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## Changing trends in the epidemiology of hip fracture in Spain

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### Abstract

**Summary**—Temporal trends in hip fracture incidence have recently been reported in some developed countries. Such data in Spain has previously been incomplete; this study reports the stratified incidence of hip fractures in people over 65 in Spain during the last 14 years.

**Introduction**—The main objective is to establish whether temporal trends in hip fracture incidence in Spain exist.

**Methods**—Ecological study with data from hospital discharges nationwide. The study includes patients aged ≥ 65 years during a 14-year period (1997-2010). The analysis compares two periods of four years: 1997-2000 (P1) and 2007-2010 (P2).

**Results**—There were 119,857 fractures in men and 415,421 in women. Comparing periods (P1 vs P2), over ten years the crude incidence rate/100,000 inhabitant/year increased an average of

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2.3%/year in men and 1.4% in women. After adjustment, the rate increased an average of 0.4%/year in men ( $p<0.0001$ ), but decreased 0.2%/year in women ( $p<0.0001$ ).

In men younger than 85, the decrease was not significant except in 70-74 years and from 80 years the adjusted rate increases significantly ( $p<0.0001$ ). In women under 80 years of age, the decrease in adjusted rate was significant, there was no change in 80-84 years and the adjusted rate increased significantly in individuals 85 years and older ( $p<0.0001$ ). Mortality rates declined by 22% in both sexes and the index of overaging population rises 30.1% in men and 25.2% in women.

**Conclusions**—This study supports other international studies by showing changes in the incidence of hip fractures after age-population adjustment, which denotes a decrease in the younger age groups and among women and shows an increase in both groups over 85 years. The increase in the crude incidence rate of hip fracture in Spain reflects changes in population structure.

### Keywords

Elderly; Epidemiology; Hip fracture; Osteoporosis

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### Introduction

Osteoporotic fracture is a major public health burden and related to a great socioeconomic impact in developed countries [1,2]. The incidence of hip fracture (upper extremity of the femur) increases with advanced age, is more prevalent in women, and is becoming ever more frequent in an aging population [3–5].

Osteoporotic fracture in general, and especially hip fracture, has been demonstrated to increase the risk of new fractures [6,7], to reduce personal autonomy through associated disability and dependence [8], to worsen the quality of life [9,10] or in its worst consequence, to increase mortality in both sexes [7,11,12].

The incidence of hip fracture shows marked geographic variation with higher rates observed in Nordic countries, America and Europe. There may also be differences found within each country [13–15].

With regard to risk factors for hip fracture, the most common are advanced age, female gender and previous fractures. There are also genetic and environmental factors implicated [16]. The latter include nutritional factors, vitamin D deficiency, acute and chronic comorbidity, and pharmacological factors associated with falls and bone health [17–21].

Some international studies have recently reported an increase in the crude incidence of hip fracture due to demographic changes, but showing a plateau when age-adjusted [22,23]. There are also data to suggest a decrease in the age-adjusted incidence rates of hip fracture in North America (Canada and USA) and Europe [24–28], while a plateauing of rates has been reported in Southern European countries [22,23,28]. Secular trend in hip fracture rate might be explained by cohort effects, whereby aetiological factors which might act early in the life course cause rising fracture rates in successive later generations [28]; it has also been suggested that the use of drugs such as bisphosphonates may be relevant [28,29]. Finally,

preventative measures through better identification of individuals at risk may also be relevant [30–34].

Global epidemiological studies in hip fracture in the last decades are scarce in Spain [15,35,36]. They are limited to some regions, use different registry systems or consist of a short period of analysis [22,23], which only provides a partial view of incidence and trends.

The main objective of the study was therefore to assess the trend of hip fracture in Spain over a period of 14 years among a population of 65 year-old and upwards.

