/sternum) fractures; [b]Pelvis, acetabulum, and hip (i.e., proximal femur) fractures. Percentage totals may not sum to 100.0% due to rounding. All IRs are expressed per 10,000 PYR. *P* value indicates the differences between cervical, thoracic, and lumbar spine for each of the listed variables. ED - Emergency department; IRs - Incidence rate; PYR - Person-years at-risk

compared with males (female:male IRR = 1.44, 95% CI = 1.04–1.99; $P < 0.05$). When looking at specific types of spine fractures, however, the injury rate in females was significantly higher than that of males only for thoracic spine fractures (female:male IRR = 1.81, 95% CI = 1.35–2.44; $P < 0.05$), whereas injury rates in males and females were similar for both cervical (female:male IRR = 1.08, 95% CI = 0.76–1.54; $P > 0.05$) and lumbar spine fractures (female: male IRR = 1.44, 95% CI = 0.98–2.13; $P > 0.05$) [Table 3]. When comparing injury rates between males and females based on age, injury rates were significantly higher for females only among octogenarians, whereas injury rates were similar among male and female nonagenarians and centenarians.

The annual incidence of spine fractures increased significantly over the study period in both males (AAPC = 8.2, 95% CI = 4.7–11.7; $P = 0.0005$) and females (AAPC = 8.1, 95% CI = 6.2–10.1; $P = 0.00001$), and there was no significant difference in the annual rate of increase between the sexes ($P = 0.96229$) [Figure 2].

Table 3: Estimates, incidence rates, and incidence rate ratios of all spine fractures among very elderly individuals (80+ years of age) in the united states, 2011–2020, by sex and fracture type

	n	*N*	IR (95% CI)	IRR[a] (95% CI)
Female				
All	5897	269,663	35.6 (27.8–43.4)	1.44* (1.04–1.99)
Cervical	1411	53,976	7.1 (5.5–8.8)	1.08 (0.76–1.54)
Thoracic	1860	86,108	11.4 (9.2–13.5)	1.81* (1.35–2.44)
Lumbar	2864	139,614	18.4 (13.5–23.4)	1.44 (0.98–2.13)
Male				
All	2677	115,711	24.8 (18.7–30.9)	Reference
Cervical	838	30,725	6.6 (4.7–8.4)	Reference
Thoracic	672	29,259	6.3 (4.8–7.7)	Reference
Lumbar	1275	59,727	12.8 (9.2–16.4)	Reference

*A statistically significant difference in IR when compared with male sex, [a]Ratio of total, cervical, thoracic, and lumbar spine fractures by sex with male sex as the referent. *n* - Unweighted cases; *N* - Weighted national estimate; IR - Incidence rate (expressed per 10,000 PYR); IRR - IR ratio; CI - Confidence interval; PYR - Person-years at-risk

Age

Octogenarians accounted for a majority (68.2%) of the total number of spine fractures in the super-elderly population, whereas nonagenarians accounted for just under one-third (30.9%), and centenarians accounted for a small fraction (0.9%). Despite accounting for a smaller number of total cases overall, the overall spine fracture IRs among nonagenarians and centenarians were significantly higher than that of octogenarians [Table 4]. When looking at the different types of spine fractures individually, nonagenarians had significantly higher injury rates than octogenarians for all fracture types, whereas centenarians had significantly higher rates of cervical fractures when compared with octogenarians [Table 4]. Injury rates were similar among nonagenarians and centenarians for all fracture types.

The annual incidence of spine fractures increased significantly from 2011 to 2020 among octogenarians and nonagenarians and remained relatively unchanged among centenarians [Figure 3].

DISCUSSION

This study sought to describe the contemporary epidemiology and trends of spine fractures occurring in the super-elderly population in the US during the recent decade from 2011 to 2020. Overall, the annual incidence of all spine fractures in the super-elderly population increased considerably over the last decade, increasing by an average of 8% annually (from 20.8 per 10,000 individuals in 2011–40.3 per 10,000 individuals in 2020). Furthermore, the annual incidence of each different type of spinal fracture increased significantly, with cervical, thoracic, and lumbar spine fractures increasing annually by 6.9%, 9.5%, and 8%, respectively, from 2011 to 2020.

