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ORIGINAL PAPER

Incidence and costs of hip fractures in elderly Italian population: first regional-based assessment

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Abstract

Summary We analyzed for the first-time hospitalizations and costs for hip fractures in the elderly Italian population at the regional level from 2007 to 2014. The number of fractures and the overall costs increased, mainly due to people aged > 85 in all the Italian regions, although at different rates.

Objective We aimed at evaluating the burden of hip fractures in elderly Italian population at the regional level.

Methods We analyzed national hospitalizations records 2007–2014 to compute standardized hospitalizations rates (SHR) due to hip fractures per 10,000 inhabitants at the regional level and average annual percent change (AAPC), along with related costs.

Results Hip fractures occurred in people over 65 years increased from 89,601 to 94,525 over 8 years. The overall increase in the number of hospitalizations is attributable only to people aged ≥85. Actually, in the 65–74 and 74–84 age groups, total hospitalizations decreased from 13,396 to 12,268 and from 40,733 to 37,786 respectively, while they increased from 35,472 to 44,471 in people aged ≥85 (women = 28,605 and men = 6,867 in 2007; women = 34,636 and men = 9,835 in 2014). Almost 50% of hip fractures were found to have been experienced by patients aged 85 or older in 2014 (with women ≥ 85 representing 36.6% of total fractures), in accordance with the higher prevalence of osteoporosis in this age group. Fractures increase in people aged ≥ 85 was two-folds higher in males (AAPC: + 5.0%; $P > 0.05$) than in females (AAPC: + 2.6%; $P > 0.05$). Increases in the number of hospitalizations and related costs were observed for all the regions, with the only exception of Lazio (AAPC: − 4.6%; $P < 0.05$) and Friuli Venezia Giulia (hip fractures AAPC: − 1.9%; $P < 0.05$). The most significant increases in hip fractures and related costs were recorded in Calabria (+ 2.7%), Campania (+ 2.2%), and Lombardia (+ 2.0%). At the national level, SHR per 10,000 inhabitants due to hip fractures decreased in all three examined age groups (65–74, 75–84, and ≥ 85), both in males and females during the 8-year period ($P < 0.05$). This reduction was confirmed also when looking at the regional dataset, with few exceptions concerning female population (AAPC not statistically significant). When looking at the SHR per 10,000 inhabitants for the entire nation, we recorded a decreasing trend also in females aged 85 years old and over but not in males ≥ 85. Actually, men aged ≥ 85 showed increased HR per 10,000 in 10 regions out of 20. Direct hospitalization and rehabilitation costs increased in all the regions over the 8-year period (although at different rates), except for Friuli Venezia Giulia (where costs decreased from 21 to 19 million Euros) and Lazio (from 107 to 87 million Euros). Lombardia and Piemonte were the regions spending the highest amount of money to treat hip fractures in elderly people (151 and 95 million Euros in the year 2014, respectively).

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Conclusion Hip fractures in the elderly population remain a major public health issue in all Italian regions, especially in people aged 85 years old and over, although the problem is starting to become more controlled compared with the past. Women represent the majority of hip fractures, but the highest increasing rate has been observed in men. Pilot projects at regional level targeting elderly people at higher risk of fractures and treatment compliance are needed.

Keywords Hip fractures · Osteoporosis · Hospitalizations · Regions · Incidence · Costs

Introduction

The life expectancy of the Italian population has constantly increased during the last 50 years [1]. Italy is currently the country in the world with the highest percentage of elderly people in the general population and it is estimated that people aged ≥ 85 years old will exceed 12% of the entire population by the year 2050 [1]. Therefore, it represents an interesting case study for all industrialized countries. In this perspective, chronic and degenerative diseases—including osteoporosis and fragility fractures—will represent a dramatic challenge for health professionals and decision makers. Actually, the World Health Organization considers osteoporosis to be second only to cardiovascular diseases as a critical health problem [1]. In our previous studies, we have shown that incidence and costs of hip fractures in Italy are already comparable with those of acute myocardial infarctions, with an average cost of € 13,500 per patient and a very high burden of this type of fracture in terms of expenditures [2, 3].

Hip fractures represent the most catastrophic complication of osteoporosis and result in significant 1-month and 1-year mortality (5% and 20%, respectively) [4]. Furthermore, 30% of patients are estimated to become permanently disabled, while 40% of them loose the ability to walk independently, and 80% are estimated to become unable of independently performing daily activities after the fracture [4].

The correct perception of the epidemiological burden of fragility fractures is essential to allow institutions planning large-scale prevention initiatives and to identify the target population who need to be treated with drugs able to reduce the risk of fracture. The availability of data at the regional level is crucial because regions represent the institutions having the duty of planning the healthcare services to be delivered to the Italian population.

In our previous researches, we have already defined the burden of hip fractures in Italy between the years 2000 and 2005 [2, 5–7]. More recently, in our study carried out with Kanis et al., Italy has been classified as belonging to the group of nations with the highest incidence of hip fractures, showing rates per 100,000 inhabitants > 300 in women and > 150 in men, respectively [8]. However, in some countries, a decreasing trend in the number of hip fractures in elderly people has been observed [9]. Based on hospitalization records used in our previous researches, we have been able to assess for the first time that also in Italy, the incidence of hip fractures was showing a decreasing trend from 2000 to 2009, although limited to women aged 65–74 [10, 11]. The aim of this new work was to assess the incidence and costs of femoral fractures including more recent data in the analyses and presenting them on a regional basis.

Materials and methods

Information concerning all hospitalizations occurring in Italian regions are registered in hospital discharge records, which are collected at the central level by the Italian Ministry of Health (national hospitalization database, SDO). This information is collected anonymously and includes the patient's age, sex, and diagnosis. The present manuscript focuses on the number of hospitalizations due to femoral fractures in Italy from the year 2007 to 2014. We assumed that almost all hip fractures occurred in the elderly patients resulted in hospital admissions [1]. Population data were obtained from the National Institute for Statistics (ISTAT) for each year. Hip fractures were defined by the following ICD-9CM major diagnosis codes: 820.0 (femoral neck fractures), 820.2 (pertrochanteric femoral fractures), 820.8 (other femoral neck fracture). Data were stratified by gender and into age groups (65–74, 75–84, and ≥ 85 years) in order to specifically evaluate the incidence of hip fragility fractures in the oldest people. We performed descriptive statistical analyses of the incidence in each gender and age subgroup also by region, across the eight examined years. Data were processed using Stata (StataCorp, College Station, USA) and Excel (Microsoft, Redmond, USA) software. Standardized hospitalization rates (SHR) due to hip fractures per 10,000 inhabitants have been computed for each region per age groups (65–74, 75–84, and ≥ 85 years old) and gender (males and females), referring as standard to the Italian population of each examined year.

We performed joinpoint regression analyses for all the regions to evaluate trend variations over 8 years both in the number of fractures and HR per 10,000. Data were computed using the Joinpoint Regression Program (Version 4.6.0.0 - April 2018, provided by the National Cancer Institute, Surveillance Research Program) [12]. This type of analysis is a well-known approach used to study variation in the trends over the time; its outcome is the average annual percent change (AAPC), a geometrically weighted average of various annual percent change (APC) values undergoing regression analyses. The use of joinpoint regression analysis has an

important element of strength that is represented by the advantage of a rigorous statistical procedure instead of carrying out a qualitative evaluation to identify the time points at which the trend is significantly changing [13].