## Methods

An ecological study was performed to include subjects aged 65 years and upward with a fracture in the upper extremity of the femur during the period from 1997 to 2010. Population data was obtained from the National Statistics Institute of Spain [<http://www.ine.es/>]. The fracture register was obtained from the Ministry of Health and Social Policy (MHSP) databases [<http://pestadistico.msc.es/PEMSC25/>]. This data comes from patients treated in the country's hospitals (Minimal Basic Data Set). ICD-9 codes 820.0-820.9 were taken into account for the 14 year-period as primary diagnosis. This system provides reliable data that pertains to the place where the fracture happened, but provides no reliable data as to the cause of the fracture itself. The population was divided into 5-year age groups (the last group included people of the ages of 85 upwards). According to the National Statistics Institute, the population of Spain was 39,583,381 in 1997 and 47,021,031 in 2010. This population had a life expectancy at birth of 78.6 years for men and 84.9 for women in 2009. At the age of 65, life expectancy is 18.3 for men and 22.4 years for women.

To analyse the trends, two four-year periods were compared with a separation of ten years in between. Period 1 (P1) includes data from 1997 to 2000 and period 2 (P2) from 2007 to 2010. Both periods are separated by ten years and their rates are compared. Age adjustment was made using the total population included (1997-2010).

Variables collected were:

- Incidence: number of registered hip fractures per year and gender according to the selected codes.
- Crude incidence rate: number of registered hip fractures per 100,000 person-year and gender: P1 (1997-2000) and P2 (2007-2010).
- Incidence rate by gender in both periods: P1 (1997-2000) and P2 (2007-2010).
- Age and gender-adjusted incidence rate in both periods: P1 (1997-2000) and P2 (2007-2010).
- Incidence rate by age groups and gender in both periods: P1 (1997-2000) and P2 (2007-2010).
- Crude rate of mortality in people 65 years old or older in both periods: P1 (1997-2000) and P2 (2007-2010) determined by dividing the number of deaths

through any cause by the overall Spanish population and the mortality rate adjusted by age is adjusted with the total population of the study (1997-2010).

- Longevity rate (overaging index): proportion of the population among people over 75 and among people 65 and over by gender in both periods: P1 (1997-2000) and P2 (2007-2010).

Each variable was compared between the two periods and their difference is shown as percentage difference with reference to P1.

This paper follows the guidelines of the STROBE initiative [37] for epidemiological studies.

## Results

This study reports an analysis of 7,111,035 people-years over a 14-year period (1997-2010). During this period there were 119,857 hip fractures in men and 415,421 in women (table 1). In the first year (1997) 6,874 hip fractures occurred in men while 24,459 in women and in the last year (2010) there were 10,819 and 34,391 fractures, respectively. The female to male ratio for the incidence of hip fracture was 3.6 in 1997 and 3.2 in 2010. In table 2 age-standardized hip fracture incidence rates per 100,000 person-years are shown. An overall rate of 259.24 in men and 664.79 in women is shown for 1997 and 325.30 and 766.37 for 2010, respectively. Their graphs are shown in figure 1. The age-standardized female to male hip fracture ratio was 2.6 in 1997 and 2.4 in 2010.

Distribution according to age and gender is shown in table 1. The number of fractures in men 85 years and older were 3.5 times greater in 1997 and 6.8 times greater in 2010 when compared with the men in the 65-69 years age range. In women it was 6.6 times greater in 1997 and 14.6 times greater in 2010. When age-standardized rates are considered (table 2), these differences between the two groups become more pronounced

Age-standardized hip fracture incidence rates per 100,000 people-years increased 23.3% in P2 among men, and increased by 13.7% for women. Once adjusted however, the population rates increased by only 3.7% for men and actually decreased by 1.9% for women (table 3). In men the group of age 80-84 year-old there was a significant increase of 10.0% and 7.2% for those of 85 years old or older. In women, in the three younger age groups (65-69; 70-74 and 75-79), incidence rates fell significantly by 23.7%, 16.6% and 7.7%, respectively while in the group of 85 years and older there was a significant increase. Age-adjusted mortality rate in P2 falls to 22.4% in men and 22.3% in women. The index of over aging population (proportion of people of 75 and upwards / people of 65 and upwards) rose 30.1% in men and 25.2% in women during the period of study (table 3).

