Original Article

The Incidence of Fractures Among the Adult Population of Germany

An Analysis From 2009 Through 2019

Markus Rupp*, Nike Walter*, Christian Pfeifer, Siegmund Lang, Maximilian Kerschbaum, Werner Krutsch, Florian Baumann, Volker Alt

Summary

Background: Detailed analyses of epidemiological data on fractures are an important resource for persons and institutions providing health care services, as they yield information on the effects of current treatment strategies and on the need for preventive measures. The epidemiology of fractures in Germany, however, is unknown. The goal of this study is to determine the nationwide fracture burden from 2009 through 2019, as a function of anatomical site, age, and sex.

Methods: Annual compilations of ICD-10 diagnosis codes for the years 2009–2019 were made available to us by the German Federal Statistical Office. The prevalence and incidence of fractures at 30 different sites were quantified, and standardized sex and age distributions were calculated.

Results: A total of 688 403 fractures was registered in 2019. From 2009 to 2019, the incidence of fractures rose by 14%, to 1014 fractures per 100 000 persons per year. The most common fracture types were femoral neck fractures (120 per 100 000 persons per year), pertrochanteric femoral fractures (109 per 100 000 persons per year), and distal radius fractures (106 per 100 000 persons per year). All types were more common in women, with incidences that rose with age. The highest incidence was of pertrochanteric femoral fractures in women over age 90, with an incidence of 2550 per 100 000 persons per year. The largest rises in incidence were seen with regard to acetabular fractures (+ 58%) and clavicular fractures (+ 44%).

Conclusion: The increasing frequency of fractures, particularly among the elderly, presents a challenge to the health care system. Given the high frequency of geriatric fractures, prophylactic measures against fractures ought to be intensified.

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Fracture healing can be a complex and lengthy process, causing a high level of stress for patients. With a lifetime prevalence of 44% in adults aged 55 years or older, fractures remain a major public health problem, with the likelihood of osteoporotic fractures increasing sharply with age (1, 2).

Various treatment strategies have been developed, ranging from conservative management with plaster immobilization to surgical measures such as external fixation, intramedullary nailing or plate fixation. Apart from the stress associated with treatment, which often involves surgery, stays in hospital, and rehabilitation programs, complications can also be particularly challenging for patients. In 5–10% of cases, for example, bone consolidation is impaired, which can lead to nonunion with adverse effects on physical and mental health (3, 4).

In addition, infections occur after fracture fixation at rates of 1–2% in closed fractures and up to 30% in Gustilo-Anderson type III open tibial fractures, which can result in loss of function or even amputation in otherwise healthy patients (5, 6).

With increasing life expectancy of the general population, the incidence of fractures of the long bones is expected to increase, especially in the elderly (7). Demographic changes affect the occurrence of osteoporotic fractures, which are reported to be on the increase (8).

However, current knowledge of the epidemiology of fractures is largely limited to specific anatomical sites (9, 10) or based on relatively small populations of no more than 6000 patients (11, 12). Detailed analysis of epidemiological data is a valuable resource for protagonists in the healthcare system. It provides insights into the impact of current osteoporosis therapy and can support the effectiveness evaluation of prevention strategies. In addition, epidemiological data are of value in assessing the urgency of implementing fall prevention programs (13), in calculating fracture-related costs, and in developing and updating fracture risk assessment tools (14).

The aim of this study was to identify trends in the nationwide fracture burden in relation to age, sex, and anatomical site for Germany between 2009 and 2019.

Methods

The data, comprising annual ICD-10 diagnosis codes from 2009 to 2019 obtained from all German medical institutions, were provided by the Federal Statistical Office (Destatis). The dataset contains only inpatient cases. Patients who presented more than once with the same diagnosis are recorded as one case, so the data do not contain any duplicates.

The total number of fractures was quantified using the ICD-10 codes "S32.1–S92.3" (*eTable 1*) and analyzed according to anatomical site, sex, and age in 10-year increments for patients older than 20 years from 2009 to 2019.

ICD-10 codes "S62.1", "S62.2" and "S62.3" were combined as fractures of carpal and metacarpal bones and ICD-10 codes "S12.0", "S12.1", and "S12.2" as fractures of the cervical spine. For calculating the number of pelvic ring fractures, the diagnoses "S32.1", "S32.2", "S32.3", "S32.5", "S32.6" and "S32.8" were added together. The incidences were calculated based on the population of Germany aged 20 years and older and standardized with respect to age and sex (15). The number of inhabitants per birth cohort for each of the 16 German federal states was taken into account for each year of the period 2009 to 2019. The cut-off date for each year was 31 December.

Results

A total of 688 403 fractures were recorded in 2019. Compared with 2009, the incidence had increased by 14% to 1014/100 000 inhabitants. Females were affected more often than males (64%, 1263/100 000 female population versus 36%, 755/100 000 male population). Fifty-nine percent of all fractures (3059/100 000 population) occurred in patients over 70 years of age. The highest incidence was in females in the age group over 90 years with 10 286/100 000 female inhabitants, followed by males in the age group over 90 years with 4999/100 000 male inhabitants (*Table 1, eTable 2, Table 2*).

