Osteoporos Int (2013) 24:2413–2421
DOI 10.1007/s00198-013-2339-0

ORIGINAL ARTICLE

Epidemiology of proximal humeral fractures in Austria between 1989 and 2008

H. P. Dimai · A. Svedbom · A. Fahrleitner-Pammer · T. Pieber · H. Resch · E. Zwettler · H. Thaler · M. Szivak · K. Amrein · F. Borgström

Received: 4 November 2012 / Accepted: 20 February 2013 / Published online: 9 April 2013

Abstract
Summary Incidence rates of proximal humeral fractures in Austria over a period of twenty years (1989–2008) were estimated. Age standardized incidence rates increased until 2008, primarily driven by an increase in incidence rates in women.
Introduction The aim of the prevailing study was to estimate incidence rates of proximal humeral fractures and to assess changes in trend in the Austrian population aged 50 years and above, over a period of 20 years (1989–2008).
Methods Number of proximal humeral fractures were obtained from the Austrian Hospital Discharge Register for the entire population ≥50 years of age. Adjustment factors were determined for multiple registrations of the same diagnosis, and for the fact that not all patients with proximal humeral fractures are treated in an inpatient setting. To analyze the overall change in this type of fracture for the period, average annual changes expressed as incidence rate ratios were calculated.
Results The estimated age-standardized incidence (fractures per 100,000 individuals) of proximal humeral fractures among Austrians ≥50 years of age increased in men from 112 (95 % CI, 99–124) to 141 (129–153) and in women from 222 (202–241) to 383 (360–406). The increase appeared to be linear with no leveling off towards the end of the study period.
Conclusion While some caution is necessary when interpreting the results given the use of adjustment factors, there appears to have been a rise in the incidence of proximal humeral fractures in Austria in both men and women, with no leveling off in recent years. The reasons for this are not clear, but in the light of previously reported leveling off in the increase in the incidence of hip fractures, a change in the patterns of falls cannot be ruled out.

Keywords Age-adjusted incidence · Crude incidence · Humeral fracture · Osteoporosis · Trend analyses

H. P. Dimai (✉) · A. Fahrleitner-Pammer · T. Pieber · K. Amrein
Department of Internal Medicine, Division of Endocrinology and Metabolism, Medical University of Graz, Auenbruggerpl. 2, A-8036 Graz, Austria
e-mail: hans.dimai@medunigraz.at

H. Resch
St. Vincent Hospital, Medical Department II, Vienna, Austria

E. Zwettler
Ludwig-Boltzmann Institute of Osteology, Hanusch Hospital of Vienna, Vienna, Austria

H. Thaler
Trauma Center Meidling, Vienna, Austria

A. Svedbom
OptumInsight, Stockholm, Sweden

M. Szivak
Austrian Trauma Insurance Agency (AUVA), Vienna, Austria

F. Borgström
LIME/MMC, Karolinska Institutet, Stockholm, Sweden

Introduction

Osteoporosis is defined as a “systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture"[1].Besides vertebral fractures, hip fractures and distal forearm fractures, humeral fractures are among the most common osteoporotic fractures, and the average lifetime risk in a 50 year old Caucasian to experience this type of fracture has been estimated at 12.9 % for women and at 4.1 % for men [2]. Osteoporotic fractures are associated with significant morbidity and fractures of the hip, vertebrae, and humerus have been shown to be associated with excess mortality [3, 4].

Whereas the incidence of hip fractures has been studied extensively in many countries and populations worldwide, humeral fractures are infrequently considered individually in osteoporotic studies, reflecting their comparatively low incidence and presumed limited impact on health related quality of life (HRQoL). However, a number of recent studies indicate that humeral fractures are common—with only hip and distal forearm fractures being more common in the elderly—and usually associated with substantial impairment in HRQoL [5–7].

Notwithstanding, only little is known about the secular trends in the incidence of humeral fractures: A recent review of the literature on temporal trends in incidence of osteoporotic fractures only found studies conducted on the Finnish National Hospital Discharge Registry, which has provided data for a number of studies on secular trends in the incidence of humeral fractures [8–13]. Furthermore, a recent Canadian study reported on the secular trend for a number of osteoporotic fractures, including humeral fractures [14]. In addition, a small number of studies have been performed to estimate changes in the incidence of humeral fractures in comparatively small geographic areas [15–17]. In Finland, the age-standardized incidence of both proximal and distal humeral fractures increased from 1970 until the mid 1990s and stabilized (proximal humeral fractures) or decreased (distal humeral fractures) thereafter [11]. In Manitoba Canada, the age-standardized incidence declined in both men and women from 1986 to 2006, albeit at a measured pace (0.8 % per year for men and women combined) [14]. In the studies on smaller geographic areas, the incidence of proximal humeral fractures increased in Malmo Sweden (1950 to 1982) and Tottori Prefecture, Japan (1986 to 1995) but remained stable in one hospital area in Denmark (1976 to 1984) [15–17].

The Republic of Austria is located in the southern part of Central Europe. In 2008, Austria counted some 8.3 million inhabitants. The present day age pyramid shows a narrow base due to a reduction in birth rates and similar to other countries in the European Union; the percentage of the senior population 50 years and above is increasing. Within the elderly Austrian population, the number of women clearly exceeds the number of men which is due not only to the higher life expectancy of women, but also to the large number of men who died in World War II [18, 19].