## Discussion

In the present study hip fracture incidence rate trends in Spain are examined. The analysis shows a continuous rise in people of 65 years of age or more. A steady rise at a yearly pace of 3.6% was seen in both genders. Nevertheless, this increase has been slowing down over the last few years and it is currently 2.1% yearly. Progression is linear in both genders, except a slight drop for younger men in the period 1997-2000 (table 1). Age-adjusted

female-to-male ratio incidence of hip fracture gradually decreases from 2.6 to 2.4 at the end of the period. This ratio is lower than that published in other countries [2] and changes the trend previously described in Spain [22,23].

Data was extracted from the Minimal Basic Data Set gathering all the information from hospital discharges (mandatory reporting from 1992). This validated register is widely used around the country [15,35,37]. Our results are in accord with results reported in other studies analyzing shorter periods (3-4 years) in Spain [22,23].

Incidence rates of hip fracture were measured in two separate periods with the objective of improving reliability in the analysis of trends and ascertain development at the end of a ten-year period. This also avoids the influence of years that show exceptional trends, as happened with the standardized rate in the years 1997-2000, in both male and female groups. We have insufficient data to properly assess if the change in trends in those years is due to a transient change or other factors affecting the register of hip fractures.

When comparing both periods, crude incidence rate shows a remarkable increase in the second period. An average annual growth rate of 2.3% is shown in men and a 1.4% in women. When population-adjusted, there is a 3.7% increase in men in the period (0.4% average yearly), whereas women show a drop of 1.9% (0.2% average yearly).

The trend of hip fracture according to age groups and gender is clearly downward in women 65 to 80 years old. The 80-84 year-old group has remained more or less the same. However, there is a significant increase in the 85 year-old groups. Moreover, the differences between the oldest and the youngest groups are rising in men, from 3.3-fold to 6-fold from 1997 to 2010. Nonetheless, in women, they decrease from 8-fold to 2-fold. These changes may be due to population variations.

In men between 80 and 84 years old and in those of 85 years old or more incidences rise markedly by 10% and 7.2%, respectively. The drop in the incidence in the younger groups, especially in women, has also been observed in other recent studies and it comes together with a rise in the average age of hip fracture [28]. Nonetheless, our results differ from other studies published in Spain. The reasons for a different incidence rate may be either a shorter studied period [15], or data coming from a different data source or just studying one region [22,23].

Another innovative approach of the present study is the analysis of mortality rate and that takes into account the increase in the percentage of elderly people in the same period. In the period studied, the mortality rate dropped remarkably in men and women (22.4% and 22.3%). The percentage of people 75 years old or more is higher in the second period, 30.1% in men and 25.2% in women. These two factors contribute to the aging of the population and as a result to the rise in the crude hip fracture incidence in men 80 years old or more and women 84 years old or more.

The changes in the trend of hip fracture in Spain seen in this study are related, on the one hand, to the demographic changes and the population aging in industrialized countries [4]; and on the other hand, to the relative drop seen in the younger groups as described recently

[24–28]. The reason for this may be manifold. One of the suggested reasons is that the conditions related to the age of birth and thus associated to the age in which bone development occurs in the cohort [4,28]. Population 85 years old or more in the second period was born in 1925 or before. Thus, their bone development occurred in the years 1935-1950, a period in which food resources were scarce in Europe and, specifically in Spain, due to the Civil War and the post-war years.