In our previous studies, we have already estimated the overall average costs of hip fractures, consisting in € 13,500 per patient [2, 3], and include rehabilitation costs following hip fractures, which are comparable with the costs directly related to hospitalizations [2]. Direct hospitalization costs were calculated by using diagnoses-related groups (DRGs) paid for each patient and recorded at the central level of Ministry of Health in the national hospitalization records (SDO). As already assessed in our previous researches, the DRGs that were considered relevant to hip fractures were 209 (surgical procedures on major joints and hip replacement), 210–211 (hip and femur surgery), and 235–236 (hip, femur, or pelvis fractures) [2, 3]. Since not all patients that were assigned these DRGs had a main diagnosis of hip fracture (actually, osteoarthritis accounts for a substantial number of hip replacements), only 30% of costs ascribed to DRG 209 and 80% of costs ascribed to DRGs 210, 211, plus 100% of costs ascribed to DRGs 235, and 236 were attributable to a main diagnosis of hip fracture [2, 3]. We considered these rates to represent the weight of hip fracture–related costs for each DRG, based on national estimations provided by the Ministry of Health, which were confirmed by specific analyses performed on the whole hospitalization database from the Tuscany region (about 4 million inhabitants) and on those of the local health authorities of Lecce (about 1 million inhabitants) [2, 3]. The analysis of rehabilitation costs was carried out according to the most recently published Italian data and official rate lists (Fig. 1). First, we assumed that 5% of patients currently die a few days after the fracture (acute mortality rate) [2, 14, 15]. Among the patients who survive (95% of people hospitalized), 13.5% begin immediately 1-month in-hospital intensive rehabilitation programs (average cost, 6600 Euros per subject) [14, 16]. At the end of this in-hospital intensive rehabilitative period, 10% of these patients move to long-term facilities after leaving the hospital (average yearly cost, 9920 Euros per patient) [14, 16]. We have then to consider that 18.2% of the subjects who survived (namely 95% of people hospitalized) become directly institutionalized because of the hip fracture (9920 Euros per patient) [14] and that 63% of these people immediately treated in nursing homes undergo in-hospital rehabilitation (6600 Euros per patient) [14] at the end of the institutionalization period [14]. All the remaining patients (63.3% of patients discharged alive from the hospital) enter the home-based rehabilitation program provided by the Italian local health authorities, which consists in a 3-months therapeutical cycle (2304 Euros per patient, according to the regional healthcare services rate lists and to the Italian Society of Rehabilitative Medicine, SIMFER) [14]. Furthermore, within 6 months from their hospitalization, 13.2% of the overall fractured people discharged alive from the hospital are treated in ambulatories ruled by the local health authorities (1767 Euros per patient) [2, 15], after having completed other kinds of rehabilitative programs (both home-based or in-hospital and nursing homes rehabilitation), but 40% of these patients treated in ambulatorial level need to be hospitalized once again to undergo in-hospital rehabilitation (6600 Euros per patient) [14–16]. Social costs, indirect costs, and those related to the loss of productivity of patients and their relatives were not computed in this study.

Results

Table 1 displays the number of hospitalizations between 2007 and 2014 (patients aged ≥ 65 hospitalized due to hip fractures), with related direct costs, rehabilitation, and total costs per each region in Northern, Central, and Southern Italy, respectively.

Direct hospitalization and rehabilitation costs increased in all the regions over the 8-year period (although at different rates), except for Friuli Venezia Giulia (reduction from 21 to 19 million Euros) and Lazio (reduction from 107 to 87 million Euros) where a reduced number of fractures were hospitalized. Remarkably, overall direct and rehabilitation costs in Lombardia exceeded 150 million Euros in the year 2014, and reached 95 and 68 million Euros in Piemonte and Veneto, respectively. In Central Italy, Emilia Romagna and Tuscany spent a total of 76 and 68 million Euros in the same year, respectively. Also in Southern Italy, Sicily (76 million Euros), Campania (71 million Euros), and Apulia (58 million Euros) were spending a considerable amount of money to treat hip fractured elderly patients.

Between 2007 and 2014, we observed an overall increase in the number of hospitalized elderly people aged ≥ 65 and related costs across the 8-year period in all the regions, with the significant exception of Lazio (Fractures AAPC: − 4.6; $P < 0.005$) and—to a lesser extent—of Friuli Venezia Giulia (Fractures AAPC: − 1.9; $P < 0.005$) (Table 1). The highest significant increases in AAPC and the consequent rise of total costs due to hip fractures were recorded Calabria (+ 2.7%), Campania (+ 2.2%), and Lombardia (+ 2.0%). Statistically significant increases in fractures AAPC were registered also in Piemonte, Basilicata, and Marche (Table 1). The small region of Valle d'Aosta showed a + 5.3% increase.

Table 2a and b present the number of hospitalizations due to hip fractures per age groups in males and females for each Italian region. In Italy, hip fractures occurred in people over 65 years increased from 89,601 to 94,525. During the period 2007–2014, the overall increase in the number of hospitalizations is attributable only to people aged ≥ 85. Specifically, in the 65–74 and 74–84 age groups, hospitalizations decreased from 13,396 to 12,268 and from 40,733 to 37,786,

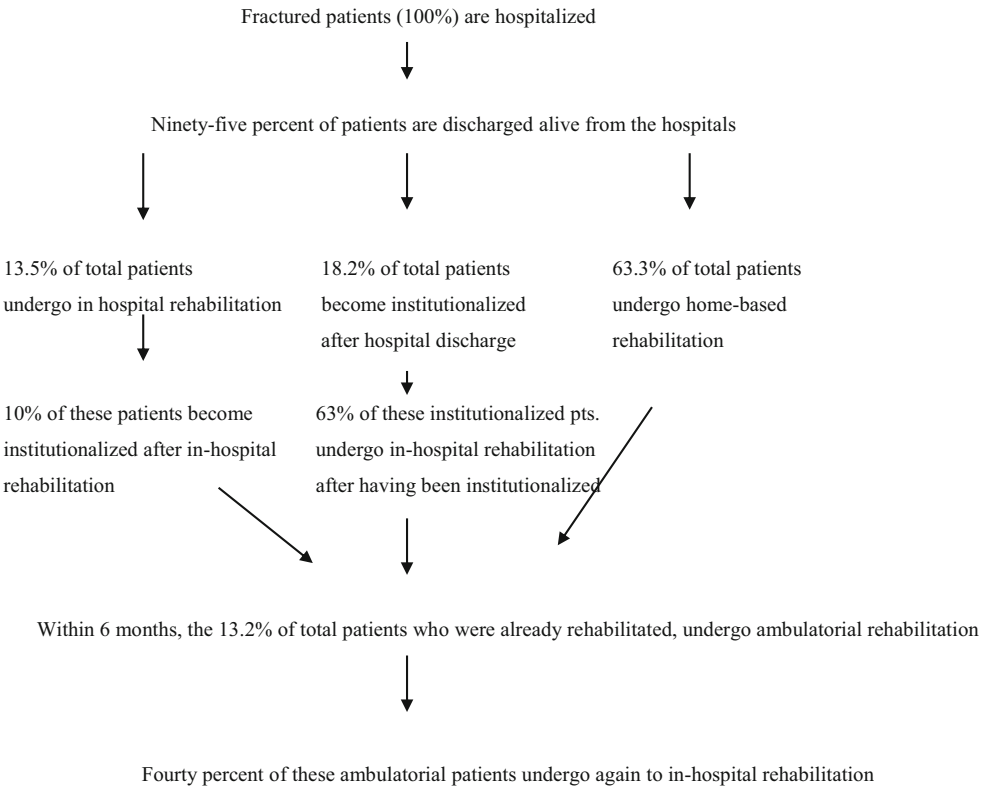

Fig. 1 Flow chart showing the percentages used for the different rehabilitative outcomes of fractured patients

respectively, while they increased from 35,472 to 44,471 in people aged ≥ 85 (women = 28,605 and men = 6,867 in 2007; women = 34,636 and men = 9,835 in 2014). Fractures AAPC in ≥ 85 age group resulted to be two-folds higher in males (AAPC: + 5.0%; $P > 0.05$) than in females (AAPC: + 2.6%; $P > 0.05$).

