A 1-YEAR PROSPECTIVE MONOCENTRIC STUDY OF LIMB, SPINAL AND PELVIC FRACTURES: CAN MONITORING FRACTURE EPIDEMIOLOGY IMPACT INJURY PREVENTION PROGRAMMES?

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SUMMARY

Objectives: The aim of this study was to assess fractures of extremities, spine and pelvis in patients with respect to mechanism, time of the incident and demography of patients in order to propose preventive measures.

Methods: A mono-centric (Level I Trauma Centre, predominantly urban population) prospective study was carried-out during the one-year period from 1 January to 31 December 2012. Patients with bone fractures of extremities, spine and pelvis were studied. Demography, mechanism and time of the injury were analysed.

Results: The study group consisted of 3,148 patients, 53% being women and treated for 3,909 fractures. The mean age of patients was 53 years. The most traumatised patients were of the 3rd and 4th decade, a further increase in the incidence of fractures was seen in the 7th and 9th decade. Multiple fractures were significantly higher in men ($p = 0.002$). A car crash or fall from a height was more common cause of spinal fracture or pelvic fracture than fracture to the upper or lower limbs ($p < 0.001$). Most of the fractures occurred during the day between 9 a.m. and 6 p.m., on Saturdays and during the winter season. The bones most often broken were the radius (739 patients, 18.5%) and femur (436 patients, 11.1%).

Conclusions: Our study highlights the need for injury prevention focused on sex, age and types of activities performed. Among younger individuals, such programmes should primarily be targeted toward men who, as observed in our sample, have a higher fracture frequency compared to women. Conversely, injury prevention programmes for individuals ≥ 60 years should primarily be targeted toward women, who have the highest fracture prevalence in this population.

Key words: fractures of extremities, spinal fractures, pelvic fractures, injury prevention programmes

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INTRODUCTION

Fractures, especially those occurring in osteoporotic bones, represent an enormous public health burden (1). They are relatively common with associated complicated treatments and high costs (2). In monitoring fractures and their causes, epidemiological and demographic data are important for the management of health care, for health insurance companies and for prevention. Epidemiological studies focused on the skeleton injury have different goals. For clinical management, it is important to know details of the precise anatomical location of fractures and their distribution in the population in order to plan and assess efficient treatment, to evaluate complications, and to monitor the time of hospitalisation (3–6). Studies based on the data from global and trans-regional databases are important for the organization of health care and the proposition of preventive measures (1, 7–12). Another important approach is to monitor injuries and their causes among certain population groups (13–18). The aim of this study was to describe external causes, seasonality and distribution of fractures of extremities, spine and pelvis in patients treated in Trauma Centre Level I.

MATERIALS AND METHODS

Data on skeletal fractures of extremities, spine and pelvis were collected prospectively at the Level I Trauma Centre from 1 January to 31 December 2012. The Trauma Centre is based at

Faculty Hospital Královské Vinohrady in Prague. It is one of ten major centres in the Czech Republic covering a population of 1,250,000 people (12% of the population of the Czech Republic) for specialized trauma care (polytraumas with Injury Severity Score > 16). It serves also as a basic trauma care centre for part of the Prague population (230,000). Fractures of the skull and ribs were excluded, because these fractures are part of the cranial and thoracic injuries, while we were only interested in limb and axial skeletal injuries. Variables on age and gender of the patient, anatomical location of fractures, external causes of fractures, and date and time of the injury were analysed. Data were extracted from patients' documentation and entered into a computer database (MS Excel) and then analysed using the Chi-square test of independence or the Fisher factorial test as appropriate. Probabilities of less than 0.05 were accepted as significant.

RESULTS

Out of total of 39,338 patients treated at the centre in 2012, 3,148 (8%) patients with 3,909 fractures were included in the analysis, 1,668 (53%) were women (Table 1); 1,521 (48.3%) patients required hospitalization. The mean age of patients was 53 years (range 15–100 years, SD 22.5 years); for women the mean age was 62 years, for men 44 years (Fig. 1). The male patients in the 3rd and 4th decade accounted for almost half of all injured men (670 men, 46.6%). In contrast, women were injured most often in the 7th to 9th decade (909 females, 54.5%), while the proportion of men in these decades was only 21.8% (323 men).