The most common fractures were femoral neck fractures with 81 570 registered cases and an incidence of 120/100 000 inhabitants. The incidence was higher in females than in males (158/100 000 female inhabitants versus 81/100 000 male inhabitants), with the highest incidence in female patients in the age group 90 years or older at 1828/100 000 female inhabitants. The second highest incidence was found in pertrochanteric fractures of the femur (109/100 000 population), followed by distal radius fractures (106/100 000 population), proximal humerus fractures (91/100 000 population), lumbar spine fractures (71/100 000 population), and pelvic ring fractures (60/100 000 population). The age and sex distribution was even for these fractures. The majority involved women, with incidences increasing with age. Of all fractures, the highest incidence was for pertrochanteric femur fractures in women in the over 90 age group, with 2550/100 000 female inhabitants (*Table 1, Table 2, eTable 3*).

On comparing fracture incidences for 2009 with those for 2019, the highest increase is evident for acetabular fractures (+ 58%) and clavicular fractures (+ 44%), followed by pelvic ring fractures (+ 39%), femoral shaft fractures (+ 38%), and scapula fractures (+ 31%). The figures for distal femur fractures (+ 30%), subtrochanteric femur fractures (+ 30%), tarsal bone fractures (+ 28%), pertrochanteric femur fractures (+ 24%), and femoral neck fractures (+ 23%) were also significantly increased. A continual rise in these fractures over the years has been recorded. A decrease over the years was observed in tibial shaft fractures (– 22%), distal tibial fractures (– 20%), lateral malleolus fractures (– 20%), scaphoid fractures (– 17%), calcaneal fractures (– 16%), fibular shaft fractures (– 10%), medial malleolus fractures (– 6%), radial shaft fractures (– 6%), and distal radius fractures (– 3%) (*Table 1, eTable 2*). The decrease in these fractures was consistent over the examined period.

Discussion

The incidence of fractures in relation to age and sex is reported here for 30 different anatomical sites. A striking feature of the present article is that the analysis is based on registry data, comprising ICD-10 diagnosis codes from all German medical institutions. While studies based on data from individual departments provide results for which conclusions are limited, the present article reports the total fracture burden for Germany nationwide, including the development of fracture rates over the past ten years.

A total of 688 403 fractures were recorded in 2019, which is a rise of 14% since 2009. The identified increase in total fracture incidence was higher in comparison with that reflected in the available literature. For example, fractures in residents of Olmsted County, Minnesota, USA, over the age of 50 years were analyzed for the years 2009 to 2011 against data from 1989 to 1991. Prevalence increased by 11% during this period (12). A study conducted in the Netherlands with 14 613 participants observed no secular trend differences in fracture incidence between the years 1989 to 2001 and 2001 to 2013 (16). In contrast, an analysis of national registries for 2004 to 2012 in the Netherlands showed a significant rise in extremity fractures from 129 188 to 176 129 (26.7%) (17). The increase in fracture frequency can be attributed to demographic change and the ageing general population. An impact on the figures by changes in the applied diagnostic investigations may be assumed unlikely, as the gold standard of imaging procedures, such as X-ray, computed tomography, and magnetic resonance imaging, has become firmly established over the years (18).

The present study shows that the most common fractures were at the femoral neck and the pertrochanteric femur, with females forming the majority and incidence increasing with age. The greatest rise over the period under investigation was found for acetabular fractures. In keeping with these