Table 3a and b show the SHR per 10,000 inhabitants stratified for the age group from 2007 to 2014 in males and females. Related AAPC of hospitalization rates per 10,000 are reported in Table 4. Substantial differences come from the analysis by gender and by a single region. When looking at the data for the entire nation, SHR per 10,000 inhabitants due to hip fractures decreased in all three examined age groups (65–74, 75–84, and ≥ 85), both in males and females. Overall, the decreasing trend observed in Italy during the 8-year period of the study showed statistical significance ($P < 0.05$). This reduction is confirmed also when looking at the regional dataset, with few exceptions concerning female population (AAPC not statistically significant). When looking at the SHR per 10,000 inhabitants for the entire nation, we recorded a decreasing trend also in females aged 85 years old and over, but not in males ≥85 years old. Actually, men aged ≥ 85 showed increased HR per 10,000 in 10 regions out of 20, reaching statistical significance only in Campania (HR AAPC + 2.0%; $P < 0.005$) and Val d'Aosta (HR AAPC + 16.4%; $P < 0.005$). At the opposite, a significant reduction in HR per 10,000 was found for males in Lazio, Friuli V. G., and Sardegna both in the age group 75–84 and ≥ 85. Calabria was the only region where the HR per 10,000 in the female population increased in all three analyzed age groups (although not being statistically significant). Lazio and Puglia showed a statistically significant reduction in HR per 10,000 inhabitants in all three female age groups examined. The highest reductions in HR per 10,000 inhabitants ($P < 0.005$) were found in females living in Lazio and Friuli V.G. belonging to the age groups 75–84 and ≥ 85 (AAPC: − 8.2% and − 7.2% in Lazio, respectively; − 4.4% and − 3.4% in Friuli V. G., respectively).

Discussion

We have computed the number of femoral fractures in Italy on a regional basis from 2007 to 2014, standardized hospitalization rates (SHR) per 10,000 (computing also the average annual percent change, AAPC) and related costs. The number of hip fractures in elderly Italian people continues to show an overall increase in all the regions, with the significant exception of Lazio (Fractures AAPC: − 4.6; $P < 0.005$) and, to a lesser extent, of Friuli Venezia Giulia (Fractures AAPC: − 1.9; $P < 0.005$). The reasons for these two exceptions are not clear but they might rely on the efforts made by the scientific and medical community in these regions. However, it is clear that the increase in the absolute number of hip fractures is due to a higher number of fractures occurred in people aged 85 and over, which represents only 2.5% of the Italian population

Table 1 Number of hospitalizations due to hip fractures in Italian regions from 2007 to 2014 per age group

Year	2007	2008	2009	2010	2011	2012	2013	2014	AAPC
Piemonte									
Hospitalizations due to hip fractures (femoral neck) (*n*)	8775	8946	8823	9020	9391	9639	9479	9510	+ 1.4*
Overall hospitalizations direct costs (€)	42,428,118	43,254,922	42,660,203	43,612,721	45,406,548	46,605,656	45,832,038	45,981,926	
Overall rehabilitation costs (€)	46,844,323	47,757,187	47,100,566	48,152,227	50,132,768	51,456,687	50,602,546	50,768,036	
Overall direct costs estimation (€)	89,272,441	91,012,109	89,760,769	91,764,948	95,539,316	98,062,343	96,434,584	96,749,962	
Valle d'Aosta									
Hospitalizations due to hip fractures (femoral neck) (*n*)	155	174	186	196	199	210	216	225	+ 5.3*
Overall hospitalizations direct costs (€)	749,442	841,310	899,332	947,683	962,188	1,015,373	1,044,384	1,087,901	
Overall rehabilitation costs (€)	827,450	928,879	992,939	1,046,323	1,062,338	1,121,061	1,153,091	1,201,136	
Overall direct costs estimation (€)	1,576,892	1,770,189	1,892,271	1,994,006	2,024,526	2,136,434	2,197,475	2,289,037	
Lombardia									
Hospitalizations due to hip fractures (femoral neck) (*n*)	12,902	13,260	13,599	14,145	13,898	14,410	14,581	14,894	+ 2.0*
Overall hospitalizations direct costs (€)	62,382,630	64,113,601	65,752,705	68,392,676	67,198,404	69,673,981	70,500,785	72,014,176	
Overall rehabilitation costs (€)	68,875,836	70,786,977	72,596,689	75,511,447	74,192,866	76,926,119	77,838,983	79,509,897	
Overall direct costs estimation (€)	131,258,466	134,900,578	138,349,394	143,904,123	141,391,270	146,600,100	148,339,768	151,524,073	
Trentino Alto Adige									
Hospitalizations due to hip fractures (femoral neck) (*n*)	1615	1617	1678	1758	1930	1750	1682	1687	+ 0.7
Overall hospitalizations direct costs (€)	7,808,708	7,818,378	8,113,320	8,500,129	9,331,768	8,461,448	8,132,660	8,156,836	
Overall rehabilitation costs (€)	8,621,491	8,632,168	8,957,809	9,384,880	10,303,082	9,342,173	8,979,163	9,005,854	
Overall direct costs estimation (€)	16,430,199	16,450,546	17,071,129	17,885,009	19,634,850	17,803,621	17,111,823	17,162,690	
Veneto									
Hospitalizations due to hip fractures (femoral neck) (*n*)	5748	6149	6051	6242	5995	6148	6159	6156	+ 0.6
Overall hospitalizations direct costs (€)	27,792,230	29,731,111	29,257,270	30,180,777	28,986,504	29,726,276	29,779,462	29,764,957	
Overall rehabilitation costs (€)	30,685,034	32,825,726	32,302,564	33,322,195	32,003,614	32,820,387	32,879,110	32,863,094	
Overall direct costs estimation (€)	58,477,264	62,556,837	61,559,834	63,502,972	60,990,118	62,546,663	62,658,572	62,628,051	
Friuli Venezia Giulia									
Hospitalizations due to hip fractures (femoral neck) (*n*)	2116	2096	1934	2065	1864	1777	1884	1918	− 1.9*
Overall hospitalizations direct costs (€)	10,231,100	10,134,397	9,351,109	9,984,509	9,012,651	8,591,996	9,109,353	9,273,747	
Overall rehabilitation costs (€)	11,296,021	11,189,254	10,324,435	11,023,764	9,950,749	9,486,309	10,057,516	10,239,021	
Overall direct costs estimation (€)	21,527,121	21,323,651	19,675,544	21,008,273	18,963,400	18,078,305	19,166,869	19,512,768	
Liguria									
Hospitalizations due to hip fractures (femoral neck) (*n*)	3232	3401	3190	3253	3195	3203	3392	3359	+ 0.3
Overall hospitalizations direct costs (€)	15,627,086	16,444,220	15,424,011	15,728,624	15,448,187	15,486,868	16,400,704	16,241,145	
Overall rehabilitation costs (€)	17,253,658	18,155,845	17,029,446	17,365,764	17,056,138	17,098,845	18,107,800	17,931,633	
Overall direct costs estimation (€)	32,880,744	34,600,065	32,453,457	33,094,388	32,504,325	32,585,713	34,508,504	34,172,778	
Emilia Romagna									
Hospitalizations due to hip fractures (femoral neck) (*n*)	7041	7249	7219	7478	7100	7365	7326	7502	+ 0.6

Table 1 (continued)