The aim of the present study was to estimate the incidence of humeral fractures in the Austrian population aged 50 years and above and to estimate the trend in average annual change of this fracture type over a period of two decades (1989–2008).

Materials and methods

Since 1989, it has been mandatory for all hospitals within Austria to record discharge diagnoses by using the code classes of the International Classification of Diseases (ICD). This information is registered into the Austrian Hospital Discharge Register (AHDR) which is maintained by Statistics Austria [19].

For the purpose of this study, number of humeral fractures were obtained from the AHDR for the entire Austrian population ≥50 years of age between 1989 and 2008. For identification of proximal humeral fractures, the code-classes 812.0 and 812.1 (ICD-9; 1989–2000) and S42.2 (ICD-10; 2001–2008) have been applied. Code-class 812.0 covers all closed fractures of the upper end of humerus, whereas code-class 812.1 covers all open fractures of the upper end of humerus. Accordingly, code-class S42.2 covers open as well as closed fractures of the upper end of humerus. The data derived from the AHDR provides information on the number of fractures in 5-year intervals (50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, and 85+) per year stratified by sex and region (Upper Austria, Lower Austria, Styria, Carinthia, Salzburg, Tyrol, Vorarlberg, Burgenland, and Vienna).

Given that the AHDR only captures humeral fractures treated in an inpatient setting, an adjustment factor enabling estimation of the total number of fractures was introduced. The adjustment factor was derived using data from the Allgemeine Unfallversicherungsanstalt (AUVA—the Austrian Workers' Compensation Board). The AUVA is the Austrian social insurance for occupational risks for more than three million employed persons and 1.3 million school children and students. However, apart from its function as one of the largest insurers in Austria, the AUVA is also running seven large trauma hospitals with a total of 918 beds (including 54 intensive care beds), and treatment in these hospitals is not limited to patients who sustained an occupational accident. In fact, e.g., in 2010, only 57.066 patients who sustained an occupational accident, but 215.597 patients who sustained a home and/or leisure accident were treated in these hospitals [20].

For the purpose of the prevailing study, the data derived from the AUVA contained 17,691 proximal humeral fractures in patients aged 50 years and above, sustained between 1999 and 2010, with information on sex, calendar year, birth year, and treatment (inpatient or outpatient). Moreover, in the AHDR as in many other registries, it is possible that patients have multiple registrations for the same diagnosis. The number of patients with multiple registrations in the register cannot be reviewed given that the data is presented in aggregated form. To assess the proportion of diagnoses with multiple registrations, the medical records of humeral fracture patients at the trauma units of two further large Austrian hospitals (the University Hospital of Graz and the Hanusch Hospital of Vienna) were reviewed. These two units have been randomly chosen from a total of 67 trauma units in Austria. The number of humeral fractures treated in these trauma units represent roughly 5 % of all humeral fractures admitted to hospitals in Austria per year. The proportion of diagnoses with multiple registrations found in these two hospitals might therefore give a reasonable estimate of the percentage of multiple registrations nationwide. Overall, it was found in this review that 4 % of all humeral fracture diagnoses had multiple registrations. The data obtained from the AHDR were corrected accordingly.

Number and structure (age, sex) of the Austrian population has been provided by Statistics Austria [19]. According to the Austrian Registration Act of 1991, all individuals taking up long-term or permanent residence in Austria have to report their name and address to the local authorities (city, town, and village) within three days by means of a special registration form (Meldezettel) [21]. Local authorities are running their local resident registers, and these data are forwarded to the central resident register which is maintained by the Federal Government. Since 2002, data from the local registers are registered into the central register in real time mode. For the years 1989–1991, number and structure of the Austrian population has been estimated through “traditional” census.

The number of patients with humeral fractures in Austria stratified by year, sex, and age group were estimated by multiplying the number of inpatient fractures from the AHDR corrected for multiple registrations with the adjustment factor derived from the AUVA.

Statistical analysis

Using data from the AUVA, a regression with treatment setting (inpatient/outpatient) as dependent variable and sex, age at fracture, and calendar year as independent variables was run to determine which variables the adjustment factor should reflect.

The numbers of humeral fractures were estimated in 5-year age groups for both sexes using the fractures observed in the AHDR adjusted for treatment setting (inpatient vs. outpatient) and multiple registrations. Crude incidence rates (fractures per 100,000) were calculated based on the estimated number of fractures and the annual midyear populations for the years under consideration obtained from Statistics Austria. Age and sex standardized incidence rates were estimated using the direct standardization method with the average population 2001 to 2008 set as standard.

Given that the AUVA data accounted for approximately 29 % of all inpatient proximal humeral fractures observed in the AHDR dataset in the population over 50 years of age, confidence intervals were conservatively estimated based on the assumption that the dataset captured 29 % of the population and fractures. Confidence intervals for crude and standardized rates were estimated using the normal approximation and the Poisson approximation.

Temporal trends in incidence of humeral fractures were assessed by estimating the average annual change in incidence rate ratios (IRRs) using regression models based on count data stratified by sex-age class and year. Regressions models were run for the entire population as well as split into sex and sex-age classes, controlling for age and sex as appropriate. For analyses run on the entire data set, an interaction variable for sex and annual change was introduced to correct for differences in annual change between men and women.