TABLE 1

Fracture incidences in 2019 in decreasing frequency

Anatomical site	Total	Incidence per 100 000 inhabitants	Change from 2009 to 2019	Ratio female/male	Incidence female/male	Ratio < 70 years/ ≥ 70 years	Incidence < 70 years/ ≥ 70 years
Total	688 403	1014.4	+ 14%	64/36	1262.5/754.7	41/59	519.4/3059.3
Femoral neck	81 570	120.2	+ 23%	68/32	157.3/81.3	18/82	26.2/508.2
Femur pertrochanteric	73 785	108.7	+ 24%	69/31	148.2/67.4	13/87	17.2/486.5
Distal radius	72 087	106.2	– 3%	78/22	162.7/47.0	57/43	75.0/235.4
Proximal humerus	61 606	90.8	+ 10%	75/25	133.4/46.1	38/62	42.9/288.4
Lumbar spine	47 874	70.5	+ 21%	62/38	85.0/55.5	32/68	28.1/254.7
Pelvic ring	40 571	59.8	+ 39%	81/19	94.4/23.5	17/83	12.5/255.2
Lateral malleolus	33 226	49.0	– 20%	56/44	53.6/44.1	76/24	46.0/61.2
Multiple ribs	31 499	46.4	+ 40%	43/57	38.7/54.5	39/61	22.2/146.4
Thoracic spine	28 057	41.3	+ 32%	64/36	51.4/30.8	35/65	18.1/137.4
Clavicle	22 752	33.5	+ 44%	30/70	19.7/48.0	82/18	34.3/30.5
Proximal tibia	19 455	28.7	+ 9%	63/37	35.0/22.0	71/29	25.3/42.5
Shaft of femur	13 901	20.5	+ 38%	66/34	26.6/14.1	27/73	6.9/76.5
Femur subtrochanteric	13 817	20.4	+ 30%	69/31	27.4/13.0	17/83	4.4/86.4
Shaft of humerus	12 368	18.2	+ 14%	68/32	24.3/10.7	43/57	9.6/53.7
Cervical spine	11 179	16.5	+ 94%	48/52	15.5/17.5	30/70	6.1/59.3
Metatarsal bones	10 567	15.6	+ 11%	56/44	17.0/14.0	81/19	15.6/15.5
Proximal ulna	10 554	15.6	+ 13%	66/34	20.1/10.8	54/46	10.3/37.1
Patella	9590	14.1	0%	68/32	18.7/9.3	49/51	8.5/37.3
Distal tibia	9111	13.5	– 20%	49/51	12.9/14.0	77/23	12.8/15.9
Distal femur	9077	13.4	+ 30%	77/23	20.1/6.3	31/69	5.2/47.3
Shaft of tibia	9077	13.4	– 22%	40/60	10.4/16.5	83/17	13.8/11.7
Proximal radius	8423	12.4	+ 19%	58/42	14.1/10.7	87/13	13.3/8.6
Carpal and metacarpal bones	8412	12.4	+ 9%	31/69	7.5/17.5	82/18	12.6/11.6
Acetabulum	8142	12.0	+ 58%	46/54	10.8/13.3	29/71	4.3/43.9
Rib	7355	10.8	+ 5%	46/54	9.6/12.1	42/58	5.7/32.1
Distal humerus	7192	10.6	+ 9%	71/29	14.8/6.2	42/58	5.6/31.3
Calcaneus	6010	8.9	– 16%	30/70	5.2/12.7	84/16	9.3/7.1
Scapula	3364	5.0	+ 31%	38/62	3.7/6.3	64/36	3.9/9.2
Medial malleolus	3235	4.8	– 6%	43/57	4.0/5.6	79/21	4.7/5.0
Sternum	3134	4.6	+ 15%	55/44	5.0/4.2	53/47	3.1/11.1
Shaft of radius	2877	4.2	– 6%	58/42	4.8/3.7	65/35	3.4/7.6
Shaft of ulna	2798	4.1	+ 15%	54/46	4.3/3.9	70/30	3.6/6.3
Tarsal bones	1191	1.8	+ 28%	43/57	1.5/2.1	87/13	1.9/1.2
Fibula	1741	2.6	– 10%	50/50	2.5/2.8	65/35	2.1/4.6
Scaphoid	1551	2.3	– 17%	25/75	1.1/3.5	92/8	2.6/0.9
Talus	1266	1.9	+ 3%	34/66	1.2/2.5	92/8	2.1/0.7

TABLE 2

Age- and sex-standardized incidence of fractures in 2019, presented for the total number and for the 10 most common fractures