Year	2007	2008	2009	2010	2011	2012	2013	2014	AAPC
Overall hospitalizations direct costs (€)	34,044,032	35,049,735	34,904,682	36,156,976	34,329,304	35,610,609	35,422,039	36,273,019	
Overall rehabilitation costs (€)	37,587,565	38,697,949	38,537,797	39,920,439	37,902,529	39,317,201	39,109,004	40,048,560	
Overall direct costs estimation (€)	71,631,597	73,747,684	73,442,479	76,077,415	72,231,833	74,927,810	74,531,043	76,321,579	
Toscana									
Hospitalizations due to hip fractures (femoral neck) (*n*)	6545	6729	6805	7018	6856	6813	7035	6703	+ 0.4
Overall hospitalizations direct costs (€)	31,645,816	32,535,476	32,902,945	33,932,824	33,149,536	32,941,626	34,015,022	32,409,763	
Overall rehabilitation costs (€)	34,939,726	35,921,989	36,327,706	37,464,782	36,599,963	36,370,413	37,555,534	35,783,191	
Overall direct costs estimation (€)	66,585,542	68,457,465	69,230,651	71,397,606	69,749,499	69,312,039	71,570,556	68,192,954	
Umbria									
Hospitalizations due to hip fractures (femoral neck) (*n*)	1647	1680	1732	1833	1847	1885	1773	1825	+ 1.4
Overall hospitalizations direct costs (€)	7,963,432	8,122,990	8,374,416	8,862,762	8,930,454	9,114,188	8,572,655	8,824,081	
Overall rehabilitation costs (€)	8,792,319	8968,486	9,246,082	9,785,259	9,859,996	10,062,855	9,464,956	9,742,552	
Overall direct costs estimation (€)	16,755,751	17,091,476	17,620,498	18,648,021	18,790,450	19,177,043	18,037,611	18,566,633	
Marche									
Hospitalizations due to hip fractures (femoral neck) (*n*)	2605	2693	2689	2739	2839	2803	2714	2811	+ 0.9*
Overall hospitalizations direct costs (€)	12,595,470	13,020,960	13,001,619	13,243,375	13,726,887	13,552,823	13,122,497	13,591,503	
Overall rehabilitation costs (€)	13,906,491	14,376,269	14,354,916	14,621,835	15,155,673	14,963,491	14,488,375	15,006,199	
Overall direct costs estimation (€)	26,501,961	27,397,229	27,356,535	27,865,210	28,882,560	28,516,314	27,610,872	28,597,702	
Lazio									
Hospitalizations due to hip fractures (femoral neck) (*n*)	10,601	11,106	11,403	8180	8067	8326	8438	8447	− 4.6*
Overall hospitalizations direct costs (€)	51,257,035	53,698,767	55,134,796	39,551,226	39,004,858	40,257,152	40,798,685	40,842,201	
Overall rehabilitation costs (€)	56,592,213	59,288,097	60,873,597	43,667,984	43,064,747	44,447,389	45,045,288	45,093,333	
Overall direct costs estimation (€)	107,849,248	112,986,864	116,008,393	83,219,210	82,069,605	84,704,541	85,843,973	85,935,534	
Abruzzo									
Hospitalizations due to hip fractures (femoral neck) (*n*)	2084	2315	2419	2429	2341	2363	2425	2376	+ 1.7
Overall hospitalizations direct costs (€)	10,076,376	11,193,287	11,696,139	11,744,490	11,319,000	11,425,373	11,725,150	11,488,229	
Overall rehabilitation costs (€)	11,125,193	12,358,360	12,913,552	12,966,936	12,497,158	12,614,602	12,945,582	12,684,001	
Overall direct costs estimation (€)	21,201,569	23,551,647	24,609,691	24,711,426	23,816,158	24,039,975	24,670,732	24,172,230	
Molise									
Hospitalizations due to hip fractures (femoral neck) (*n*)	571	569	566	586	598	607	547	586	+ 0.3
Overall hospitalizations direct costs (€)	2,760,850	2,751,179	2,736,674	2833,377	2,891,398	2,934,914	2,644,807	2833,377	
Overall rehabilitation costs (€)	3,048,217	3,037,541	3,021,526	3,128,293	3,192,354	3,240,399	2,920,096	3,128,293	
Overall direct costs estimation (€)	5,809,067	5,788,720	5,758,200	5,961,670	6,083,752	6,175,313	5,564,903	5,961,670	
Campania									
Hospitalizations due to hip fractures (femoral neck) (*n*)	6091	6293	6456	6485	6534	6789	7231	6992	+ 2.2*
Overall hospitalizations direct costs (€)	29,450,675	30,427,367	31,215,490	31,355,709	31,592,629	32,825,583	34,962,703	33,807,111	
Overall rehabilitation costs (€)	32,516,099	33,594,453	34,464,610	34,619,423	34,881,004	36,242,292	38,601,858	37,325,984	

Table 1 (continued)

Year	2007	2008	2009	2010	2011	2012	2013	2014	AAPC
Overall direct costs estimation (€)	61,966,774	64,021,820	65,680,100	65,975,132	66,473,633	69,067,875	73,564,561	71,133,095	
Puglia									
Hospitalizations due to hip fractures (femoral neck) (*n*)	5187	5372	5293	5427	5401	5502	5530	5729	+ 1.1
Overall hospitalizations direct costs (€)	25,079,732	25,974,228	25,592,254	26,240,159	26,114,446	26,602,793	26,738,176	27,700,364	
Overall rehabilitation costs (€)	27,690,200	28,677,801	28,256,069	28,971,412	28,832,614	29,371,791	29,521,266	30,583,604	
Overall direct costs estimation (€)	52,769,932	54,652,029	53,848,323	55,211,571	54,947,060	55,974,584	56,259,442	58,283,968	
Basilicata									
Hospitalizations due to hip fractures (femoral neck) (*n*)	1001	968	983	1044	1023	1056	1059	1081	+ 1.4*
Overall hospitalizations direct costs (€)	4,839,948	4,680,390	4,752,916	5,047,858	4,946,321	5,105,879	5,120,385	5,226,757	
Overall rehabilitation costs (€)	5,343,723	5,167,556	5,247,632	5,573,273	5,461,167	5,637,334	5,653,349	5,770,794	
Overall direct costs estimation (€)	10,183,671	9,847,946	10,000,548	10,621,131	10,407,488	10,743,213	10,773,734	10,997,551	
Calabria									
Hospitalizations due to hip fractures (femoral neck) (*n*)	2504	2664	2695	2726	2877	2837	3018	3054	+ 2.7*
Overall hospitalizations direct costs (€)	12,107,123	12,880,742	13,030,630	13,180,518	13,910,621	13,717,216	14,592,371	14,766,436	
Overall rehabilitation costs (€)	13,367,315	14,221,456	14,386,946	14,552,436	15,358,532	15,144,997	16,111,244	16,303,426	
Overall direct costs estimation (€)	25,474,438	27,102,198	27,417,576	27,732,954	29,269,153	28,862,213	30,703,615	31,069,862	
Sicilia									
Hospitalizations due to hip fractures (femoral neck) (*n*)	7131	7063	7371	7893	7648	7816	7486	7482	+ 0.9
Overall hospitalizations direct costs (€)	34,479,192	34,150,404	35,639,620	38,163,548	36,978,946	37,791,245	36,195,657	36,176,317	
Overall rehabilitation costs (€)	38,068,019	37,705,009	39,349,231	42,135,868	40,827,964	41,724,812	39,963,146	39,941,792	
Overall direct costs estimation (€)	72,547,211	71,855,413	74,988,851	80,299,416	77,806,910	79,516,057	76,158,803	76,118,109	
Sardegna									
Hospitalizations due to hip fractures (femoral neck) (*n*)	2050	2188	2077	2032	2130	2109	2141	2188	+ 0.5
Overall hospitalizations direct costs (€)	9,911,982	10,579,228	10,042,530	9,824,950	10,298,791	10,197,253	10,351,977	10,579,228	
Overall rehabilitation costs (€)	10,943,688	11,680,385	11,087,824	10,847,597	11,370,759	11,258,653	11,429,481	11,680,385	
Overall direct costs estimation (€)	20,855,670	22,259,613	21,130,354	20,672,547	21,669,550	21,455,906	21,781,458	22,259,613	

DRG rates in Euros considered: DRG 209 (€ 7979.78), DRG 210 (€ 7582.10); DRG 211 (€ 4264.90); DRG 235 (€ 3875.49); DRG 236 (€ 3894.09)

AAPC average annual percent change

*$P < 0.05$

Table 2 Number of hospitalizations due to hip fractures in Italian regions from 2007 to 2014 per age group