Number of Fractures

By comparing patients with a single fracture and patients with multiple fractures, there was a significantly higher number of multiple fractures in men ($p = 0.002$) (Table 1).

External Causes of Fractures

A fall from the same level was the most frequent cause of fracture (2,024, 51.8%), followed by sport (619, 15.8%) (Table 2). Falls from the same level or fracture by a falling object were more often a cause of fractures of extremities than of the spine or pelvis ($p < 0.001$). A car crash or fall from a height were significantly more frequent in spinal or pelvic fractures than the upper or lower extremities ($p < 0.001$). Car crashes and falls were the main causes of fractures in younger ages, especially in men (Table 3, Fig. 2). In older patients, especially among women, the major cause of fracture was fall from the same level (Table 3, Fig. 2). An assault resulted significantly more frequently in a fracture of the upper limb than the lower limb ($p < 0.001$) or the spine ($p = 0.006$). Women injured in assaults were significantly older than men ($p < 0.001$) (Table 3).

Table 1. *Distribution of single and multiple fractures by gender and age (N = 3,148)*

	Gender						Total		Mean age (years)
	Female		Male		Female/Male	p	n	%	
	n	%	n	%	Ratio				
Single fracture	1,424	45.2	1,204	38.2	1:0.85	**0.002**	2,628	83.4	53
Multiple fractures	244	7.8	276	8.8	1:1.13	**0.002**	520	16.6	55
Two	175	5.6	174	5.5	1:0.99	0.283	349	11.1	57
Three	33	1.0	41	1.4	1:1.24	0.178	74	2.4	50
Four	13	0.4	15	0.5	1:1.15	0.610	28	0.9	51
Five and more	23	0.8	46	1.4	1:2	**0.001**	69	2.2	49
Total	1,668	53.0	1,480	47.0	1:0.89		3,148	100	53

Table 2. *Distribution of fractures by external cause and anatomical region (N = 3,909)*

	Upper extremities		Lower extremities		Spine		Pelvis		Total	
	n	%	n	%	n	%	n	%	n	%
Car crash	42	27.5	54	35.3	35	22.9	22	14.4	153	3.9
Motorbike	28	40.0	28	40.0	8	11.4	6	8.6	70	1.8
Pedestrian	39	27.7	62	44.0	26	18.4	14	9.9	141	3.6
Fall from the same level	965	47.7	852	42.1	132	6.5	75	3.7	2,024	51.8
Fall from height	96	27.2	103	29.2	98	27.8	56	15.9	353	9.0
Sport	385	62.2	185	29.9	29	4.7	20	3.2	619	15.8
Falling object	207	49.8	192	46.2	11	2.6	6	1.4	416	10.6
Assault	67	67.7	21	21.2	6	6.1	5	5.1	99	2.5
Suicide	10	29.4	7	20.6	11	32.4	6	17.6	34	0.9
Total	1,839	47.0	1,504	38.5	356	9.1	210	5.4	3,909	100

Table 3. *Distribution of fractures by external cause and gender (N = 3,148)*

	Gender								Total		
	Female			Male			Female/Male	p	n	%	Mean age (years)
	n	%	Mean age	n	%	Mean age	Ratio				
Car crash	29	0.9	41	60	1.9	42	1:2.1	**<0.001**	89	2.8	42
Motorbike	3	0.1	24	34	1.1	37	1:11.3	**<0.001**	37	1.2	36
Pedestrian	41	1.3	58	40	1.3	53	1:0.9	0.751	81	2.6	55
Fall from the same level	1,248	39.6	68	551	17.5	55	1:0.4	**<0.001**	1,799	57.1	64
Fall from height	40	1.3	50	156	5.0	45	1:3.9	**<0.001**	196	6.3	46
Sport	154	4.9	37	369	11.7	33	1:2.4	**<0.001**	523	16.6	34
Falling object	131	4.2	42	216	6.9	37	1:1.7	**<0.001**	347	11.1	39
Assault	17	0.5	48	51	1.6	32	1:3	**<0.001**	68	2.1	36
Suicide	5	0.2	46	3	0.1	36	1:0.6	NS	8	0.3	42
Total	1,668	53.0	62	1,480	47.0	44	1:0.9		3,148	100	53