Given that the data exhibited substantial overdispersion (variance greater than the mean) poisson models which assumes that mean and variance of the error term are equal were not appropriate, and negative binomial regression models were used instead.

In order to determine if a change in the trend over time could be observed, the linear trend in the average annual change was estimated using regression models of the first differences in count data as described previously [22].

All statistical tests were two-sided with the level of significance set at 5 %. Statistical analyses were conducted with Stata 10.0.

Results

Age and calendar year at fractures, but not sex, were statistically significantly associated with treatment setting ($p<0.01$ for age and calendar). Consequently, age-specific

(5-year groups) adjustment factors were estimated (Appendix). Given that the regression showed that the risk of hospitalization increased by 0.5 % per calendar year holding the other variables constant, the age stratified adjustment factor were factored down by 0.5 % per year after 2004 (the midyear in the dataset from the AUVA) and up by 0.5 % per year before 2004. Overall, approximately 40 % of all fractures were treated in an inpatient setting. The age-stratified adjustment factors by year are presented in the Appendix.

Figure 1 shows the number of registered proximal humeral fracture discharge diagnoses from 1989 to 2008. Over the period, the number in women and men increased from 1,139 to 2,913 and from 365 to 786, respectively. When adjusting for treatment setting (inpatient vs. outpatient) and multiple registrations, the crude incidence per 100,000 person years increased in women from 219 (95 % CI, 204–233) to 392 (374–410) and in men from 111 (95 % CI, 98–123) to 144 (132–156). Crude incidences stratified by sex-age group and year are presented in the Appendix.

Annual age standardized incidence rates per 100,000 person years 1989 to 2008 (adjusted for treatment setting and multiple registrations per fracture) are shown in Figure 2. The age standardized incidence rates for women and men increased from 222 (95 % CI, 202–241) to 383 (360–406) and from 112 (95 % CI, 99–124) to 141 (129–153), respectively. The overall increase in the age standardized incidence rates are reflected in the IRR analysis which shows statistically significant increases in incidence per year of 2.9 % ($p<0.001$) in women and 1.6 % ($p<0.001$) in men over the period. The change in incidence per annum increased significantly across all sex-age groups except for men below 60 years of age, where the increase was not significant. The changes in incidence per annum ranged between 1 to 5 % for different sex and age groups. Age standardized incidence by year and sex as well as IRRs for the period are presented in the Appendix.

Visual inspection of Figure 2 indicates that the growth in age-standardized incidence of proximal humeral fractures was stable over the period under consideration. This impression is supported by the analysis of the trend in the average annual change which does not deviate significantly from linearity in either men (−0.25 $p>0.05$) or women (−1.27 $p>0.05$).

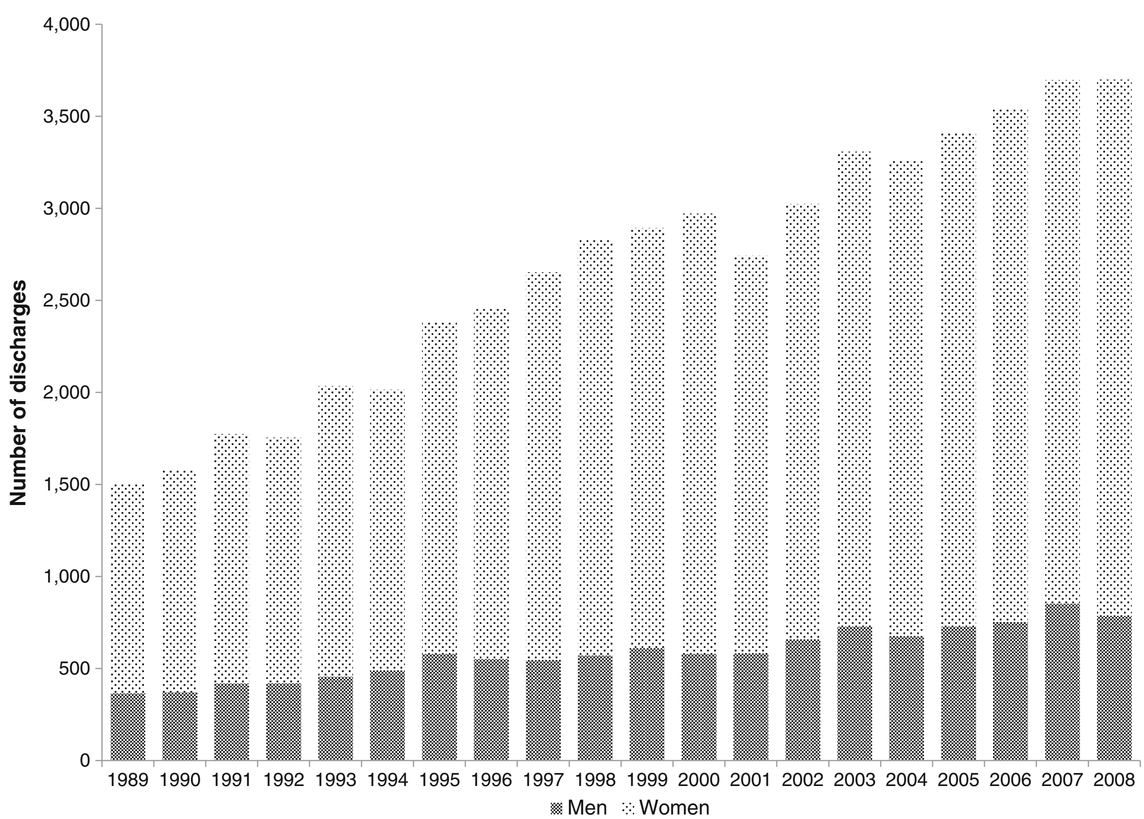

Fig. 1 Number of annual proximal humeral fracture discharges in Austrian population aged ≥50