Region	65–74								75–84								> 85							
	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014
A. Males																								
Piemonte	360	311	364	374	364	421	446	340	877	949	916	926	949	942	995	944	625	675	692	798	819	942	802	879
Val d'Aosta	9	7	6	7	6	10	12	8	19	20	22	31	13	20	24	23	5	9	10	14	19	17	22	26
Lombardia	563	592	576	613	624	576	539	566	1279	1324	1275	1397	1370	1366	1430	1510	874	935	1039	1144	1101	1212	1314	1408
Trentino A.A.	99	83	100	101	103	87	84	87	166	149	175	175	154	151	165	163	95	116	135	143	185	161	143	161
Veneto	277	295	281	269	288	278	261	238	563	578	589	590	605	598	592	581	454	488	430	584	569	575	601	621
Friuli V. G.	109	94	82	82	64	70	90	75	196	181	175	193	165	169	164	163	146	178	159	173	165	163	170	169
Liguria	109	96	114	101	106	113	116	117	274	333	312	319	295	261	291	297	258	275	285	295	332	311	354	372
Emilia Romagna	260	283	279	270	246	273	243	258	743	777	696	763	688	749	684	715	603	706	687	779	759	840	859	850
Toscana	239	225	212	256	238	223	236	246	674	640	665	731	661	642	597	639	533	644	632	714	784	741	769	760
Umbria	52	74	54	58	59	66	53	63	186	159	191	202	161	173	171	167	135	144	161	188	202	193	173	227
Marche	99	89	118	102	86	87	80	79	284	277	270	274	282	273	222	256	203	269	258	255	316	316	356	318
Lazio	445	458	481	301	264	315	282	324	1111	1083	1156	825	868	840	801	837	738	945	939	764	819	836	879	912
Abruzzo	69	78	90	94	92	92	83	84	232	258	259	254	259	243	255	222	160	197	240	260	241	240	280	262
Molise	30	28	18	19	25	21	16	13	50	55	59	53	81	63	63	49	38	62	55	51	61	67	54	69
Campania	303	324	289	265	291	328	294	305	712	736	717	772	733	722	829	712	412	461	516	552	595	602	694	677
Puglia	234	208	192	229	226	219	183	223	588	582	566	571	579	581	588	561	442	460	516	506	553	557	591	632
Basilicata	36	49	40	29	41	35	38	27	121	120	108	116	109	87	93	126	88	82	98	110	115	89	102	129
Calabria	120	104	113	117	110	100	98	120	270	309	253	315	313	324	326	301	244	238	227	267	257	311	332	307
Sicilia	303	277	301	298	280	288	300	297	785	835	906	860	872	870	778	759	623	632	724	773	843	841	753	818
Sardegna	106	88	90	89	96	90	102	80	235	234	222	208	216	224	200	233	191	219	210	201	233	218	227	238
Italy	3822	3763	3800	3674	3609	3692	3556	3550	9365	9599	9532	9575	9373	9298	9268	9258	6867	7735	8013	8571	8968	9232	9475	9835
AAPC				AAPC − 1.7*								AAPC − 0.4								AAPC + 5.0*				
B. Females																								
Piemonte	987	903	945	862	875	937	845	796	3093	3170	3096	3072	3177	3088	3008	3072	2833	2938	2810	2988	3207	3309	3383	3479
Val d'Aosta	21	24	20	22	25	21	25	14	50	56	68	50	58	62	53	75	51	58	60	72	78	80	80	79
Lombardia	1394	1505	1377	1444	1351	1325	1421	1361	4480	4434	4608	4559	4511	4527	4485	4487	4312	4470	4724	4988	4941	5404	5392	5562
Trentino A.A.	184	196	162	168	209	150	150	172	556	553	514	529	558	511	502	454	515	520	592	642	721	690	638	650
Veneto	567	604	645	573	555	552	580	567	1951	2078	1943	1959	1805	1828	1731	1772	1936	2106	2163	2267	2173	2317	2394	2377
Friuli V. G.	198	195	162	191	188	204	201	202	728	625	593	605	517	493	498	524	739	823	763	821	765	678	761	785
Liguria	335	319	270	307	284	290	300	252	1076	1136	1008	986	939	936	977	952	1180	1242	1201	1245	1239	1292	1354	1369
Emilia Romagna	685	663	687	650	622	664	632	680	2320	2233	2269	2232	2100	2003	2040	2096	2430	2587	2601	2784	2685	2836	2868	2903
Toscana	587	588	650	631	603	598	606	521	2245	2257	2180	2141	2048	2041	2088	1913	2267	2375	2466	2545	2522	2568	2739	2624
Umbria	138	162	132	167	123	175	134	136	559	584	600	547	587	596	514	517	577	557	594	671	715	682	728	715
Marche	256	244	218	223	238	201	222	252	923	862	851	864	835	834	796	782	840	952	974	1021	1082	1092	1038	1124
Lazio	1113	1195	1074	799	737	819	857	780	3812	3864	3902	2675	2589	2585	2475	2504	3382	3561	3851	2816	2790	2931	3144	3090
Abruzzo	223	223	215	204	191	202	182	201	708	767	766	830	717	706	724	723	692	792	849	787	841	880	901	884
Molise	60	39	59	44	57	34	43	33	196	191	177	210	176	192	154	208	197	194	198	209	198	230	217	214
Campania	799	768	762	724	734	809	827	804	2330	2340	2382	2377	2250	2285	2386	2290	1535	1664	1790	1795	1931	2043	2201	2204
Puglia	573	618	588	592	550	540	547	600	1847	1906	1785	1773	1759	1771	1787	1776	1503	1598	1646	1756	1734	1834	1834	1937
Basilicata	117	94	97	109	90	98	92	73	386	359	328	333	359	379	366	328	253	264	312	347	309	368	368	398

Table 2 (continued)

Region	65–74								75–84								> 85							
	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014
Calabria	268	318	300	258	305	265	298	305	879	939	923	920	959	907	994	985	723	756	879	849	933	930	970	1036
Sicilia	848	788	782	805	769	796	781	748	2568	2495	2544	2778	2438	2511	2474	2441	2004	2036	2114	2379	2446	2510	2400	2419
Sardegna	221	235	212	203	210	229	232	221	661	741	699	684	664	657	678	629	636	671	644	647	711	691	702	787
Italy	9574	9681	9357	8976	8716	8909	8975	8718	31,368	31,590	31,236	30,124	29,046	28,912	28,730	28,528	28,605	30,164	31,231	31,629	32,021	33,365	34,112	34,636
AAPC				AAPC − 1.4*								AAPC − 1.7*								AAPC + 2.6*				

AAPC average annual percent change

*$P < 0.05$

(2.3% in 2007 and 3.1% in 2014), given that a reduction in the number of hip fractures and SHR have been observed in people aged 65–84 years old. About 46.1% of hip fractures were found to have been experienced by patients aged 85 or older, in accordance with the higher prevalence of osteoporosis in this age group [4]. Women aged ≥ 85 accounted for the majority (about 36.6%) of total fractures occurred in 2014 among people aged ≥ 65 years old, although they represented just 1.8% of the Italian general population.

The number of fractures increases only in people aged 85 and over with a rate which is double in males compared with females. This finding could be explained by the increase of the male population in this oldest age group, with the consequent increased prevalence of chronic diseases linked to the onset of secondary osteoporosis. Moreover, osteoporosis in males still remains an underdiagnosed and under-treated condition [17]. Our findings confirm the crucial role of osteoporosis, which is the most frequent underlying cause of hip fractures in the elderly. The improvement of social standards and care led to a lengthening of life with an increase in the number of people over 85 in Italy. In older subjects, there is an alteration of bone architecture with decreased bone strength, leading to an increased fracture risk. These fractures are often due to falls that occur especially in a domestic environment, because of low-energy trauma in people with an increased risk of falling. There are several causes that lead to a similar picture, including in particular sarcopenia (the depletion of muscle fibers, especially at proximal level) [18, 19]. Men showed the fastest increase of fracture incidence over the 8-year period, thus pointing out a specific need for not excluding males from osteoporosis prevention and post-fracture treatment.