While there are little published data regarding the incidence of spine fractures among super-elderly individuals in particular, prior studies involving other large populations have demonstrated an

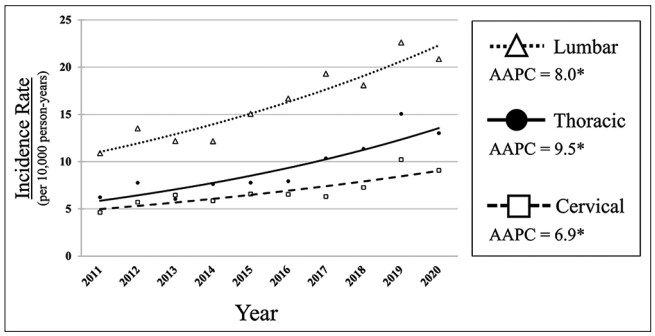

Figure 1: Trends in the annual incidence of cervical, thoracic, and lumbar spine fractures among super elderly patients in the United States, 2011-2020. AAPC, average annual percent change. *Indicates that the AAPC is significantly different from zero at the alpha=0.05 level

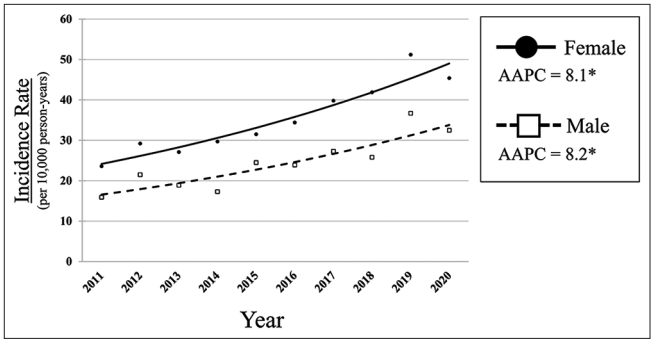

Figure 2: Trends in the annual incidence of spine fractures among super elderly patients in the United States, 2011-2020, by sex. AAPC, average annual percent change. *Indicates that the AAPC is significantly different from zero at the alpha=0.05 level.

increasing incidence of spine fractures in recent years. Baaj *et al*.[5] analyzed the Nationwide Inpatient Sample, a large US inpatient healthcare database, and found that hospitalizations and hospital charges for cervical spine fractures increased significantly in the US during the period from 1997 to 2006. Passias *et al*.[6] analyzed the same database from 2005 to 2013 and found that the incidence of cervical spine fractures, as well as hospital charges and inpatient complications, increased significantly during this period. These studies analyzed the US population as a whole. Consistent with the results of these studies, the current investigation demonstrated a substantial increase in cervical spine fractures among super-elderly individuals in the US. Another notable finding from the current investigation was that super-elderly individuals who sustained cervical fractures were more likely to require hospital admission and were more likely to present with concomitant closed-head injuries, face/skull fractures, and upper extremity fractures. These findings are consistent with prior investigations which have demonstrated a high rate of multiple traumatic injuries among patients suffering cervical spine trauma.[26,27]

Table 4: Estimates, incidence rates, and incidence rate ratios of all spine fractures among very elderly individuals (80+ years of age) in the united states, 2011–2020, by age group and fracture type

	n	*N*	IR (95% CI)	IRR[a] (95% CI)
Octogenarians				
All	5880	262,896	26.8 (20.9–32.8)	Reference
Cervical	1483	54,472	5.6 (4.2–6.9)	Reference
Thoracic	1733	79,096	8.1 (6.5–9.6)	Reference
Lumbar	2897	138,665	14.1 (10.5–17.8)	Reference
Nonagenarians				
All	2612	119,083	50.7 (38.6–62.8)	1.89* (1.33–2.69)
Cervical	736	28,955	12.3 (9.2–15.5)	2.22* (1.49–3.29)
Thoracic	771	35,187	15 (11.8–18.2)	1.86* (1.35–2.54)
Lumbar	1210	59,324	25.2 (17.6–32.9)	1.78* (1.16–2.76)
Centenarians				
All	82	3396	42.6 (27.8–57.3)	1.59* (1–2.52)
Cervical	30	1274	16 (7.5–24.4)	2.87* (1.23–6.73)
Thoracic	28	1083	13.6 (6.9–20.3)	1.68 (0.89–3.19)
Lumbar	32	1352	16.9 (8.8–25.1)	1.2 (0.68–2.12)