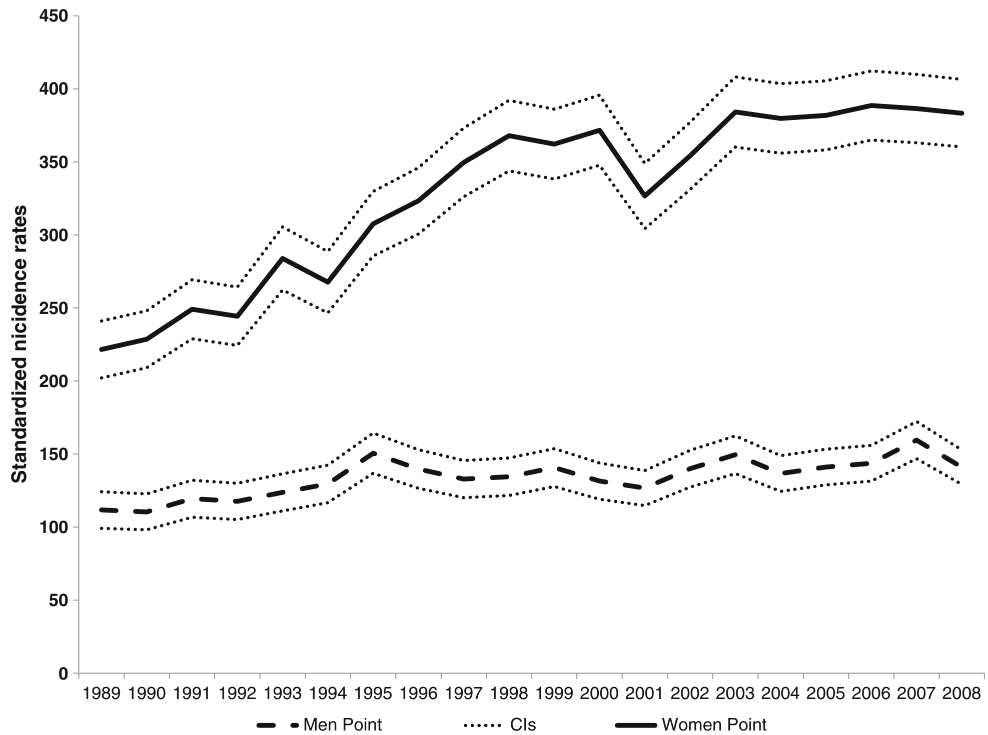

Fig. 2 Age-standardized proximal humeral fracture incidence rates (per 100,000) for the Austrian population aged ≥50

Discussion

The epidemiology of humeral fractures has been far less studied compared to other fracture types such as hip and vertebral or wrist fracture. In the present study, we estimated that the age-adjusted incidence of proximal humeral fractures in Austria has increased between the years 1989 and 2008 for both women and men. The estimated incidence increased more in women than men in both absolute and relative terms. To some extent, the findings are similar to the studies conducted in Finland, showing an increase in the incidence of humeral fractures in women [11]. However, the stabilization of the incidence apparent since the mid 1990s in Finland is not seen in Austria. Furthermore, the results contrast a Canadian study where a decrease in age-standardized incidence in Manitoba was observed from 1996 to 2006 [14].

The estimated incidence rates of proximal humeral fractures for Austria (392 per 100,000 women over 50 years of age) appear higher than in Finland (298 per 100,000 women over 60) [11]. This may in part be due to the fact that studies performed in the Finnish population only considered proximal humeral fractures that were treated in an inpatient setting, whereas the present study included fractures treated in inpatient as well as in outpatient settings. Considering only inpatient treated fractures, the incidence of proximal humeral fractures for women in 2008 falls to 181 per 100,000 women in Austria, below the incidence observed for proximal humeral fractures in Finland.

Recent studies have shown that humeral fracture is a more common fracture type than previously believed [5–7]. This is supported by the findings in this study. In a previous study using the same data source and methodology, the incidence and secular trends of hip fracture was assessed in Austria [22]. Even though the distribution of risk over age differs quite substantially between hip and humeral fractures, the overall incidence of proximal humeral fractures can be considered as substantial in terms of its socioeconomic relevance.

In the hip fracture study, it was shown that the hip fracture incidence in Austria increased over the period 1989–2008, with a peak at the turn of the century and has since remained stable and even decreased in recent years [22]. This trend was driven by a leveling off and subsequent decrease in fracture incidence in women, whereas the incidence in men has continued to rise at a measured pace. A different pattern could be observed for proximal humeral fracture where a constant statistically significant linear increase in the incidence could be observed for both men and women. One possible explanation for this discrepancy might be that disability prevalence in the older population has been declining in the last decades, whereas leisure time physical activity, body mass index, and the proportion of people who can be classified as obese have been increasing [23, 24]. The pattern of falls might thus have changed, leading to an increase in the severity of the trauma impinging on the humerus. However, hitherto, no prospective studies have been performed to further evaluate or support this hypothesis.