Anatomical site	20–29 years	30–39 years	40–49 years	50–59 years	60–69 years	70–79 years	80–89 years	≥ 90 years
	Percentage female/male Incidence female/male							
Total	1.3/3.0 195.9/415.2	1.4/3.2 185.6/394.2	2.1/3.6 285.1/481.5	6.3/5.8 644.8/598.6	9.0/5.4 1146.7/731.4	14.2/6.0 2391.3/1203.3	21.4/7.3 4927.2/2646.2	7.9/1.9 10 284.5/4999.1
Femur femoral neck	0.1/0.1 1.1/2.4	0.1/0.3 2.1/4.8	0.4/0.8 6.5/12.6	2.8/2.4 33.5/29.1	6.2/4.3 95.1/68.7	15.6/8.2 310.4/192.7	29.9/12.9 816.6/554.9	11.9/4.0 1828.3/1224.4
Femur pertrochanteric	0/0.1 0.4/1.9	0.1/0.3 1.1/4.5	0.2/0.6 2.6/9.0	1.4/2.1 14.8/23.0	4.1/3.9 55.3/56.1	12.6/6.9 226.9/147.5	33.1/12.0 818.2/4 67.7	18.4/4.2 2549.9/1181.7
Distal radius	1.6/2.3 24.3/33.0	2.1/2.7 18.7/35.6	3.5/3.4 50.3/47.9	12.8/5.0 136.9/54.0	19.4/3.9 258.3/55.5	20.1/2.5 352.7/52.4	16.0/1.5 387.3/56.8	2.9/0.2 393.9/57.5
Proximal humerus	0.3/0.5 4.5/6.2	0.7/1.3 7.6/15.0	1.5/2.2 18.6/26.3	7.7/4.5 70.7/41.1	14.3/5.0 162.8/60.4	21.7/5.3 326.7/94.9	23.3/4.9 478.1/158.8	5.7/1.1 666.7/247.6
Lumbar spine	1.3/1.7 13.2/16.1	0.9/1.7 8.1/14.4	1.3/2.4 11.9/22.4	4.6/4.8 32.8/34.6	7.5/6.0 66.0/56.2	16.3/8.7 190.1/121.1	23.9/10.9 383.4/274.8	6.0/2.1 537.4/385.2
Pelvic ring	0.8/0.6 7.4/4.8	0.7/0.7 5.1/5.1	0.9/0.9 7.0/6.9	2.9/1.9 17.6/11.5	4.9/2.5 36.9/19.8	16.7/3.9 165.1/45.4	38.2/6.7 518.6/142.7	15.8/2.1 1203.4/316.8
Lateral malleolus	8.5/16.1 27.0/46.4	9.6/14.0 26.7/37.9	15.8/14.9 45.6/42.5	31.1/21.2 67.3/46.3	25.2/15.6 67.9/44.8	21.0/11.4 74.9/48.4	13.9/6.1 67.9/47.0	2.3/0.7 63.1/36.7
Multiple ribs	0.3/0.7 2.3/4.6	0.6/2.1 3.5/12.1	1.2/4.5 7.6/27.6	3.5/11.2 16.3/52.8	2.7/10.6 21.5/65.7	7.9/11.7 60.6/106.4	17.1/13.3 179.9/220.1	8.4/3.2 500.5/377.3
Thoracic spine	1.5/2.5 9.3/13.8	1.2/2.7 6.2/13.6	1.4/2.9 7.7/16.2	4.9/5.3 20.3/22.1	7.3/5.5 37.8/30.4	16.5/7.3 112.7/59.2	24.6/8.6 231.0/127.0	6.3/1.6 331.6/168.2
Clavicle	2.8/13.5 13.6/60.9	2.4/12.5 10.3/51.7	2.5/12.7 11.2/56.6	6.2/16.3 20.8/55.2	5.1/8.3 21.5/37.1	4.6/3.9 25.7/25.9	4.9/3.3 37.4/26.1	1.6/0.4 70.0/38.2

* The incidence values of the male and female population per 100 000 inhabitants are presented for the age groups in 10-year increments as well as in percent proportion of the total number of fractures at the respective anatomical site

findings, increasing numbers of hip and pelvic fractures have also been reported by other studies from Germany (7, 8), while hip fractures seem to be decreasing in the USA as well as in Finland (19, 20).

Court-Brown and Caesar analyzed 5953 fractures treated in Edinburgh and divided the fractures into eight different categories based on distribution of age and sex. They concluded that 30% of fractures in men and 66% of fractures in women are potentially osteoporotic (11).

The present article shows that 59% of all fractures occurred in patients aged 70 years or older, which is a higher prevalence than previously reported for other countries (1, 2). The highest incidence values for Germany were in the age group over 90 years with 10 285/100 000 female and 4999/100 000 male inhabitants. These increased incidence rates associated with older age suggest that osteoporosis is a key factor in the development of fracture incidence.

A figure of 928 000 fractures is forecast for 2025, with an estimated socioeconomic burden of 11 261 million euros (21). Increasing risk factors for osteoporotic fractures contribute to this development, including diabetes type 2, which affects 5.8 million Germans, and a high proportion of smokers in the German population (22–25).

In general, it is reported that the burden from fractures is decreasing worldwide, while an increase in fragility fractures is expected, which is why authors call for an intensification of resources in fracture care (26, 27). Research into the epidemiological trends of fractures or even the creation of a patient-centered fracture registry in Germany (28) would therefore be beneficial for the modification of preventive measures in society and optimization of care management.

Limitations

The study is limited by the fact that, although ICD-10 codes were available according to age and sex, neither identification of the cause of the fracture nor differentiation of possible contributing comorbidities, such as osteoporosis or diabetes mellitus, was possible.

It may be assumed that the diagnoses were coded correctly since the DRG-based flat-rate funding scheme depends on it and is strictly controlled by the health insurance funds. Possible "upcoding", on the other hand, cannot be excluded. Furthermore, the calculations were based only on inpatient data. Therefore, the reported fracture incidences may be underestimated and fragmentary since fractures treated on an outpatient basis were not included in the

analysis. This limitation refers in particular to fractures which are often also treated in the outpatient sector, such as radius fractures or carpal and metacarpal bone fractures.

Summary

In summary, the rising incidence of fractures is a major public health problem. Fifty-nine percent of all fractures occurred in patients aged 70 years or older. The highest prevalence was found for proximal femur fractures, with case figures increasing sharply with age. Therefore, a development towards more osteoporosis-related fractures may be assumed, especially in geriatric patients. Since other developed countries are facing similar demographic trends, the present article can help protagonists in health systems worldwide to adapt their resource management.

Conflict of interest statement
The authors confirm that they have no conflicts of interest.