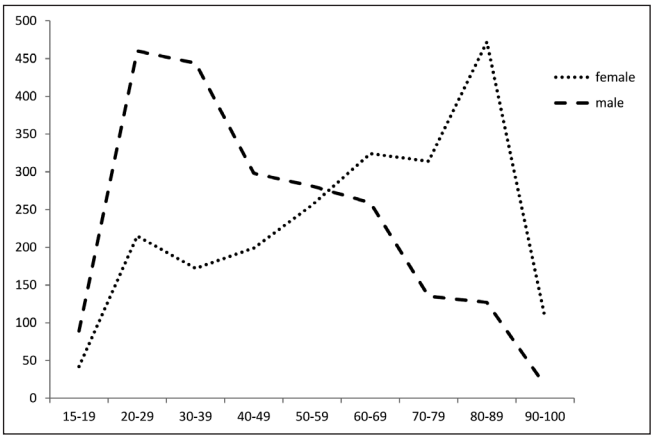

Fig. 1. *Distribution of patients with fractures by age group and gender.*

Time of Fracture Occurrence

During the week, the highest incidence was on Saturday (Fig. 3a); this distribution was evidenced primarily in male fractures. Most of the fractures occurred during the day between 9 a.m. and 6 p.m. (Fig. 3b). For men, the peak incidence of fractures was between 6 p.m. and 9 p.m. During the year, the highest number of fractures was observed in the winter (Fig. 3c).

Anatomical Site of Fractures

Of the 3,909 evaluated fractures, the most frequently broken bones were the radius (739 patients, 18.5%) and femur (436 patients, 11.1%) (Table 4). When comparing the gender distribution, women had a significant predominance in fractures of proximal humerus ($p < 0.001$), distal radius ($p < 0.001$) and proximal femur ($p < 0.001$). Men were significantly predominant in fractures of the clavicle ($p < 0.001$), bones of carpus ($p < 0.001$), metacarpus ($p < 0.001$), and finger phalanges ($p < 0.001$), then calcaneus ($p < 0.001$), metatarsus ($p < 0.001$) and lumbar vertebrae ($p = 0.007$) (Table 4).

Age and Anatomical Region of Fractures

The distribution of fractures in anatomical regions by age are shown in Figure 4. In order to illustrate better the relation between various bone fractures and age, fractures that have a statistically significant difference between women and men are shown in Figure 5. Fractures occurring mainly in women (proximal humerus, distal radius, proximal femur) are illustrated with individual curves, while other fractures of the upper and lower limbs, which occurred more in men, are grouped into two curves. It is clear that fractures in women occurred predominantly in older age groups, while fractures in men occurred mostly in young patients. With increasing age, frequency decreased (Fig. 5).

DISCUSSION

Fractures were more common in younger men and in women aged over 60. Women had significantly more fractures considered to be osteoporotic (proximal humerus, distal radius, proximal femur). Men were more often injured in traffic crashes, in falls from height and while doing sports. Women were more often injured in fall from the same level.

The age distribution of patients with fractures showing two peaks in the 3rd and 4th decade and in the 7th to 9th decade was reported in other studies (9, 11). The larger proportion of men in the younger age groups is possibly related to hazardous work and sport (5, 13, 14). It has been described previously that the increased incidence of osteoporotic fractures (proximal humerus, distal radius, proximal femur) in elderly women is caused by postmenopausal osteoporosis (3, 4, 7, 12, 19, 20). Another important factor is related to longer mean survival time among women (3, 12, 19). Both of these findings are consistent with the results of an earlier study (21).