Humeral fractures have been shown to result in substantial impairment in HRQoL [6]. However, only a few studies have been conducted to assess HRQoL reduction following humeral fractures by utilizing a generic quality of life instrument. Based on expert opinion, it has been recommended to assume a 20 % reduction in HRQoL during the first year after a humeral fracture in health economic studies. Also, in an interim analysis of Austrian patients included in the ICUROS study (www.icuros.org), the HRQoL was reduced by 20 % during the first year which is close to the reduction estimated for hip fracture (25 %) [25].

Given the relatively high risk of proximal humeral fractures observed in this study, it is important to conduct further studies on the epidemiological pattern of humeral fractures. The study results indicate that the estimated incidence of proximal humeral fractures has increased more than the incidence of hip fractures in recent years. This may mean that the share of the total burden of osteoporotic fractures that can be attributed to proximal humeral fractures has increased. This is important to account for in health economic studies that often in the past have not considered humeral fracture as a relevant fracture to include.

Our analysis has some limitation that needs to be considered when interpreting the results. The main limitation is related to the fact that the AHDR does not capture patients treated in an outpatient setting, and hence, the results provided in this study are estimates of the true incidence. To account for outpatient treatment in the incidence calculations, we derived an adjustment factor based on a sample of 17,691 proximal humeral fractures in patients aged 50 years and above sustained between 1999 and 2010, with information on sex, calendar year, birth year, and treatment (inpatient or outpatient) factor. It is important to note that the adjustment factor was extrapolated outside the dataset in terms of calendar years which may have affected the results. However, given that the adjustment factor was modeled to decrease over time by 0.5 % per year, the increase in age-standardized incidence with time would have been even steeper, had the adjustment factor been held constant. Furthermore, it is of note that an increase in the age-standardized fracture incidence was also observed during the time of data availability from AUVA. Even though the correction factor was derived from a large dataset accounting for approximately 20 % of the Austrian population, and there is no reason to believe that the ratio of outpatient vs. inpatient would differ across Austria, this raises some uncertainty to the results.

Another potential uncertainty is the correction factor related to multiple registrations. This correction factor was derived from two large trauma units and assumed to be valid for the whole of Austria. However, to consider potential changes over time, we also conducted a small substudy that showed that the percentage of multiple registrations for the same diagnosis has been fairly stable over time. A potential source of uncertainty also lies in the fact that fractures caused by high trauma, such as vehicle accidents, could not be excluded from analyses. The fact that traditional census was replaced by a computerized population register in the early nineties may as well be considered a limiting factor. And finally, another limitation lies in the fact that the dataset does not contain data on risk factors which could explain the change in fracture incidence trend.

Conclusion

The present study indicates that from 1989 to 2008, estimated age-standardized incidence of proximal humeral fractures has increased in both men and women in a linear fashion. To some extent, this finding is similar to the nationwide studies on Finnish data which has reported increased incidence of proximal humeral fractures since the 1970. However, the leveling off in the increase in incidence apparent in Finland cannot be seen in Austria. Similarly, the findings contrast to the decline in age-adjusted incidence of proximal humeral fractures observed in Canada from 1996 to 2006. While the reason for the increase is not clear, in the light of the previously reported leveling off in the increase in the incidence of hip fractures, a change in the patterns of falls cannot be ruled out. The present study contributes to an increasing body of evidence suggesting that proximal humeral fractures are more common and result in more health related quality of life impairment than previously thought, indicating that more research should be devoted to this type of fracture.

Acknowledgments The study was funded by a Medical Research Fund of the Medical University of Graz. We would like to thank Ms. Dr. Erika Baldaszti and Ms. Mag. Barbara Leitner from Statistics Austria for providing us with the data from the Austrian Hospital Discharge Register. We are grateful to Dr. Marlene Klingspiegl from the Steiermärkische Krankenanstalten Ges.m.b.H. and Ingrid Lackner from the Hanusch Krankenhaus Vienna, 4th Medical Department, for extracting the data file from the hospital register.

Conflicts of interest None.