One of the other suggested causes of the drop in the incidence rate is the introduction and widespread use of the prescription of antiresorptive drugs, especially bisphosphonates in developed countries [28,38]. In Spain the management of osteoporosis and the prevention of osteoporotic fractures focused on analyzing with DXA and the prescription of antiresorptive drugs to women and men younger than 70 years [34,36]. Whether this time overlap implies a causal relationship or not remains to be elucidated. The implementation and wide use of the FRAX<sup>®</sup> tool [30], recommended for the first approach to the management of osteoporosis [31], has a potential impact in the future evolution of fracture incidences in Spain, where a number of studies have assessed their performance in the local population [32–34, 40–41]. With respect to the management of osteoporosis in Spain, the selection of segments of the population at higher risk for osteoporotic fracture has spread in clinical practice, in order to support the use of drug prescriptions not only focused on bone mineral density [39]. However, when we compare the incidence of hip fracture in the same conditions (age, sex, BMI, period and ICD-9 codes), the current version of FRAX<sup>®</sup> for Spain predicts an absolute risk at 10 years 41-50% less than the updated version for Italy [42] when age-adjusted rates standardised per 100,000 world population aged incidence rate is only 22.2% lower for men (140 vs. 108.9) and 21.4% for women (334 vs 262.4) as suggested by the predictions of the WHO in 2002 [13].

In an international context, there is now a lot of evidence that indicates a decrease in hip fractures incidence rates when adjusted for age and population in women in most countries analyzed, especially in the last 10 years [4,38,43–45] but not in all cases [43]. At the time of analyzing the incidence rates between countries we had several difficulties in comparing them with each other, due to different reasons: different sources of information: hospital discharges directly from hospitals or in some regions [22,23,43] or centralized data for the whole country [our study,4,26,29,43,45], different coding systems: ICD9 [29,38] or ICD10 [26] although most are currently using ICD10, others use different codes (820 i/o 821 in ICD9 vs S72.0-S72.2 in ICD10), quality of records validations requiring multiple adjustments records [4,43] and different time periods analyzed. However, one of the biggest problems is that the populations included in the analysis of fracture rates. Given that there are large differences in rates depending on the ages included (any age [26,43] or above 40 [45], 50 [4,38,44] or 65 years [29]). For example, in period 2 of this study (2007-2010), the hip fractures in women between 50-64 years was 3.5% when this age group reflects 46% of the population. There were 10% of fractures in men, when the male population made up 50% of the overall population. This means that, in the present study the global/100.000 standardized rate of hip fracture decreased in the period (2007-2010) from 764.3 to 413.9 in women and from 315.3 to 160.3 in men. These rates are 45.8% and 49.2% lower respectively. This difficulty could also exist when comparing studies carried out in a country,

but does not affect trend studies when using the same source and methodology over a long time period as in the present study.

The present study has some limitations and strengths. Possible errors in the databases that contain fracture registers or population data stand out among the various limitations. Nevertheless, incidence rates in our country are consistent with previous studies published elsewhere [15,35]. This is an ecological study and it is not possible to find any other individual data on opposite side hip fractures or other previous fractures. The MHSP only provides general statistical data and does not provide a breakdown of individual cases but is the most important resource for monitoring hip fracture rates because of its size, national coverage and relatively standardized recording regulation [26]. Another limitation may be that we used the ICD9 because currently both coding systems are still used in Spain when most countries changed the system around 1996-1999 and currently the majority only use the ICD10. We have selected fractures included in the 820.0-820.9 groups of CIM9 as most studies [4,29,38], although few studies also include 821.1 group (other femoral fractures) [42]. It may affect the results when they are compared with other studies coming from other regions [35] or countries [43], but may even be considered strength when we take into account different periods in the same country. It is also important to remark that non-osteoporotic fractures (major trauma, fractures secondary to cancer and other) are not clearly excluded as in similar secular trend studies [4,43]. We have only analysed fractures in people over 65 years old but it is widely recognized that most of the fractures in the population 65 years old or more are due to low-impact trauma, and that only 11% of hip fractures in Spain take place below the age of 65 [35] or 8% in Italy [42].

In conclusion, the crude hip fracture incidence rates in Spain in the last 14 years have increased gradually more in men than in women, but when population-adjusted, rates in the second period rose only slightly in men and decrease in women. This study supports previous studies from other countries in showing a decrease in hip fracture incidence among older women, especially among women between 65-80 years. Possible causes for the change in trends are intrinsic factors related to the cohort's age of birth, changes in lifestyle, and general background, especially in postmenopausal young women. Also, some authors included the use of drug therapy and the implementation of strategies to prevent falls and osteoporotic fractures [28,43]. In Spain, fall and fracture prevention programs need to be developed for the elderly. Future studies are necessary to further monitor the changes and explore in deep the reasons in trend found in this study.