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► **Supplementary material**

eTables:
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Supplementary material to:

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eTABLE 1

ICD-10 codes used and description

ICD-10 Code	Description
S12.0	Fracture of first cervical vertebra
S12.1	Fracture of second cervical vertebra
S12.2	Fracture of other specified cervical vertebra
S22.0	Fracture of thoracic spine
S22.2	Fracture of sternum
S22.3	Fracture of rib
S22.4	Multiple fractures of ribs
S32.0	Fracture of lumbar spine (L1-L5)
S32.1	Fracture of sacrum
S32.2	Fraktur of coccyx
S32.3	Fracture of ilium
S32.4	Fracture of acetabulum
S32.5	Fracture of pubis
S32.6	Fracture of ischium
S32.8	Fracture of other parts of pelvis
S42.0	Fracture of clavicle
S42.1	Fracture of scapula
S42.2	Fracture of proximal humerus
S42.3	Fracture of shaft of humerus
S42.4	Fracture of distal humerus
S52.0	Fracture of proximal ulna
S52.1	Fracture of proximal radius
S52.2	Fracture of shaft of ulna
S52.3	Fracture of shaft of radius
S52.5	Fracture of distal radius
S62.0	Fracture of scaphoid bone
S62.1	Fracture of carpal bones
S62.2	Fracture of first metacarpal bone
S62.3	Fracture of other metacarpal bones
S72.0	Femoral neck fracture
S72.1	Pertrochanteric fracture of femur
S72.2	Subtrochanteric fracture of femur
S72.3	Fracture of shaft of femur
S72.4	Fracture of distal femur
S82.0	Fracture of patella
S82.1	Fracture of proximal tibia
S82.2	Fracture of shaft of tibia
S82.3	Fracture of distal tibia
S82.4	Fracture of fibula
S82.5	Fracture of medial malleolus
S82.6	Fracture of lateral malleolus
S92.0	Fracture of calcaneus
S92.1	Fracture of talus
S92.2	Fracture of tarsal bones
S92.3	Fracture of metatarsal bones

eTABLE 2

Incidence of fractures in 2019, subdivided according to anatomical site

Anatomical site	Total	Incidence per 100 000 inhabitants	Change from 2009 to 2019	Ratio female/male	Incidence female/ male	Ratio < 70 years/ ≥ 70 years	Incidence < 70 years/ ≥ 70 years
Total	688 403	1014.4	+ 14%	64/36	1262.5/754.7	41/59	519.4/3059.3
Shoulder and upper arm							
Clavicle	22 752	33.5	+ 44%	30/70	19.7/48.0	82/18	34.3/30.5
Scapula	3364	5.0	+ 31%	38/62	3.7/6.3	64/36	3.9/9.2
Proximal humerus	61 606	90.8	+ 10%	75/25	133.4/46.1	38/62	42.9/288.4
Shaft of humerus	12 368	18.2	+ 14%	68/32	24.3/10.7	43/57	9.6/53.7
Distal humerus	7192	10.6	+ 9%	71/29	14.8/6.2	42/58	5.6/31.3
Lower arm							
Proximal ulna	10 554	15.6	+ 13%	66/34	20.1/10.8	54/46	10.3/37.1
Shaft of ulna	2798	4.1	+ 15%	54/46	4.3/3.9	70/30	3.6/6.3
Proximal radius	8423	12.4	+ 19%	58/42	14.1/10.7	87/13	13.3/8.6
Shaft of radius	2877	4.2	– 6%	58/42	4.8/3.7	65/35	3.4/7.6
Distal radius	72 087	106.2	– 3%	78/22	162.7/47.0	57/43	75.0/235.4
Hand and wrist							
Scaphoid	1551	2.3	– 17%	25/75	1.1/3.5	92/8	2.6/0.9
Carpal and metacarpal bones	8412	12.4	+ 9%	31/69	7.5/17.5	82/18	12.6/11.6
Spine and thorax							
Lumbar spine	47 874	70.5	+ 21%	62/38	85.0/55.5	32/68	28.1/254.7
Cervical spine	11 179	16.5	+ 94%	48/52	15.5/17.5	30/70	6.1/59.3
Thoracic spine	28 057	41.3	+ 32%	64/36	51.4/30.8	35/65	18.1/137.4
Sternum	3134	4.6	+ 15%	55/44	5.0/4.2	53/47	3.1/11.1
Multiple ribs	31 499	46.4	+ 40%	43/57	38.7/54.5	39/61	22.2/146.4
Rib	7355	10.8	+ 5%	46/54	9.6/12.1	42/58	5.7/32.1
Femur and pelvis							
Femur femoral neck	81 570	120.2	+ 23%	68/32	157.3/81.3	18/82	26.2/508.2
Femur pertrochanteric	73 785	108.7	+ 24%	69/31	148.2/67.4	13/87	17.2/486.5
Femur subtrochanteric	13 817	20.4	+ 30%	69/31	27.4/13.0	17/83	4.4/86.4
Shaft of femur	13 901	20.5	+ 38%	66/34	26.6/14.1	27/73	6.9/76.5
Distal femur	9077	13.4	+ 30%	77/23	20.1/6.3	31/69	5.2/47.3
Acetabulum	8142	12.0	+ 58%	46/54	10.8/13.3	29/71	4.3/43.9
Pelvis	40 571	59.8	+ 39%	81/19	94.4/23.5	17/83	12.5/255.2
Lower leg and ankle							
Patella	9590	14.1	0%	68/32	18.7/9.3	49/51	8.5/37.3
Proximal tibia	19 455	28.7	+ 9%	63/37	35.0/22.0	71/29	25.3/42.5
Shaft of tibia	9077	13.4	– 22%	40/60	10.4/16.5	83/17	13.8/11.7
Distal tibia	9111	13.5	– 20%	49/51	12.9/14.0	77/23	12.8/15.9
Fibula	1741	2.6	– 10%	50/50	2.5/2.8	65/35	2.1/4.6
Medial malleolus	3235	4.8	– 6%	43/57	4.0/5.6	79/21	4.7/5.0
Lateral malleolus	33 226	49.0	– 20%	56/44	53.6/44.1	76/24	46.0/61.2
Foot							
Calcaneus	6010	8.9	– 16%	30/70	5.2/12.7	84/16	9.3/7.1
Talus	1266	1.9	+ 3%	34/66	1.2/2.5	92/8	2.1/0.7
Tarsal bones	1191	1.8	+ 28%	43/57	1.5/2.1	87/13	1.9/1.2
Metatarsal bones	10 567	15.6	+ 11%	56/44	17.0/14.0	81/19	15.6/15.5