The predominance of multiple fractures in men relates to their riskier behaviour in the context of work and sport activities. This has been indicated also by other studies (9, 13, 14). Interestingly, a decline in the number of fractures in men in the 5th and 6th decade was not very steep. A previous epidemiological study of

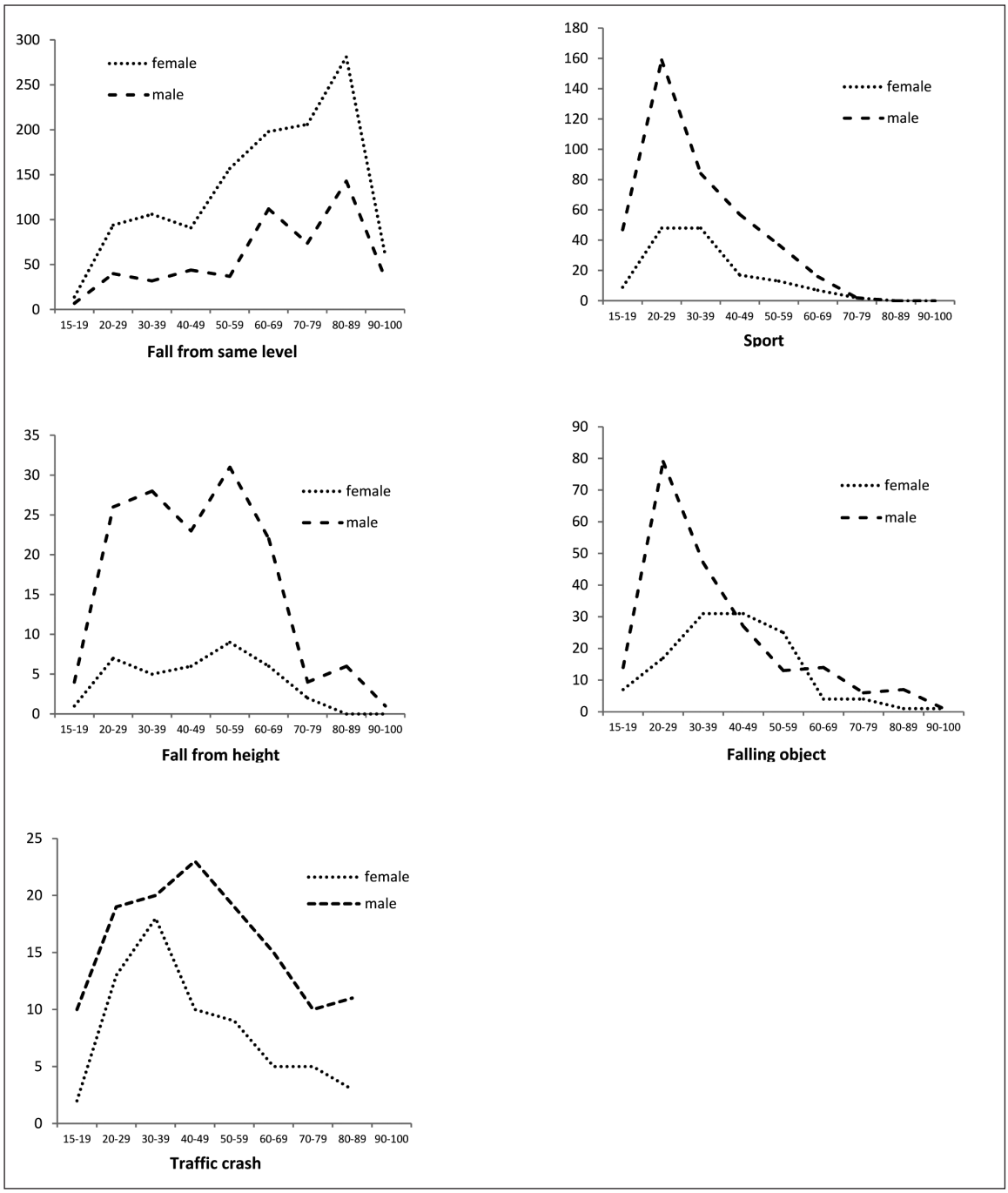

Fig. 2. *External cause of fractures by age group and gender.*

the incidence of musculoskeletal injuries proved that fractures of extremities, spine and pelvis account for about a quarter of all fractures, and that the most injured area is the wrist and hand (21). The finding that fractures occur more often in men of younger age groups is consistent with other studies (11, 16). Spinal and pelvic fractures were possibly caused by high impact injuries. Skeletal limb fractures occur predominantly in same-level falls and injuries from falling objects, findings similar to other studies (11, 20, 22).

A fall from the same level was the most predominant cause of fractures in this study, especially among women. It has caused almost three quarter of all fractures. Especially among the elderly, falls can cause serious injury and death (9, 23, 