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ORIGINAL ARTICLE

Secular trends of hip fractures in France: impact of changing characteristics of the background population

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Abstract

Introduction Hip fractures are a societal burden because of their high morbidity and mortality and the cost they generate. With the aging of the population, worries grow about an increase of the incidence and incidence rate of hip fracture in the future. Controversial data have been provided in relation to the referencepopulation used. The aim of this study was to assess the impact of the choice of the reference population in the incidence rate of hip fracture.

Methods Data were extracted from the French National Hospital Database related to the hospitalizations for hip fracture in France between 2002 and 2013 in patients over 59 years and were classified by gender and age (59–74, 75–84, over 84 years, over 59 years). The crude incidence rates of hip fracture were calculated by dividing the number of hospitalizations for hip fracture by the corresponding populations. To assess the impact of the choice of the reference population, we then calculated the adjusted incidence rates using direct standardization on age for the 2013 reference population.

Results From 2002 to 2013, the incidence of hip fracture rose by 4.8% in women (from 49,287 to 51,661) and 21.8% in men (from 12,716 to 15,482) aged over 59 years. Meanwhile, French population over 59 years increased more with a rise of 21.3% in women and 28.7% in men, resulting in a decrease in the crude incidence rates of 13.6% in women and 5.4% in men. However, this decrease was larger after direct standardization on the 2013 population of reference as 25.6% in women and 19.2% in men as a result of a difference in age-structure of the population.

Conclusions The incidence of hip fractures continues to grow despite a reduced incidence rate throughout a 12-year-period.

Keywords Hip fracture · Incidence · Incidence rate · Standardization

Introduction

Knowing the epidemiology of osteoporotic hip fractures is of major importance. Indeed, they are a public health issue because of the excess of mortality they account for and the cost they generate [1–6]. While the world population is getting older, concerns raised about an increase of the incidence rate of hip fracture and their financial burden [7–10]. At the age of 75–79 years, life expectancy was 9.4 years for men and 12 years for women, whereas it dropped to respectively 4.8 and 10.8 years after a hip fracture [1]. Indeed, an excess mortality of 19% in the year following the hip fracture and an excess of mortality of 1.8% per year for every year following the first fracture was found [2].

Trends of hip fractures have been addressed previously leading to controversial data. Incidence rates decreased in Europe and Northern America whereas rates are still increasing in other parts of the world like Asia and Ecuador. In Denmark, a 20% decrease in the incidence of hip fracture was found in men and 22% in women from 1997 to 2006 [11]. In the USA, a similar decrease was observed between 1986 and 2005, and also a decrease of the related hip fracture mortality over the same period [12]. Moreover, a New South Wales study showed a rising in the number of hip fracture but incidence rates remained stable [13]. Meanwhile, the age of hip fracture has increased from a mean of 73 years in the 1960s to a mean of 79 years around 2000 [14]. Such controversial data might be caused by the samples of population or heterogeneous manners to choose the reference population. Indeed, there is a large variety to express the incidence rate, some describing the variation of

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incidence rates using only the crude incidence rates [5, 15], and some after a direct standardization [10, 12, 13, 16–24] and in others after an indirect standardization [11]. Direct standardization is used to compare two or more populations with different age and sex distribution. In that case, comparison of crude rates alone is unsatisfactory because the differences observed in the incidence rates might be, in part, due to the difference of the age and sex structures. Furthermore, direct standardization implies to choose a population of reference. The choice of reference population is heterogeneous and not constantly proper as recommendations are lacking. We therefore aimed at assessing the impact of the choice of the population of reference and reporting the crude and standardized incidence rates of hip fracture, using the data of hip fracture in France in people over 59 years between a 12-year period.