eTABLE 3

Age- and sex-standardized incidence of fractures in 2019*

Anatomical site	20–29 years	30–39 years	40–49 years	50–59 years	60–69 years	70–79 years	80–89 years	≥ 90 years
	Percentage female/male Incidence female/male							
Total	1.3/3.0 195.9/415.2	1.4/3.2 185.6/394.2	2.1/3.6 285.1/481.5	6.3/5.8 644.8/598.6	9.0/5.4 1146.7/731.4	14.2/6.0 2391.3/1203.3	21.4/7.3 4927.2/2646.2	7.9/1.9 10 284.5/4999.1
Femur femoral neck	0.1/0.1 1.1/2.4	0.1/0.3 2.1/4.8	0.4/0.8 6.5/12.6	2.8/2.4 33.5/29.1	6.2/4.3 95.1/68.7	15.6/8.2 310.4/192.7	29.9/12.9 816.6/554.9	11.9/4.0 1828.3/1224.4
Femur pertrochanteric	0/0.1 0.4/1.9	0.1/0.3 1.1/4.5	0.2/0.6 2.6/9.0	1.4/2.1 14.8/23.0	4.1/3.9 55.3/56.1	12.6/6.9 226.9/147.5	33.1/12.0 818.2/467.7	18.4/4.2 2549.9/1181.7
Distal radius	1.6/2.3 24.3/33.0	2.1/2.7 18.7/35.6	3.5/3.4 50.3/47.9	12.8/5.0 136.9/54.0	19.4/3.9 258.3/55.5	20.1/2.5 352.7/52.4	16.0/1.5 387.3/56.8	2.9/0.2 393.9/57.5
Proximal humerus	0.3/0.5 4.5/6.2	0.7/1.3 7.6/15.0	1.5/2.2 18.6/26.3	7.7/4.5 70.7/41.1	14.3/5.0 162.8/60.4	21.7/5.3 326.7/94.9	23.3/4.9 478.1/158.8	5.7/1.1 666.7/247.6
Lumbar spine	1.3/1.7 13.2/16.1	0.9/1.7 8.1/14.4	1.3/2.4 11.9/22.4	4.6/4.8 32.8/34.6	7.5/6.0 66.0/56.2	16.3/8.7 190.1/121.1	23.9/10.9 383.4/274.8	6.0/2.1 537.4/385.2
Pelvic ring	0.8/0.6 7.4/4.8	0.7/0.7 5.1/5.1	0.9/0.9 7.0/6.9	2.9/1.9 17.6/11.5	4.9/2.5 36.9/19.8	16.7/3.9 165.1/45.4	38.2/6.7 518.6/142.7	15.8/2.1 1203.4/316.8
Lateral malleolus	8.5/16.1 27.0/46.4	9.6/14.0 26.7/37.9	15.8/14.9 45.6/42.5	31.1/21.2 67.3/46.3	25.2/15.6 67.9/44.8	21.0/11.4 74.9/48.4	13.9/6.1 67.9/47.0	2.3/0.7 63.1/36.7
Multiple ribs	0.3/0.7 2.3/4.6	0.6/2.1 3.5/12.1	1.2/4.5 7.6/27.6	3.5/11.2 16.3/52.8	2.7/10.6 21.5/65.7	7.9/11.7 60.6/106.4	17.1/13.3 179.9/220.1	8.4/3.2 500.5/377.3
Thoracic spine	1.5/2.5 9.3/13.8	1.2/2.7 6.2/13.6	1.4/2.9 7.7/16.2	4.9/5.3 20.3/22.1	7.3/5.5 37.8/30.4	16.5/7.3 112.7/59.2	24.6/8.6 231.0/127.0	6.3/1.6 331.6/168.2
Clavicle	2.8/13.5 13.6/60.9	2.4/12.5 10.3/51.7	2.5/12.7 11.2/56.6	6.2/16.3 20.8/55.2	5.1/8.3 21.5/37.1	4.6/3.9 25.7/25.9	4.9/3.3 37.4/26.1	1.6/0.4 70.0/38.2
Proximal tibia	2.6/3.1 10.8/12.1	3.2/5.2 11.6/18.3	4.8/6.9 18.5/26.2	14.6/9.5 42.0/27.5	14.7/6.6 52.8/25.1	11.3/3.8 53.7/21.4	9.0/2.1 58.3/21.0	2.4/0.4 87.0/28.7