24). Every year 30% to 60% of the elderly fall and half of them have multiple falls (25, 26). In a U.S. study, injury severity and mortality for same-level falls was twice that of young people (23). In 2012, 90% of women who died as result of a fall in the Czech Republic were over 65 years of age in comparison to only 64% of men (27). The higher proportion of fractures in men from falls from height in this study is possibly influenced by work-related activities. Male preponderance in fractures in traffic crashes was not surprising. Traffic injuries can be effectively influenced by enforced legislation, while sport fractures may be effectively prevented by awareness and the use of appropriate equipment. Prevention of falls, especially in the elderly, requires a complex approach focusing on physical, cognitive, behavioural and environmental areas, particularly in relation to the increasing prevalence of osteoporosis.

The finding of a significantly higher number of bone fractures of the upper extremities than lower extremities or spine during an

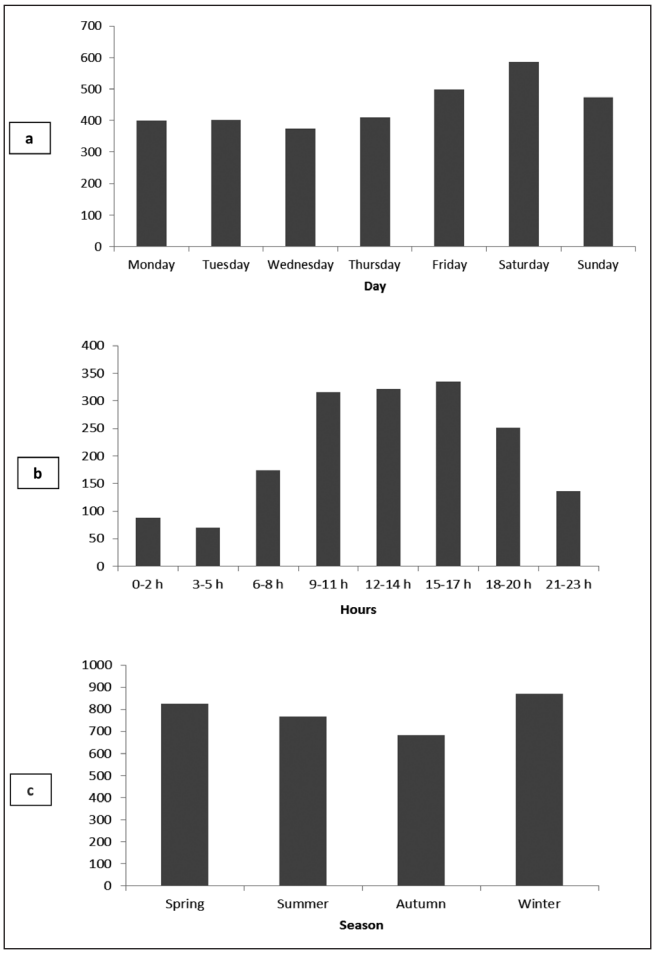

Fig. 3. *Distribution of patients with fractures by day of the week (a), hour of the day (b) and season of the year (c).*