*A statistically significant difference in IR when compared with male sex; [a]Ratio of total, cervical, thoracic, and lumbar spine fractures by age group with octogenarians as the referent. *n* - Unweighted cases; *N* - Weighted national estimate; IR - Incidence rate (expressed per 10,000 PYR); IRR - IR ratio; CI - Confidence interval; PYR - Person-years at-risk

Although cervical fractures in the super elderly were more often associated with hospitalization and concomitant injuries, the incidence of cervical fractures in this population (6.9 PYR) was significantly lower than that of both thoracic (9.4 PYR) and lumbar (16.3 PYR) fractures. In fact, the incidence of lumbar fractures among super-elderly patients was found to be more than twice that of cervical fractures. Nevertheless, the annual incidence of cervical, thoracic, and lumbar fractures increased at similar rates from 2011 to 2020. These findings are consistent with published data from other large populations worldwide. Lang *et al*.[7] reported on the nationwide rates of hospitalized patients with vertebral fractures in Germany from 2009 to 2019 and found that the number of patients with vertebral fractures increased significantly during that time period. Consistent with the results of the current study, lumbar fractures accounted for a large majority of the vertebral fractures diagnosed in the German population.[7] Kim *et al*.[8] reported on the incidence of spinal fractures in patients aged 50 years and older in Korea from 2008 to 2012 and

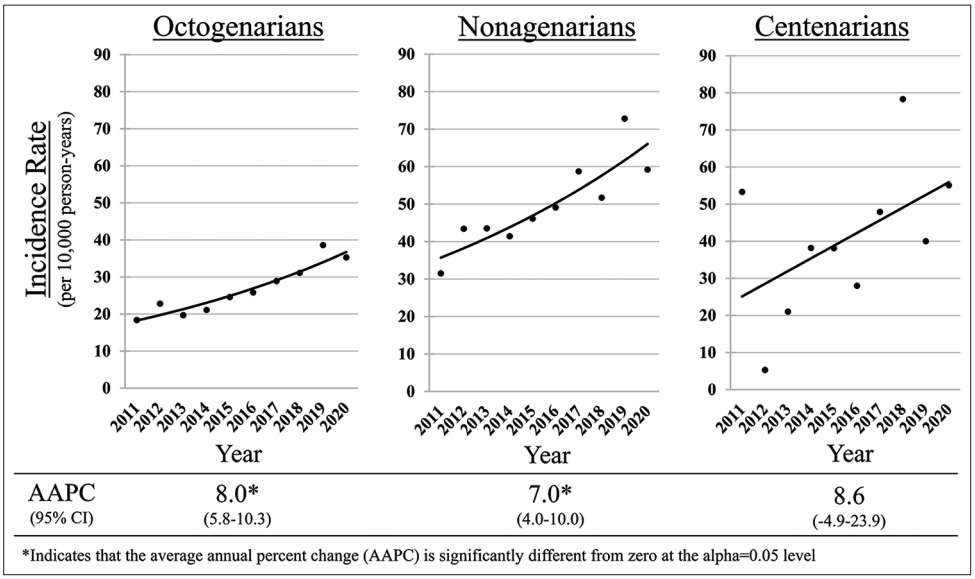

Figure 3: Trends in the annual incidence of spine fractures among super-elderly patients in the United States, 2011–2020, by age group. AAPC: Average annual percent change. (Original)

found that the annual incidence increased significantly over that time frame, consistent with the results of the current investigation.

Other important findings from the current study were a significantly higher incidence of spine fractures among females when compared with males, as well as an increasing incidence of spine fractures with increasing age. When looking at all types of spine fractures combined, the super-elderly female incidence was significantly higher than that of males. This finding is consistent with most of the published literature documenting a higher incidence of fragility fractures among females.[7,8,28,29] Interestingly, when looking at individual spine regions, the female incidence was significantly higher than that of males only for thoracic fractures, whereas super-elderly males and females sustained cervical and lumbar fractures at similar rates. Besides patient sex, patient age was another factor influencing spine fracture IRs. When compared with octogenarians, nonagenarians and centenarians sustained spine fractures at significantly higher rates. Although nonagenarians and centenarians make up a small fraction of the overall population, they sustain spinal fractures at a very high rate. Given that this population can be quite frail, with little physiologic reserve to recover from such injuries, efforts to prevent spinal fractures in these patients may substantially reduce the associated morbidity.