Appendix

Table 1 Incidence rates of proximal humeral fractures and trends in Austria (1989 to 2008)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Population >50 (k)	2.334	2.377	2.419	2.450	2.472	2.494	2.505	2.512	2.536	2.569	2.601
Nr of humeral fractures	4.071	4.256	4.685	4.610	5.264	5.139	6.062	6.143	6.518	6.860	6.954
Adjustment factor, age											
50–54	3,59	3,54	3,49	3,44	3,40	3,35	3,31	3,26	3,22	3,18	3,14
55–59	3,47	3,42	3,37	3,33	3,28	3,24	3,20	3,16	3,12	3,08	3,04
60–64	3,13	3,09	3,05	3,01	2,98	2,94	2,91	2,88	2,84	2,81	2,78
65–69	2,88	2,84	2,81	2,78	2,75	2,72	2,69	2,66	2,63	2,61	2,58
70–74	2,61	2,58	2,56	2,53	2,50	2,48	2,46	2,43	2,41	2,39	2,36
75–79	2,45	2,43	2,41	2,38	2,36	2,34	2,32	2,30	2,28	2,26	2,24
80–84	2,39	2,37	2,35	2,33	2,31	2,28	2,26	2,24	2,22	2,20	2,19
85+	2,20	2,18	2,16	2,15	2,13	2,11	2,09	2,07	2,06	2,04	2,02
Age std incidence											
Men	112 (99–124)	110 (98–123)	119 (107–132)	118 (105–130)	124 (111–137)	130 (117–142)	151 (137–164)	140 (127–153)	133 (120–146)	134 (122–147)	141 (128–154)
Women	222 (202–241)	229 (209–248)	249 (229–269)	244 (224–264)	284 (262–305)	268 (247–289)	308 (286–330)	323 (301–346)	350 (326–373)	368 (344–392)	362 (338–386)
Male, age											
50–54	78 (55–100)	109 (83–134)	106 (82–130)	105 (82–128)	88 (67–109)	106 (83–129)	144 (116–172)	114 (89–140)	103 (78–127)	118 (92–144)	123 (97–149)
55–59	111 (84–139)	99 (72–125)	126 (96–157)	114 (85–143)	132 (101–164)	126 (96–156)	136 (107–165)	138 (110–166)	140 (113–167)	104 (81–127)	130 (104–156)
60–64	107 (79–135)	92 (66–118)	73 (50–96)	103 (76–130)	121 (91–151)	141 (108–173)	141 (108–174)	113 (83–142)	106 (77–136)	112 (82–141)	116 (86–145)
65–69	85 (57–113)	103 (73–134)	103 (73–133)	107 (76–137)	95 (66–123)	102 (72–131)	132 (99–164)	123 (92–155)	112 (82–142)	109 (79–139)	105 (76–135)
70–74	149 (99–198)	115 (71–158)	125 (82–167)	117 (78–156)	122 (84–160)	150 (110–191)	141 (102–180)	103 (70–136)	133 (96–170)	119 (84–154)	127 (92–163)
75–79	133 (89–178)	114 (73–156)	114 (71–158)	134 (84–184)	127 (76–179)	108 (58–157)	160 (101–219)	205 (142–267)	172 (118–227)	154 (105–202)	200 (147–254)
80–84	126 (69–184)	164 (100–229)	275 (192–358)	120 (66–174)	178 (113–244)	171 (107–235)	220 (147–293)	264 (180–347)	178 (106–251)	242 (153–332)	225 (136–314)
85+	308 (180–436)	234 (125–343)	270 (156–385)	335 (209–460)	408 (272–544)	318 (201–436)	348 (228–469)	340 (223–456)	390 (267–513)	551 (408–695)	427 (302–551)
Women, age											
50–54	85 (62–109)	90 (67–113)	93 (71–116)	59 (42–76)	100 (78–122)	85 (65–106)	133 (106–159)	87 (65–109)	138 (110–166)	135 (108–162)	114 (89–139)
55–59	92 (67–116)	119 (91–147)	84 (60–108)	136 (105–166)	148 (116–181)	114 (86–141)	144 (115–174)	160 (131–190)	143 (116–170)	162 (133–190)	185 (154–215)
60–64	150 (120–180)	152 (122–182)	173 (140–206)	188 (153–222)	173 (139–206)	157 (125–190)	177 (142–211)	192 (155–229)	195 (158–233)	202 (163–240)	188 (152–224)
65–69	201 (168–234)	225 (190–260)	235 (199–271)	213 (178–248)	240 (202–278)	216 (180–253)	220 (182–258)	293 (249–337)	268 (225–310)	255 (213–297)	246 (204–287)
70–74	289 (237–342)	240 (193–287)	259 (213–306)	263 (219–306)	331 (285–378)	288 (246–329)	409 (360–458)	386 (338–435)	411 (360–461)	454 (400–508)	450 (395–505)
75–79	295 (248–342)	331 (280–382)	402 (344–460)	391 (330–451)	455 (386–525)	460 (388–532)	410 (343–477)	550 (478–623)	547 (479–615)	617 (548–685)	589 (525–654)
80–84	386 (319–452)	412 (345–480)	448 (378–518)	445 (376–514)	529 (454–603)	518 (445–591)	678 (593–763)	641 (556–727)	741 (644–838)	787 (681–892)	751 (644–857)
85+	626 (520–731)	599 (498–701)	714 (605–823)	641 (540–741)	736 (630–842)	783 (676–890)	793 (688–899)	776 (674–878)	962 (850–1074)	962 (852–1071)	1025 (913–1137)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	ΔIRR p.a.[a]	95 % CI
Population >50 (k)	2.631	2.664	2.694	2.719	2.752	2.790	2.836	2.884	2.934		
Nr of humeral fractures	7.086	6.408	7.050	7.627	7.526	7.704	7.990	8.305	8.212		
Adjustment factor, age											
50–54	3,10	3,06	3,03	2,99	2,96	2,92	2,89	2,85	2,82		
55–59	3,01	2,97	2,94	2,87	2,87	2,87	2,88	2,88	2,89		
60–64	2,75	2,72	2,69	2,63	2,63	2,64	2,64	2,65	2,65		