Shaft of femur	1.4/4.2 4.2/11.6	0.8/2.6 2.1/6.6	0.8/2.0 2.1/5.4	2.3/3.4 4.8/5.4	5.4/4.3 13.8/7.0	13.1/6.3 44.5/11.6	30.0/8.8 139.5/25.4	12.6/2.0 331.0/103.6
Femur subtrochanteric	0.1/0.5 0.4/1.4	0.1/0.7 0.3/1.7	0.4/1.0 1.0/2.8	2.0/2.5 4.0/5.2	5.3/4.6 13.5/12.6	14.1/7.4 47.4/29.8	31.4/11.0 145.3/79.7	15.5/3.4 402.2/178.8
Shaft of humerus	1.4/8.7 3.9/8.7	3.0/5.8 3.0/5.8	5.3/6.5 5.3/6.5	12.1/8.9 12.1/8.9	27.3/13.3 27.3/13.3	53.3/21.9 53.3/21.9	86.4/34.4 86.4/34.3	148.4/ 51.4 148.4/51.4
Cervical spine	0.9/2.4 2.2/5.2	0.9/2.5 1.8/5.1	0.9/3.0 2.1/6.6	2.4/5.9 4.0/9.8	3.8/7.1 7.9/15.6	10.0/11.0 27.4/35.8	20.2/16.3 75.5/96.2	8.9/3.6 188.3/153.1
Metatarsal bones	5.2/8.4 11.8/17.6	5.7/8.1 11.5/15.5	6.6/8.1 13.7/16.8	13.0/9.8 20.3/15.5	10.4/5.3 20.3/11.0	7.8/2.8 20.0/8.5	6.3/1.3 22.2/7.1	1.2/0.1 23.2/5.3
Proximal ulna	1.9/3.9 4.4/8.1	2.1/3.7 4.3/7.0	2.7/4.6 5.6/9.5	8.8/7.1 13.8/9.5	12.8/5.9 25.0/11.2	16.8/4.5 43.3/13.7	16.7/3.6 58.9/19.7	4.4/0.6 86.6/25.0
Patella	1.4/3.2 2.8/6.1	1.6/3.6 2.8/6.2	2.1/3.2 4.1/6.1	8.4/5.4 11.9/7.7	14.2/5.6 25.1/10.5	20.6/5.3 48.1/14.8	16.9/4.9 54.1/24.5	2.9/0.9 52.7/32.1
Distal tibia	3.2/6.4 6.4/11.5	3.8/9.1 6.5/15.0	5.6/9.3 10.1/16.5	10.3/12.2 13.8/16.6	9.2/8.0 15.5/14.3	7.3/3.7 16.2/9.8	7.3/2.1 22.3/10.0	2.4/0.3 40.7/10.6
Distal femur	0.9/2.1 1.8/3.9	0.7/1.8 1.3/3.0	1.3/2.0 2.4/3.6	5.1/3.9 6.9/5.3	9.2/3.8 15.4/6.8	16.3/4.1 36.2/10.7	28.2/4.1 85.6/19.4	15.3/1.1 261.2/ 36.3
Shaft of tibia	3.9/13.9 7.6/24.9	4.2/10.9 7.2/18.0	5.4/10.4 9.7/18.5	8.0/12.3 10.8/16.6	6.8/7.1 11.4/12.6	4.9/3.5 10.8/9.1	4.9/1.7 14.8/8.0	1.9/0.4 32.2/12.5
Proximal radius	3.5/7.0 6.4/11.7	5.2/10.1 8.3/15.4	6.9/9.3 11.5/15.3	16.6/9.4 20.8/11.8	14.5/4.1 22.5/6.8	7.7/1.5 15.9/3.6	3.3/0.5 9.2/2.1	0.5/0.1 7.2/3.0
Carpal and metacarpal bones	3.1/24.3 5.6/40.4	2.8/14.9 4.5/22.7	2.4/9.0 4.0/14.8	5.2/9.0 6.5/11.4	5.4/5.7 8.3/9.3	6.0/3.9 12.3/9.4	5.1/2.0 14.4/8.8	1.1/0.3 16.8/8.7
Acetabulum	0.6/1.8 1.0/2.9	0.6/2.0 0.9/3.0	0.7/2.4 1.1/3.8	2.2/6.8 2.7/8.2	3.6/7.9 5.4/12.7	9.6/11.9 19.1/28.2	19.7/15.6 53.6/67.0	9.0/5.5 137.8/169.0
Rib	1.0/1.8 1.5/2.6	1.1/3.6 1.5/4.7	2.0/5.6 3.0/8.0	4.2/9.9 4.6/10.9	3.9/9.1 5.3/13.1	8.1/10.1 14.5/21.6	17.1/11.7 42.0/45.1	8.2/2.6 113.2/73.0