At the national level, we recorded a decreased SHR per 10,000 inhabitants in all the age group, including female aged > 85 years old, possibly due to a demographic effect consisting in a substantial increasing rate—higher than hip fracture increasing rate—in the number of women belonging to this age group.

In age groups 65–74 and 74–85, the values of AAPC for hospitalizations rates between 2007 and 2014 are comparable between males and females (AAPC:− 1.3% and − 2.4% vs. − 1.7% and − 2.2%, respectively). In the age group ≥ 85 years of age, the difference observed in the SHR per 10,000 between males and females is clearly attributable to faster increase of fractures in male population compared with that of females. During the 8 years of the study, males aged 85 years and over have grown with a higher annual average rate (+ 27.1%) compared with females (+ 21.5%).

The picture that emerges from the regional analysis is similar to that reported for the entire nation, with few exceptions as outlined above. A decreasing trend in SHR per 10,000 was observed in the majority of regions both in males and females concerning the youngest age groups 65–74 and 75–84. In the oldest age group (≥ 85 years old), the decreasing trend has been maintained in 15 regions out of 20 for females (being

Table 3 Standardized hospitalization rates per 10,000 inhabitants per age groups in Italian regions

Age group	65–74								75–84								> 85							
Region/year	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014
A. Males																								
Piemonte	14.9	12.8	15.0	15.5	15.3	17.7	18.5	13.8	63.3	66.9	63.3	62.4	62.2	61.0	62.9	57.0	203.2	204.4	196.2	215.3	210.1	232.0	188.8	194.6
Val d'Aosta	14.4	11.0	9.3	10.7	9.2	15.3	17.7	11.6	53.6	55.3	59.1	81.7	33.8	51.7	60.1	55.6	66.8	110.8	114.7	158.0	198.1	166.8	200.7	223.9
Lombardia	11.9	12.4	12.0	12.7	13.0	11.8	10.8	11.1	52.6	52.5	49.0	51.8	48.9	47.9	48.2	48.2	177.2	174.8	178.9	183.4	165.8	172.3	174.7	175.0
Trentino A.A.	23.1	18.8	22.1	21.9	22.3	18.3	17.3	17.4	66.5	58.7	67.7	65.9	56.9	55.2	58.8	55.9	172.0	191.8	203.6	200.7	242.5	199.0	167.1	177.4
Veneto	12.3	12.8	12.0	11.3	12.3	11.6	10.6	9.5	45.0	45.3	45.3	44.1	44.0	43.0	41.3	38.6	159.3	158.1	130.1	166.6	153.6	148.3	147.1	144.2
Friuli V. G.	16.6	14.0	12.0	11.8	9.3	10.0	12.6	10.3	53.9	49.2	47.0	51.2	42.9	43.4	40.6	38.4	154.5	175.1	147.3	152.6	139.1	134.6	136.7	130.9
Liguria	11.3	10.0	11.9	10.6	11.3	12.2	12.4	12.3	44.2	53.2	49.3	49.8	45.7	40.7	44.7	44.3	165.5	166.5	163.6	162.9	174.9	160.2	174.2	174.3
Emilia Romagna	11.7	12.7	12.5	12.1	11.2	12.3	10.7	11.2	52.4	54.4	48.1	51.5	45.6	49.9	44.6	44.9	158.9	174.0	160.1	172.1	159.9	172.2	170.1	161.4
Toscana	12.2	11.5	10.8	13.0	12.1	11.3	11.7	11.9	53.4	50.3	51.9	56.6	50.3	49.1	44.8	45.9	160.3	182.4	169.4	182.1	192.2	177.1	176.4	167.1
Umbria	11.2	15.9	11.5	12.5	12.8	14.3	11.3	13.1	59.4	50.4	60.1	63.0	49.7	54.2	53.2	49.8	163.4	165.2	174.7	190.6	197.4	181.8	158.8	200.5
Marche	12.4	11.1	14.8	13.1	11.1	11.2	10.2	10.0	52.8	51.5	49.8	50.3	51.1	49.7	39.8	44.4	146.8	181.5	163.2	155.6	182.5	175.8	190.4	163.1
Lazio	17.0	17.4	18.1	11.4	10.0	12.1	10.5	11.5	74.4	69.8	72.9	50.7	52.1	51.4	47.2	46.8	219.4	254.5	233.5	176.5	177.1	184.6	173.4	175.6
Abruzzo	10.6	12.0	14.0	14.6	14.5	14.5	12.8	12.6	54.2	59.6	58.7	56.7	57.0	53.9	55.5	47.4	142.6	165.0	191.4	200.1	177.1	173.0	192.9	173.1
Molise	18.8	17.9	11.8	12.7	17.1	14.3	10.6	8.3	45.9	50.0	52.9	46.3	70.2	55.4	55.0	42.2	130.8	201.6	171.3	150.8	171.6	185.7	142.9	178.2
Campania	13.7	14.6	13.0	11.9	12.9	14.1	12.2	12.1	56.0	56.5	53.8	56.9	53.0	52.7	59.3	49.6	155.4	161.0	168.1	169.6	173.1	171.9	186.5	175.3
Puglia	13.4	11.8	10.8	12.9	12.5	11.8	9.6	11.3	55.8	54.7	51.9	50.9	50.9	50.7	50.5	46.4	180.0	176.9	183.6	170.5	175.6	170.2	173.1	175.6
Basilicata	12.7	17.7	14.9	11.1	16.1	13.8	14.9	10.2	64.6	62.8	55.1	58.4	54.2	43.4	45.8	61.8	199.1	173.0	192.1	204.5	200.6	148.6	162.2	192.9
Calabria	13.3	11.7	12.8	13.4	12.7	11.6	11.1	13.1	48.1	53.5	42.8	52.4	51.1	53.3	53.0	48.2	177.8	163.3	147.2	164.2	150.0	177.5	180.3	161.2
Sicilia	13.9	12.8	14.0	13.9	13.1	13.1	13.3	12.6	56.7	59.6	63.6	59.6	59.6	59.7	52.8	50.1	192.1	182.6	196.8	197.7	204.9	199.0	171.3	178.5
Sardegna	14.1	11.5	11.6	11.3	11.9	11.1	12.2	9.2	56.0	54.4	50.0	45.4	46.3	47.3	41.3	46.5	178.1	193.1	173.7	158.5	175.7	157.3	157.0	155.8
Italy	13.4	13.1	13.2	12.8	12.6	12.8	12.0	11.7	55.8	56.1	54.6	53.7	51.4	50.9	49.5	47.5	174.6	183.1	177.5	179.3	177.9	177.6	172.9	171.2
B. Females																								
Piemonte	35.4	32.5	34.2	31.4	32.4	34.7	31.1	28.8	143.6	146.0	141.9	139.4	142.6	139.7	135.0	134.5	348.9	342.3	314.3	322.8	332.8	333.9	330.4	326.0
Val d'Aosta	29.2	33.3	27.7	30.6	35.0	29.3	34.7	19.2	88.4	98.9	120.1	87.9	100.7	108.2	92.0	127.8	236.5	254.1	251.6	285.9	302.8	297.3	285.2	269.7
Lombardia	25.0	26.9	24.6	25.8	24.4	23.7	25.0	23.7	110.4	107.9	110.9	108.5	105.6	106.0	103.2	100.1	287.2	280.8	281.8	283.9	268.9	284.9	273.3	270.0
Trentino A.A.	37.2	38.8	31.4	32.1	40.2	28.2	27.6	31.2	138.5	138.7	129.7	133.1	140.2	128.8	125.8	111.5	331.4	310.1	329.0	334.6	358.9	333.5	299.7	297.1
Veneto	21.7	22.9	24.1	21.3	20.9	20.4	21.1	20.3	94.7	100.7	94.4	94.6	86.7	88.4	83.1	83.1	242.0	248.3	241.2	240.9	220.5	227.3	226.7	217.2
Friuli V. G.	25.9	25.2	20.7	24.2	24.1	25.9	25.0	24.9	117.3	102.2	98.4	101.1	86.7	83.9	84.1	86.3	270.3	283.3	251.1	260.8	237.0	205.7	228.6	230.1
Liguria	28.6	27.4	23.4	26.9	25.4	26.2	27.0	22.6	110.5	116.8	103.9	102.0	97.3	99.2	103.1	98.3	292.5	294.3	274.3	276.6	268.0	276.6	282.9	276.8
Emilia Romagna	26.7	25.9	26.9	25.5	24.8	26.3	24.6	26.2	109.1	105.8	108.0	105.6	99.2	96.0	97.2	97.7	272.8	275.7	265.2	271.7	251.5	261.1	257.5	252.9
Toscana	25.8	25.9	28.5	27.7	26.6	26.2	26.1	22.1	118.6	120.0	116.6	115.2	110.1	111.5	113.1	101.2	294.2	291.3	289.2	287.3	274.3	274.7	284.3	263.3
Umbria	25.9	30.4	24.8	31.5	23.5	33.4	25.4	25.3	120.1	126.7	131.1	119.4	128.7	133.3	115.0	112.8	323.3	292.0	294.1	315.4	321.2	297.2	309.1	293.5
Marche	27.8	26.6	23.9	25.0	27.1	22.9	25.2	28.5	119.9	112.3	110.5	113.0	108.6	109.9	104.7	100.7	274.1	293.6	285.3	288.8	291.4	285.1	261.8	272.8