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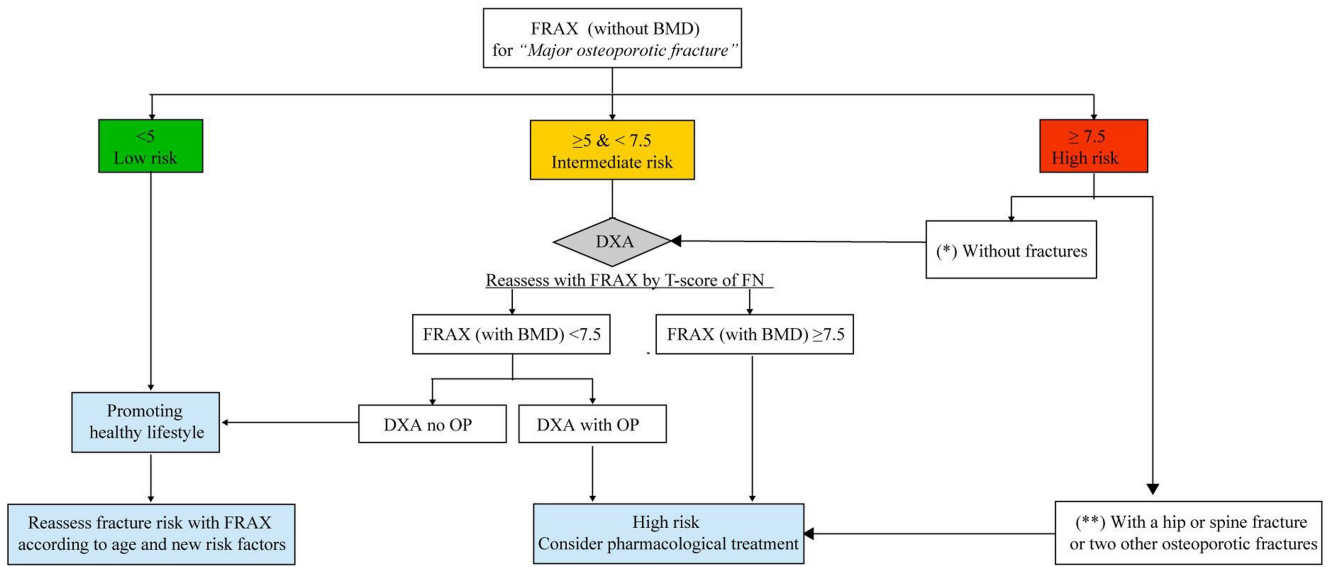


Figure 1.

**Table 1**

Cohort profile with the prevalence of fracture risk factors: FROCAT cohort

Variables	n	% / SD
Women	1090	100%
Age (years)	59.1	± 12.4
65 years (n ± %)	375	34.4%
50 to 64 years (n ± %)	715	65.6%
Weight (kg)	68	± 13
Height (cm)	155.9	± 6.9
BMI (kg/m <sup>2</sup> )	28	± 5.3
Smoking	172	15.8%
Alcohol 3 units per day	17	1.6%
Previous fractures	154	14.1%
Parental hip fracture	119	10.9%
Glucocorticoids	45	4.1%
Rheumatoid Arthritis	21	1.9%
Falls in previous year	331	30.4%
Osteoporosis (FN, TF or L1-L4)[*]	85	36.3%
Calcium or Vit D supplements[**]	263	24.1%
Anti-osteoporotics medication with or without supplements	206	18.9%

SD: Standard Deviation; BMI: body mass index; DXA: bone densitometry; FN: femoral neck; TF: total proximal femur; L1-L4: lumbar spine; [\*] available in 234/1090 cases; [\*\*] 97/856 cases (11,3%) when