Anatomical site	20–29 years	30–39 years	40–49 years	50–59 years	60–69 years	70–79 years	80–89 years	≥ 90 years
	Percentage female/male Incidence female/male							
Distal humerus	2.3/3.1 3.5/4.4	3.2/2.9 3.1/3.8	2.4/2.5 3.4/3.5	6.3/4.7 6.7/5.0	11.4/4.5 15.1/6.4	15.7/4.7 27.6/9.8	23.4/5.1 56.3/19.2	7.6/1.2 103.4/31.8
Calcaneus	1.3/5.9 1.7/7.1	2.3/13.1 2.7/14.2	3.2/14.6 3.8/17.1	6.1/19.5 5.4/17.5	7.2/11.1 8.0/13.1	5.9/4.2 8.7/7.3	3.3/1.3 6.6/4.2	0.8/0.1 9.6/2.6
Scapula	1.0/5.9 0.7/3.9	1.2/8.5 0.8/5.2	1.7/8.7 1.1/5.7	5.0/14.7 2.5/7.4	6.6/10.6 4.1/7.0	8.5/6.7 7.0/6.6	11.0/5.2 12.4/9.3	3.3/1.2 20.9/15.1
Medial malleolus	6.2/11.2 4.3/7.2	4.1/10.1 2.5/5.9	3.4/10.2 2.2/6.4	7.2/11.4 3.4/5.5	7.2/8.2 4.3/5.3	7.2/3.9 5.9/3.7	5.8/1.7 6.3/2.9	1.5/0.3 9.2/3.4
Sternum	3.3/2.8 2.2/1.7	2.4/3.3 1.4/1.9	3.7/4.4 2.3/2.7	8.0/8.2 3.7/3.8	8.9/8.3 5.2/5.1	11.9/7.7 9.1/7.0	13.2/8.9 13.9/14.6	3.9/1.2 23.0/14.7
Shaft of radius	1.9/11.0 1.2/6.3	2.7/8.2 1.5/4.3	3.8/5.9 2.2/3.3	8.3/7.6 3.5/3.3	11.6/3.9 6.2/2.2	12.1/3.2 8.5/2.6	13.2/2.2 12.8/3.4	4.2/0.2 22.6/2.6
Shaft of ulna	3.0/7.5 1.8/4.1	3.5/6.9 1.8/3.5	4.0/7.5 2.2/4.1	8.4/9.9 3.5/4.1	12.5/7.3 6.5/4.0	11.8/3.9 8.1/3.2	8.8/2.7 8.2/4.0	1.9/0.4 10.2/4.2
Tarsal bones	6.0/12.9 1.6/3.0	5.5/13.0 1.3/2.8	7.8/10.6 1.8/2.5	8.3/11.7 1.5/2.1	5.5/5.5 1.2/1.3	5.0/2.9 1.5/1.0	4.1/0.7 1.6/0.4	0.4/0.0 0.9/0.0
Fibula	2.0/8.4 0.8/2.9	2.9/7.1 1.0/2.2	4.0/7.5 1.4/2.6	9.1/10.5 2.4/2.6	7.2/6.1 2.3/2.7	10.2/6.7 4.3/2.1	11.3/3.8 6.6/3.5	3.2/0.0 10.4/3.5
Scaphoid	3.4/35.8 1.1/11.0	2.8/15.6 0.8/4.4	2.2/8.4 0.7/2.5	6.3/7.6 1.4/1.8	5.4/4.8 1.5/1.5	3.2/1.9 1.2/0.9	2.0/0.8 1.0/0.6	0.0/0.0 0.0/0.0
Talus	10.9/19.1 3.0/4.8	6.3/17.5 1.5/4.0	3.7/11.4 0.9/2.8	4.6/10.7 0.9/2.0	3.1/4.8 0.7/1.2	3.2/1.8 1.0/0.7	1.6/0.6 0.7/0.4	0.6/0.0 1.3/0.0

* The incidence values of the male and female population per 100 000 inhabitants are presented for the age groups in 10-year increments as well as in percentage proportion of the total number of fractures at the respective anatomical site