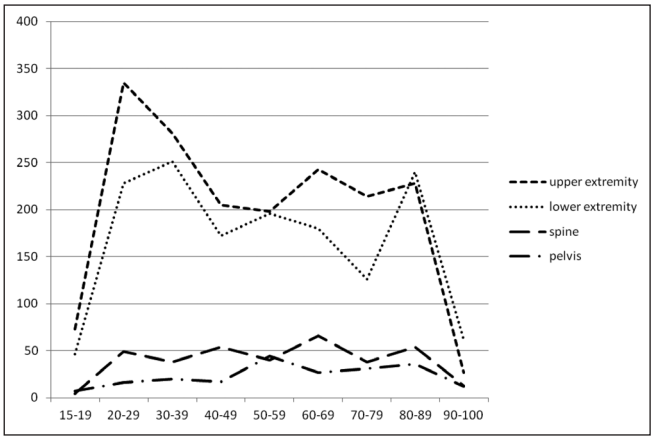

Fig. 4. *Age distribution of fractures by locations and decades.*

assault is noteworthy. This is probably related to the protection of the head and face during assault by the victim pushing out the upper extremities, and also to the efforts to temper the effects of the fall with upper extremities while falling to the ground (11).

The highest incidence of fractures in men between 6 p.m. and 9 p.m. and on weekends with a peak on Saturdays indicates connection with sport activities during leisure time. No similar statements were found in other studies.

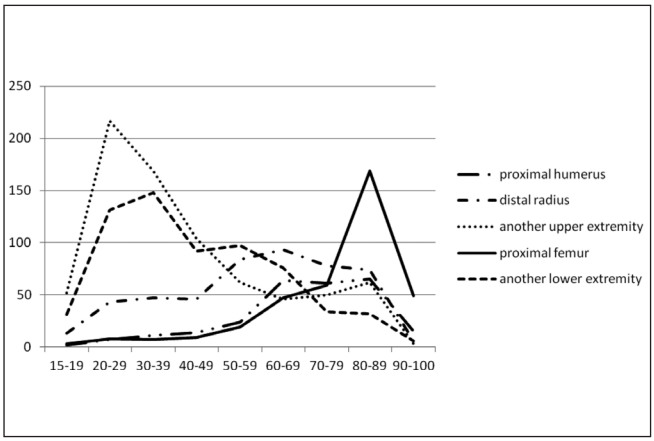

Fig. 5. *Age distribution of the most common fractures (more than 100 for the monitored period of one year) by decades.*

Limitations of Our Study

Patients with fractures of the skull and ribs were not included in the study. These fractures are a part of cranial and thoracic injuries. This study is concerned only with skeletal fractures of the musculoskeletal system, which are considered a separate issue. The lowest age of patients was 15 years, as the Trauma Centre treats only adult patients. The centre is located in a large urban cluster, which can affect the spectrum of fractures. Two other Trauma Centres Level 1 operate in the city and patients seek treatment either by themselves or are brought by ambulance to the nearest Trauma Centre from the site of injury. For this reason, it is difficult to have a proper denominator for the calculation of incidence rates of individual fractures. Another reason is that many patients with less severe fractures seek treatment in other medical facilities operating in the region. The comparison of our results with other studies is challenging because the design and data collection of epidemiological studies vary, and they are often influenced by regional factors like the provision of health care, classification schemes, structure of the population, risk factors, culture etc. (2–4, 9, 10).

CONCLUSION

Our study highlights the need for injury prevention programmes focused on sex, age, and types of activities performed.