Table 3 (continued)

Age group	65–74								75–84								> 85							
Region/year	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014	2007	2008	2009	2010	2011	2012	2013	2014
Lazio	35.2	37.6	33.7	25.1	23.3	26.4	27.1	23.7	167.9	167.2	167.2	112.7	107.3	110.9	104.3	100.5	436.2	423.8	424.6	291.8	273.9	292.9	287.9	275.6
Abruzzo	30.1	30.3	29.7	28.5	27.2	28.8	25.6	27.4	112.6	122.2	121.0	130.8	112.8	113.2	115.7	114.7	292.9	313.5	319.5	284.8	291.0	299.4	294.2	279.9
Molise	31.9	21.3	33.4	25.7	34.3	20.8	26.1	19.5	122.4	119.9	109.6	128.9	107.4	119.9	96.7	130.9	334.1	305.8	296.1	297.9	271.4	305.7	276.4	263.3
Campania	30.2	29.1	28.9	27.8	28.1	30.1	30.1	28.3	117.8	116.5	117.4	116.2	109.6	112.9	117.0	110.7	251.8	256.4	258.6	246.8	250.7	262.1	268.8	258.5
Puglia	27.8	29.9	28.5	28.7	26.6	25.5	25.3	26.9	120.8	123.6	113.9	111.5	108.8	109.3	109.5	106.5	299.2	298.4	287.1	291.6	274.7	281.7	268.6	268.3
Basilicata	35.4	29.1	31.1	36.3	30.7	34.0	31.8	24.7	150.2	138.9	124.2	123.5	131.3	139.5	133.8	119.1	308.6	300.1	328.7	351.6	296.4	335.7	319.4	330.6
Calabria	26.2	31.6	30.4	26.6	32.1	28.0	31.0	30.8	110.3	115.8	112.2	111.0	114.9	110.4	120.7	118.4	265.2	261.0	287.5	263.7	275.8	270.8	271.4	281.5
Sicilia	32.8	30.7	30.8	32.1	30.9	31.3	30.0	27.9	129.2	124.7	125.8	136.5	118.9	124.1	121.4	117.3	313.0	296.7	291.8	308.9	302.7	305.2	281.1	271.2
Sardegna	25.3	26.4	23.6	22.4	22.8	24.8	24.6	22.7	106.5	117.2	108.3	104.3	99.6	98.1	99.9	90.5	298.3	297.9	268.1	253.6	264.9	246.0	238.9	253.0
Italy	28.7	29.0	28.0	27.0	26.5	26.9	26.6	25.3	121.6	121.7	119.7	114.6	109.6	110.3	108.6	105.2	301.0	298.7	293.0	283.2	274.2	279.7	274.8	268.7

Table 4 AAPC of hospitalizations rates per 10,000 inhabitants per age group

Age class	Males			Females		
Region	65–74	75–84	≥ 85	65–74	75–84	> 85
Piemonte	+ 2.1	− 1.4*	− 0.3	− 1.9	− 1.0*	− 0.5
Val d'Aosta	+ 2.6	− 0.7	+ 16.4*	− 2.8	+ 2.5	+ 2.2
Lombardia	− 1.5 |	− 1.4*	− 0.4	− 1.1	− 1.3*	− 0.7
Trentino Alto Adige	− 3.4*	− 2.3	− 5.8	− 3.5	− 2.3*	− 1.2
Veneto	− 3.3*	− 2.3*	− 0.9	− 1.6	− 2.5*	− 1.7*
Friuli Venezia Giulia	− 5.4*	− 4.4*	− 3.2*	+ 0.4	− 4.4*	− 3.4*
Liguria	+ 2.2	− 1.8	+ 0.7	− 1.7	− 1.9*	− 0.7
Emilia Romagna	− 1.4	− 2.4*	+ 0.2	− 0.6	− 1.9*	− 1.2*
Toscana	− 0.1	− 2.3*	+ 0.4	− 1.6	− 1.9*	− 1.3*
Umbria	+ 0.2	− 1.8	+ 1.7	− 0.5	− 0.9	− 0.4
Marche	− 3.4	− 2.9*	+ 1.6	− 0.2	− 1.9*	− 0.7
Lazio	− 7.5	− 7.2*	− 4.9*	− 6.0*	− 8.2*	− 7.2*
Abruzzo	+ 2.4*	− 1.8	+ 3.1	− 1.9*	− 0.6	− 1.0
Molise	− 8.5*	+ 0.5	+ 1.0	− 4.1	− 0.6	− 2.6*
Campania	− 1.6	− 0.9	+ 2.0*	− 0.2	− 0.7	+ 0.6
Puglia	− 2.3	− 2.1*	− 0.6	− 1.7*	− 1.9*	− 1.7*
Basilicata	− 2.7	− 3.1	− 1.6	− 1.7*	− 1.6	+ 0.8
Calabria	− 3.7	+ 0.7	+ 0.3	+ 1.2	+ 0.8	+ 0.6
Sicilia	− 0.9	− 1.4	− 0.9	− 1.5*	− 1.2	− 1.4
Sardegna	− 3.3	− 3.3*	− 2.5*	− 1.1	− 2.7*	− 2.9*
Italy	− 1.3*	− 2.4*	− 0.5	− 1.7*	− 2.2*	− 1.6*

AAPC average annual percent change

*$P < 0.05$

statistically significant in 8 regions) and only in 9 regions for males (being statistically significant in 4 regions). Lazio and Friuli V.G. were the only regions with reduced AAPC in the age group ≥ 85 (− 4.6% and − 1.9%, respectively; $P < 0.05$). The demographic explanation for that is that Lazio region presented the highest increase in the number of people belonging to the oldest age group over the 8-year study period (+ 33.7% per year vs. a national average of + 27.1%).

The Italian situation can be summarized as showing a general increase in the number of people aged ≥ 85 years old in all the regions and a faster rate of fractures in males than females, more evident in Central Italy (Lazio) and Southern Italy (Molise, Abruzzo, Campania, and Calabria).

It is noteworthy to emphasize the low rate of Friuli V. G. and Veneto during the 8 examined years in terms of AAPC concerning SHR per 10,000 inhabitants in people aged ≥ 85 between 2007 and 2014, as reported in Table 4. In these two regions, SHR per 10,000 were lower than in other regions, remaining at lower values or just above 150 in males and 230 in females, respectively. Region Lazio showed the highest SHR per 10,000 in the first 3 years of analysis (> 420 in

females and > 220 in males) and remarkably reduced rates in the subsequent years.