Table 1 (continued)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	ΔIRR p.a.[a]	95% CI
65–69	2,55	2,53	2,50	2,45	2,45	2,46	2,46	2,47	2,47		
70–74	2,34	2,32	2,30	2,25	2,26	2,26	2,26	2,27	2,27		
75–79	2,22	2,20	2,18	2,14	2,14	2,14	2,15	2,15	2,16		
80–84	2,17	2,15	2,13	2,09	2,09	2,10	2,10	2,11	2,11		
85+	2,01	1,99	1,98	1,94	1,95	1,95	1,95	1,96	1,96		
Age std incidence											
Men	132 (119–144)	127 (115–139)	140 (127–153)	150 (137–162)	137 (124–149)	141 (129–153)	144 (131–156)	160 (147–172)	141 (129–153)	1,02	<0.001
Women	372 (348–396)	327 (304–349)	354 (331–377)	384 (360–408)	380 (356–403)	382 (358–405)	389 (365–412)	386 (363–410)	383 (360–406)	1,03	<0.001
Male, age											
50–54	129 (103–156)	102 (79–125)	102 (79–125)	122 (97–148)	108 (84–132)	99 (76–122)	110 (87–134)	116 (92–140)	89 (69–110)	1,00	0,587
55–59	111 (86–136)	102 (77–126)	143 (113–172)	130 (102–157)	117 (91–143)	107 (83–132)	109 (85–133)	146 (118–174)	127 (100–153)	1,00	0,591
60–64	103 (77–129)	125 (97–152)	117 (91–143)	123 (97–148)	140 (112–167)	141 (112–170)	134 (105–164)	156 (125–188)	131 (102–159)	1,02	<0.001
65–69	131 (98–165)	119 (87–151)	126 (93–159)	129 (96–163)	111 (81–141)	123 (94–153)	148 (117–179)	139 (110–168)	128 (100–155)	1,02	<0.001
70–74	102 (71–134)	127 (93–162)	127 (92–161)	157 (119–196)	140 (103–177)	135 (99–171)	146 (108–184)	167 (126–208)	142 (105–180)	1,01	<0.05
75–79	159 (112–206)	152 (107–198)	150 (105–194)	166 (120–212)	122 (83–161)	165 (121–210)	142 (102–183)	167 (123–211)	160 (117–203)	1,01	<0.05
80–84	193 (113–272)	194 (119–268)	222 (148–297)	231 (159–303)	202 (137–266)	294 (217–371)	252 (182–322)	233 (167–299)	250 (183–317)	1,02	<0.01
85+	385 (267–503)	349 (235–464)	502 (361–643)	541 (389–692)	510 (362–658)	483 (345–621)	478 (347–610)	536 (403–669)	521 (395–648)	1,03	<0.001
Women, age											
50–54	128 (102–154)	77 (57–97)	108 (84–132)	120 (94–145)	128 (102–154)	80 (59–100)	98 (76–120)	113 (89–136)	125 (100–149)	1,01	0,09
55–59	177 (147–208)	137 (109–165)	189 (156–222)	163 (133–194)	218 (183–252)	186 (154–218)	211 (177–244)	170 (140–200)	215 (181–248)	1,04	<0.001
60–64	219 (182–256)	171 (140–202)	213 (180–247)	210 (177–243)	268 (231–305)	228 (193–263)	287 (246–328)	306 (263–348)	243 (206–281)	1,04	<0.001
65–69	298 (252–345)	246 (204–289)	236 (194–278)	292 (245–339)	295 (249–341)	316 (271–360)	274 (234–314)	299 (259–339)	300 (260–340)	1,02	<0.001
70–74	416 (363–470)	385 (333–438)	351 (300–401)	510 (449–571)	386 (332–439)	453 (394–512)	436 (377–495)	441 (382–501)	371 (316–426)	1,03	<0.001
75–79	653 (586–720)	522 (462–582)	576 (512–640)	554 (490–618)	543 (478–607)	567 (501–634)	592 (523–660)	549 (482–615)	553 (486–621)	1,03	<0.001
80–84	650 (554–745)	666 (576–757)	747 (658–837)	828 (739–917)	779 (696–862)	694 (617–772)	721 (642–800)	730 (649–810)	757 (674–840)	1,03	<0.001
85+	1051 (938–1165)	1072 (956–1188)	1086 (966–1206)	1092 (968–1215)	1055 (933–1178)	1269 (1139–1399)	1181 (1060–1301)	1162 (1048–1277)	1206 (1093–1319)	1,04	<0.001

[a] Incidence rate ratio per annum (measures average annual change in the incidence of proximal humeral fractures) from negative binomial regression models