**Table 2**

Comparative analysis between women with or without fractures. FROCAT cohort

	With fractures	Without fractures	p-value	95% CI
	n= 127	n= 963		
Age	66.9 (11.3)	58.1 (12.1)	<0.001	6.64-11.09
BMI Kg/cm2	27.9 (5.1)	28.0 (5.4)	0.782	
BMI <20 Kg/cm2	5 (4.0%)	30 (3.3%)	0.591	
Previous fractures	41 (32.3%)	113 (11.7%)	<0.001	12.2-29.0
Parental hip fracture	14 (11.0%)	105 (10.9%)	0.973	
Smoking	11 (8.7%)	161 (16.7%)	0.02	2.56-13.4
Alcohol 3 units per day	3 (2.4%)	14 (1.5%)	0.436	
Glucocorticoids (%)	6 (4.7%)	39 (4.1%)	0.721	
Rheumatoid Arthritis	2 (1.6%)	19 (2.0%)	0.758	
With falls in previous year	62 (48.8%)	269 (27.9%)	<0.001	11.8-30.0
Results DXA [available in 234/1090 (21.5%)]	n= 40	n= 194		
Osteoporosis 85/234 (36.3%)	16 (40.0%)	69 (35.6%)	0.332	
Osteopenia 101/234 (43.2%)	21 (52.5%)	80 (41.2%)	0.016	2.1-20.5
Normal 48/234 (20.5%)	3 (7.50%)	45 (23.2%)	<0.001	10.4-21.0

CI: confidence interval; BMI: body mass index; DXA: bone densitometry;

**Table 3**

Analysis of accumulate incidence over 10 years and fractures standardised by 100,000 women/year among women of FROCAT cohort

	< 65 years		65 years		Total		p-value
	n: 715		n: 375		n: 1090		< 65 vs 65 years
	n (%)	100,000/year	n (%)	100,000/year	n (%)	100,000/year	
All Fractures	95 (13.3%)	1348	93 (24.8%)	2480	188 (17.2%)	1706	<0.001
Osteoporotic Fx	50 (7.0%)	699	77 (20.5%)	2053	127 (11.7%)	1165	<0.001
Hip Fx	3 (0.4%)	42	21 (5.6%)	560	24 (2.2%)	220	<0.001
Spine Fx	4 (0.6%)	56	24 (6.4%)	640	28 (2.6%)	257	<0.001
Humeral Fx	10 (1.4%)	140	11 (2.9%)	293	21 (1.9%)	193	0.079
Wrist Fx	33 (4.6%)	468	21 (5.6%)	560	54 (5.0%)	495	0.475

Fx: fracture

**Table 4**

Relationship between risk levels according Frax model of FRAX<sup>®</sup> Spain for major osteoporotic fracture. applied to the results of the FROCAT cohort without exclusions for antiosteoporotic treatments.

	% of cohort	Total women	Women with osteoporotic fracture	% of women with fractures in each level of risk	95% CI
Low risk [FRAX < 5]	67.8%	739	50	6.8%	5.1-8.8
Intermediate risk [FRAX ≥ 5 and < 7.5]	11.9%	130	24	18.5%	12.2-26.2
High risk [FRAX ≥ 7.5]	20.3%	221	53	24.0%	18.5-30.2
Total		1090	127	11.7%	9.8-13.7

**Table 5**

Relationship between risk levels according Frax model of FRAX<sup>®</sup> Spain for major osteoporotic fracture applied to the results of the FROCAT cohort, excluded 206 women treated during the period.

	% of cohort	Total women	Women with osteoporotic fracture	% of women with fractures in each level of risk	95% CI
Low risk [FRAX < 5]	70.3	621	34	5.5%	3.8-7.6
Intermediate risk [FRAX ≥ 5 and < 7.5]	11.2%	99	12	12.1%	6.4-20.2
High risk [FRAX ≥ 7.5]	18.6%	164	26	15.9%	10.6-22.4
Total		884	72	8.1%	6.4-10.2