Our findings suggest that regional healthcare services should target a very specific population at higher risk of fractures to get an optimal cost-efficacy intervention in the field of osteoporosis prevention and treatment. Specific regional projects involving orthopedic surgeons who manage fractured patients could address the crucial issue of prescription and compliance with antifracture drugs [20]. Actually, a very small proportion (estimated not to exceed 30%) of hip-fractured patients is currently prescribed with an antifracture drug, although they present an extremely higher risk of developing subsequent hip or non-hip fractures. Moreover, the average compliance of treated people is lower than 50% or even 30% at 1 year, thus remaining very far from the target of antifracture efficacy set up at 80% [18, 21]. Therefore, regional healthcare systems are currently wasting a lot of money in treatments that are not effective because the compliance is too low. Optimal compliance is also related to clinical and social conditions of the patients, who are not always able to take medicine on daily basis (especially in case of multimorbidities and consequently multi-treatments), and sometimes has no caregivers to count on for attending control visits with a specialist. The adoption of specific pilot projects at regional level could be helpful in generating a positive pressure on specialists and general practitioners to make sure that people aged ≥ 85 at higher risk of fractures (i.e., low BMD) could receive adequate preventive therapies before developing a fracture (real primary prevention) and a proper treatment once fractured (secondary prevention). The managers of regional pharmaceutical services and general managers of local health authorities should be assessed also with a specific focus on the results obtained in this field: how many elderly people aged 85 and over at higher risk of fracture or with previous hip fractures receive a treatment? What is their compliance? This latter aspect is so crucial that regional decision makers should focus mainly on trying to address it in the most feasible way.

Costs generated at the regional level are extremely high not only in those regions where the elderly population is becoming a significant proportion of the general population, such as Lombardia, Piemonte, Veneto, and Emilia Romagna, but also in Campania, Puglia, and Sicily (regions with a "younger" population).

Finally, the possible explanation for the observed reduction in hip fractures absolute numbers and rates in people aged 65–79 or 65–84 (with remarkable regional differences) could be found not only as a consequence of different re-distribution of age groups within the Italian population but also taking into account all the efforts made since year 2000 by the scientific and medical community in raising the awareness about prevention and treatment of osteoporosis.

Conclusion

The number of hospital admissions for hip fractures in Italy is still increasing in almost all Italian regions due to the fractures occurred in people age 85 years old and over. Therefore, also overall direct and rehabilitation costs have increased. Women represent the majority of hip fractures, but the highest increasing rate has been observed in men. Regional healthcare services should focus on patients at higher risk of fractures and address the crucial issue of antifracture treatment compliance. From this analysis emerges that the implementation of specific disease management projects at the regional level is needed in order to reduce both the number of hospitalization and costs sustained for hip fractures.

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Compliance with ethical standards

Conflict of interest UT has received research grant and funding for consulting/speaking by Merck, Sanofi-Aventis, Novartis, Stroder-Servier, Ely Lilly, Roche, Glaxo, Nicomed; PP, MF, CN, AV, ER, CR, MR, FC, NF, AM, FG, and AD declare that they have no conflict of interest concerning this work.

References

1. Kanis JA, Burlet N, Cooper C, Delmas PD, Reginster JY et al (2008) European guidance for the diagnosis and management of osteoporosis in postmenopausal women. Osteoporos Int 19(4): 399–428
2. Piscitelli P, Iolascon G, Gimigliano F, Muratore M, Camboa P et al (2007) Incidence and costs of hip fractures compared to acute myocardial infarction in the Italian population: a 4-year survey. Osteoporos Int 18(2):211–219
3. Bouee S, Lafuma A, Fagnani F, Meunier PJ, Reginster JY (2006) Estimation of direct unit costs associated with non-vertebral osteoporotic fractures in five European countries. Rheumatol Int 26(12): 1063–1072
4. Cooper C (1997) The crippling consequences of fractures and their impact on quality of life. Am J Med 103(2a):12S–17S discussion 7S-9S

5. Piscitelli P, Brandi ML, Tarantino U, Baggiani A, Distante A et al (2010) Incidence and socioeconomic burden of hip fractures in Italy: extension study 2003-2005. Reumatismo 62(2):113–118
6. Piscitelli P, Chitano G, Johannson H, Brandi ML, Kanis JA, Black DM (2013) Updated fracture incidence rates for the Italian version of FRAX(R). Osteoporos Int 24(3):859–866
7. Piscitelli P, Gimigliano F, Gatto S, Marinelli A, Gimigliano A et al (2010) Hip fractures in Italy: 2000-2005 extension study. Osteoporos Int 21(8):1323–1330
8. Kanis JA, Oden A, McCloskey EV, Johansson H, Wahl DA, Cooper C (2012) A systematic review of hip fracture incidence and probability of fracture worldwide. Osteoporos Int 23(9): 2239–2256
9. Cooper C, Cole ZA, Holroyd CR, Earl SC, Harvey NC et al (2011) Secular trends in the incidence of hip and other osteoporotic fractures. Osteoporos Int 22(5):1277–1288
10. Piscitelli P, Feola M, Rao C, Celi M, Gasbarra E et al (2014) Ten years of hip fractures in Italy: for the first time a decreasing trend in elderly women. World J Orthop 5(3):386–391
11. Tarantino U, Piscitelli P, Feola M, Neglia C, Rao C et al (2018) Decreasing trend of hip fractures incidence in Italy between 2007 and 2014: epidemiological changes due to population aging. Arch Osteoporos 13(1):23
12. Kim HJ, Fay MP, Feuer EJ, Midthune DN (2001) Permutation tests for joinpoint regression with applications to cancer rates. Stat Med 19:335–351 (correction: 2001;20:655)
13. Clegg LX, Hankey BF, Tiwari R et al (2009) Estimating average annual percent change in trend analysis. Stat Med 28:3670–3682
14. Tediosi F, Bertolacci S, Roti L, Buiatti E (2003) La valutazione economica dei percorsi assistenziali dei soggetti con Ictus e Frattura del femore in Toscana: risultati di uno studio pilota. MECOSAN 48:67–82
15. Tediosi F, Bertolacci S, Roti L, Buiatti E (2004) L'assistenza ospedaliera e riabilitativa per le fratture osteoporotiche in Toscana. Politiche Sanitarie 5:61–69
16. Visentin P, Ciravegna R, Fabris F (1997) Estimating the cost per avoided hip fracture by osteoporosis treatment in Italy. Maturitas 26(3):185–192
17. Willson T, Nelson SD, Newbold J, Nelson RE, LaFleur J (2015) The clinical epidemiology of male osteoporosis: a review of the recent literature. Clin Epidemiol 7:65–76. https://doi.org/10.2147/CLEP.S40966
18. Iolascon G, de Sire A, Calafiore D, Moretti A, Gimigliano R, Gimigliano F (2015) Hypovitaminosis D is associated with a reduction in upper and lower limb muscle strength and physical performance in post-menopausal women: a retrospective study. Aging Clin Exp Res 27(Suppl 1):S23–S30
19. Iolascon G, Letizia Mauro G, Fiore P, Cisari C, Benedetti MG et al (2017) Can vitamin D deficiency influence muscle performance in post-menopausal women? A multicenter retrospective study. Eur J Phys Rehabil Med
20. Piscitelli P, Brandi ML, Nuti R, Rizzuti C, Giorni L et al (2010) The TARGET project in Tuscany: the first disease management model of a regional project for the prevention of hip re-fractures in the elderly. Clin Cases Miner Bone Metab 7(3):251–254
21. Piscitelli P, Marcucci G, Parri S, Cavalli L, Colli E et al (2011) Compliance to antifracture treatments in Tuscany: a regional survey based on institutional pharmaceutical dataset. Clin Cases Miner Bone Metab 8(3):62–65