References

1. No authors listed. (1991) Consensus development conference: prophylaxis and treatment of osteoporosis. Am J Med 90:107-10
2. Johnell O, Kanis J (2005) Epidemiology of osteoporotic fractures. Osteoporos Int 16(Suppl 2):S3–S7
3. Johnell O, Kanis JA, Oden A, Sernbo I, Redlund-Johnell I, Petterson C, De Laet C, Jonsson B (2004) Mortality after osteoporotic fractures. Osteoporos Int 15:38–42
4. Johnell O, Kanis JA (2006) An estimate of the worldwide prevalence and disability associated with osteoporotic fractures. Osteoporos Int 17:1726–1733
5. Tarantino U, Capone A, Planta M, D'Arienzo M, Letizia Mauro G, Impagliazzo A, Formica A, Pallotta F, Patella V, Spinarelli A, Pazzaglia U, Zarattini G, Roselli M, Montanari G, Sessa G, Privitera M, Verdoia C, Corradini C, Feola M, Padolino A, Saturnino L, Scialdoni A, Rao C, Iolascon G, Brandi ML, Piscitelli P (2010) The incidence of hip, forearm, humeral, ankle, and vertebral fragility fractures in Italy: results from a 3-year multicenter study. Arthritis Res Ther 12:R226
6. Calvo E, Morcillo D, Foruria AM, Redondo-Santamaria E, Osorio-Picorne F, Caeiro JR, GEIOS-SECOT Outpatient Osteoporotic Fracture Study Group (2011) Nondisplaced proximal humeral fractures: high incidence among outpatient-treated osteoporotic fractures and severe impact on upper extremity function and patient subjective health perception. J Shoulder Elbow Surg 20:795–801
7. Bell JE, Leung BC, Spratt KF, Koval KJ, Weinstein JD, Goodman DC, Tosteson AN (2011) Trends and variation in incidence, surgical treatment, and repeat surgery of proximal humeral fractures in the elderly. J Bone Joint Surg Am 93:121–131
8. Cooper C, Cole ZA, Holroyd CR, Earl SC, Harvey NC, Dennison EM, Melton LJ, Cummings SR, Kanis JA, IOF CSA Working Group on Fracture Epidemiology (2011) Secular trends in the incidence of hip and other osteoporotic fractures. Osteoporos Int 22:1277–1288
9. Kannus P, Palvanen M, Niemi S, Parkkari J, Jarvinen M, Vuori I (1996) Increasing number and incidence of osteoporotic fractures of the proximal humerus in elderly people. BMJ 313:1051–1052
10. Kannus P, Palvanen M, Niemi S, Parkkari J, Jarvinen M, Vuori I (2000) Osteoporotic fractures of the proximal humerus in elderly Finnish persons: sharp increase in 1970–1998 and alarming projections for the new millennium. Acta Orthop Scand 71:465–470
11. Kannus P, Palvanen M, Niemi S, Sievanen H, Parkkari J (2009) Rate of proximal humeral fractures in older Finnish women between 1970 and 2007. Bone 44:656–659
12. Palvanen M, Kannus P, Niemi S, Parkkari J (1998) Secular trends in the osteoporotic fractures of the distal humerus in elderly women. Eur J Epidemiol 14:159–164
13. Palvanen M, Kannus P, Niemi S, Parkkari J (2006) Update in the epidemiology of proximal humeral fractures. Clin Orthop Relat Res 442:87–92
14. Leslie WD, Sadatsafavi M, Lix LM, Azimaee M, Morin S, Metge CJ, Caetano P (2011) Secular decreases in fracture rates 1986–2006 for Manitoba, Canada: a population-based analysis. Osteoporos Int 22:2137–2143
15. Bengner U, Johnell O, Redlund-Johnell I (1988) Changes in the incidence of fracture of the upper end of the humerus during a 30-year period. A study of 2125 fractures. Clin Orthop Relat Res 231:179–182
16. Lauritzen JB, Schwarz P, McNair P, Lund B, Transbol I (1993) Radial and humeral fractures as predictors of subsequent hip, radial or humeral fractures in women, and their seasonal variation. Osteoporos Int 3:133–137
17. Hagino H, Yamamoto K, Ohshiro H, Nakamura T, Kishimoto H, Nose T (1999) Changing incidence of hip, distal radius, and proximal humerus fractures in Tottori Prefecture, Japan. Bone 24:265–270
18. No authors listed. (ed) (2008) Austria. Data . Figures . Facts. STATISTICS AUSTRIA Federal Institution under Public Law Guglgasse 13, 1110 Vienna, 1110 Vienna
19. No authors listed. (2007) Statistics Austria, Federal Institution under Public Law: Federal Act on Federal Statistics (Federal Statistics Act 2000) no.163/ 1999, as amended by BGBL. I, no. 136/2001, by BGBl. I, no.71/2003 and by BGBl. I, no. 92/2007. Vienna
20. Allgemeine Unfallversicherungsanstalt (ed) (2011) AUVA Annual Report 2010. AUVA, 1200 Vienna, Austria
21. No authors listed. (1991) Bundesgesetz über das polizeiliche Meldewesen (Meldegesetz 1991 - MeldeG) StF: BGBl. Nr. 9/ 1992 (NR: GP XVIII RV 279 AB 329 S. 48. BR: 4149 AB 4171 S. 547.; Federal Ministry of the Interior
22. Dimai HP, Svedbom A, Fahrleitner-Pammer A, Pieber T, Resch H, Zwettler E, Chandran M, Borgstrom F (2011) Epidemiology of hip fractures in Austria: evidence for a change in the secular trend. Osteoporos Int 22:685–692
23. Hung WW, Ross JS, Boockvar KS, Siu AL (2011) Recent trends in chronic disease, impairment and disability among older adults in the United States. BMC Geriatr 11:47
24. Johansson S, Wilhelmsen L, Welin C, Eriksson H, Welin L, Rosengren A (2010) Obesity, smoking and secular trends in cardiovascular risk factors in middle-aged women: data from population studies in Goteborg from 1980 to 2003. J Intern Med 268:594–603
25. Dimai HP, Jakob-Pelikan C, Thaler H, Lekander I, Ström O, Borgström F (2010) Quality of life reduction one year after an osteoporotic fracture in Austria. Osteoporos Int 21:S277