Among younger individuals, such programmes should primarily be targeted toward men who, as observed in our sample, have a higher fracture frequency compared to women. These preventive programmes should focus on male risk-taking behaviours (motorsports and cycling, in particular) and work-related activities with potential exposure to high energy (e.g., heavy loads and machinery, working at great heights, etc.), which is the cause of the significantly greater number of multiple fractures, and serious spinal or pelvic injuries seen in men. The increased incidence of fractures sustained by men during weekends, especially Saturdays, underscores the need to focus these programmes also on male leisure activities (e.g., sports and do-it-yourself projects).

Conversely, injury prevention programmes for individuals ≥ 60 years should primarily be targeted toward women, who have the highest fracture frequency in this population. The increased

Table 4. *Distribution of fractures by anatomical site and gender (N = 3,909)*

	Gender					Total		Mean age (years)
	Female		Male		p	n	%	
	n	%	n	%				
Upper extremity	937	21.7	902	21,1	0.483	1,839	42.8	52
Clavicle	32	0.8	71	1.8	**<0.001**	103	2.6	46
Scapula	8	0.2	21	0.5	**0.016**	29	0.7	51
Proximal humerus	184	4.7	79	2.0	**<0.001**	263	6.7	69
Humeral diaphysis	26	0.7	19	0.5	0.492	45	1.1	58
Distal humerus	21	0.5	18	0.4	0.887	39	0.9	54
Olecranon	21	0.5	11	0.3	0.155	32	0.8	57
Radial head	42	1.0	40	1.0	1.000	82	2.0	43
Radial and ulnar diaphysis	85	2.2	81	2.0	1.000	166	4.2	54
Distal radius	326	8.3	157	4.0	**<0.001**	483	12.3	58
Carpus	20	0.5	55	1.4	**<0.001**	75	1.9	36
Metacarpal bone	54	1.4	173	4.4	**<0.001**	227	5.8	39
Phalanx	118	3.0	177	4.5	**<0.001**	295	7.5	40
Lower extremity	799	18.9	705	16,7	0.132	1,504	35.7	53
Proximal femur	263	6.7	108	2.8	**<0.001**	371	9.5	76
Femoral diaphysis	19	0.5	23	0.6	0.502	42	1.0	49
Distal femur	13	0.3	11	0.3	1.000	24	0.6	62
Patella	29	0.7	25	0.6	0.862	54	1.3	53
Proximal tibia	43	1.0	42	1.0	0.920	85	2.0	55
Tibial diaphysis	20	0.5	25	0.6	0.416	45	1.1	46
Fibular diaphysis	23	0.6	33	0.8	0.147	56	1.4	46
Distal tibia	27	0.7	35	0.9	0.252	62	1.6	48
Ankle	142	3.6	119	3.0	0.377	261	6.6	50
Talus	7	0.2	13	0,3	0.207	20	0.5	35
Calcaneus	17	0.4	45	1.1	**<0.001**	62	1.5	44
Other tarsal bones	20	0.5	16	0.4	0.751	36	0.9	35
Metatarsal bone	74	1.9	117	3.0	**<0.001**	191	4.9	41
Phalanx	102	2.6	93	2.4	0.887	195	5.0	41
Spine	162	3.8	194	4.6	0.072	356	8.4	56
Cervical	29	0.7	24	0.6	0.751	53	1.3	56
Thoracal	53	1.4	59	1.5	0.413	112	2.9	56
Lumbar	80	2.0	111	2.8	**0.007**	191	4.8	56
Pelvis and acetabulum	118	3.0	92	2.4	0.192	210	5.4	60
Total	2,016	51.6	1,893	48.4		3,909	100	53

frequency is due to the predominance of osteoporotic limb fractures among women over 60 years (e.g., proximal humerus, distal radius, proximal femur). Such fractures can occur after a simple fall; therefore, these programmes should encompass a complete set of measures to reduce the risk of falling not only outdoors but, equally important, within the home. Another important public health issue, which is currently advocated, is a lifelong prevention of osteoporosis, which can reduce the risk of an osteoporotic limb and spinal fractures.

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Conflict of Interests

None declared

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