The societal and economic ramifications of increasing spine fracture rates in the elderly are substantial. Prior research has demonstrated that spinal fractures in elderly patients are associated with significant morbidity and cost. Weycker *et al*.[9] analyzed costs, resource utilization, and outcomes associated with osteoporosis-related fractures using a large database of US hospitals and found that patients with vertebral fractures had notably high hospital mortality (1.5%) and intensive care unit utilization (9.5%). Patients with vertebral fractures also had hospital costs and lengths of stay which were higher than those who were admitted with nonvertebral fractures (excluding the hip).[9] In another study, Williams *et al*.[10] quantified overall and fracture-related health-care costs among US Medicare beneficiaries treated for an osteoporosis-related fracture. Using propensity score matching, the authors performed a comparison of health-care costs and outcomes among Medicare patients who sustained a fragility fracture versus those who did not. They found that the highest incremental costs versus the nonfracture cohort were for hip and spine fractures.[10] For spine fractures, 1-year costs were ~$38,000 in the fracture cohort versus ~$17,000 in the nonfracture cohort, a difference of ~$21,000 per person. Furthermore, mortality was significantly higher in the fracture cohorts versus the nonfracture cohorts (18% versus 9.3%). Given the substantial burden of spine fractures in the elderly, as an increasing incidence noted in the current study, early identification and treatment of elderly patients at high risk for fractures are of immediate importance to slow the growing economic burden that these fractures place on health-care systems.

This study has limitations. Because the NEISS database contains information regarding ED visits only, any patients with spine fractures who received care in an alternate setting (e.g., outpatient or urgent care clinic) were not captured in the data. Thus, the injury rates presented here are likely conservative estimates. It has been suggested that a majority of certain osteoporotic fractures, such as those of the spine, are never formally treated by medical professionals because many patients do not seek treatment.[30] If this is the case, some of the numbers in the current study would likely significantly underestimate the true IRs. Unfortunately, it is impossible to know what percentage of super-elderly patients with spine fractures present for medical care or are treated in an ED setting.

In addition, the NEISS database relies on accurate coding and data entry, and the accuracy of the analysis depends on the correctness of the narrative section, which is inherently prone to reporter bias. As mentioned in the Methods section, the thoracic spine and lumbar spine are not represented by single body part codes in the NEISS database. The lumbar spine is included in the broader "lower trunk" category (which also includes fractures of the hip and pelvis), whereas the thoracic spine is included in the broader "upper trunk" category (which also includes fractures of the ribs and sternum). Thus, we relied on case narratives to differentiate between the different types of upper and lower trunk fractures and to isolate only spine fractures for analysis. The authors believe that this represents a strength of this study because by manually reviewing each case narrative and isolating only the spine fractures, we were able to analyze spine fractures independent of the other types of upper/lower trunk fractures, something that most prior investigations of the NEISS database have not been able to do. On the other hand, a reliance on the case narratives (which are limited to a specific number of characters) to distinguish between upper/lower trunk fracture types is also a limitation of this study, as no radiographic data are available in the NEISS database to confirm the diagnosis in each case. Finally, the available data do not allow for an assessment of whether the observed trends in injury rates over time resulted from an actual change in incidence or for other reasons, such as increased recognition and diagnosis of spine fractures by ED physicians or increased ED attendance among super-elderly patients with spine fractures. Despite these limitations, the NEISS is an established model for epidemiological surveillance of musculoskeletal injuries, and its strengths include its large-scale, heterogeneous patient population, and substantial external validity.

CONCLUSIONS

Spine fractures in the elderly population can cause significant morbidity and are a serious public health concern. This study suggests that the nationwide burden of spine fractures increased significantly among super-elderly individuals (age > 80 years) in the US during the decade from 2011 to 2020. The annual incidence of cervical, thoracic, and lumbar spine fractures increased at similar rates over the study period. Injury rates increased at similar rates in both super-elderly males and females. Increased injury rates highlight the need for additional efforts aimed at the prevention and optimal management of these fractures to lessen the associated morbidity in this delicate and growing segment of the population.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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