Methods

Data collection

Data had been collected from the French Hospital National Database which includes all hospitalization in public and private acute care settings in France. Hospitals have to complete its own database according to the law of 1992, and this system is mandatory since 2004 in public hospitals and since 2005 in private hospitals. However, we started from 2002 as such data were available. Hip fractures were designated as the number of hospitalization in the French metropolitan population aged 59 years and older from 2002 to 2013 as reported previously [24–26]. The selected hospitalization stays were those for which the primary diagnosis was hip fracture in people aged 59 years and over with the initial surgical treatment performed during the same hospitalization managed in metropolitan France. Hip fractures were defined by their ICD-10 diagnosis codes: S72.0, S72.1, and S72.2 (ICD-10 codes) [26]. We selected hospitalizations for which the primary diagnosis was hip fracture in people aged 60 years and over with the initial surgical treatment performed during the same hospitalization living and managed in metropolitan France. The selected hospitalizations represented 82% of all hospitalizations with hip fractures encoded as primary diagnosis. For the remaining 18%, the reasons for hospitalizations were medical including hospital transfer or other surgical management related to polytraumatism, removal or change of prosthesis, reduction of prosthesis, removal of osteosynthesis material, or fractures occurring in a context of cancer or mention of cancer or prosthesis complications as secondary diagnosis [26]. Rehospitalizations and transfer were not retained even if a hip fracture on the contralateral side may occur in a given patient within the same year because it was considered that the small proportion has no significant impact on the hip fracture incidence trend.

Data of reference

For the reference population, we used the whole French population extracted from the National Institute for Statistics and Economics Studies (Institut National de la Statistique et des Études Économiques) [24–26]. From 2002 to 2004, five age classes were available by gender (0–19, 0–39, 40–59, 60–74, over 74 years old). From 2005, data were available by gender for each age. Data were described by gender in the following age groups: 60–74, 75–84, over 84, and over 59 years old. For data before 2005, the proportion of 2005 were used to estimate the population in 75–84 and ≥ 85 years assuming no major change in the structure of the population over 3 years [26].

Tables 1 and 2 described in women and men the number of hip fractures, population, crude incidence rate by age groups (60–74, 75–84, over 84, and over 59 years old), and the evolution of each variable between 2002 and 2013.

Analysis

To study the impact of the population of reference, we calculated the direct standardized incidence rates using the French 2013 population. In each age group, we multiplied the crude incidence rate of each year by the corresponding population of 2013 and divided it by the overall population of 2013 of subjects aged over 59 years in order to obtain the direct standardized incidence rate.

Data are presented by gender using graphs as follows: evolution of hip fracture by years (1A and 2A), cumulated variation of the population and incidence of hip fracture in the overall studied population and in those over 84 years (Figs. 1b and 2b), and evolution of crude and standardized incidence in the studied population (Figs. 1c and 2c) from 2002 to 2013.

Results

Trends of hip fracture incidence in women

Table 1 shows the number of hip fracture in women aged over 59 years between 2002 and 2013 for each year with the corresponding population and the incidence rates [24, 25]. There is a global increase in the number of hip fracture in women (Fig. 1a, Table 1), from 49,287 in 2002 to 51,661 in 2013. This is mostly related to an increase of hip fractures in women aged over 84 years (Fig. 1b). In parallel, the demography of the whole population of women aged 59 over years also increased, from 7,112,695 in 2002 to 8,629,431 in 2013. Therefore, the incidence rate of hip fracture in women over 59 years globally decreases from 2002 to 2013.

The cumulating variation of incidence of hip fracture showed an increase from 2002 to 2013 (Fig. 1b), in particular

Table 1 Incidence rates of hip fracture of each year between 2002 and 2013 in women, based on the population of each year (crude incidence[16]) and after direct standardization on 2013

		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Variation 2002–2013 (%)
Hospitalization (*n*)	60–74	6568	6394	6068	5919	5816	5741	5564	5515	5599	5640	5558	5842	−11.1
	75–84	18,668	19,447	20,271	20,252	19,829	19,316	18,749	18,396	17,819	17,221	16,599	16,413	− 12.1
	> 84	24,051	22,913	21,144	22,045	22,688	23,865	24,879	25,577	26,674	27,072	28,058	29,406	22.3
	> 59	49,287	48,754	47,483	48,216	48,333	48,922	49,192	49,488	50,092	49,933	50,215	51,661	4.8
Population	60–74	4,210,517	4,194,641	4,192,542	4,201,718	4,196,846	4,282,120	4,382,599	4,502,200	4,618,621	4,750,202	4,862,769	4,989,780	18.5
	75–84	2,168,450	2,225,294	2,278,274	2,324,372	2,386,353	2,398,822	2,415,501	2,419,969	2,428,155	2,404,219	2,397,376	2,383,138	9.9
	> 84	733,728	752,963	770,889	786,487	855,087	930,452	995,701	1,058,395	1,117,014	1,160,349	1,215,320	1,256,513	71.3
	> 59	7,112,695	7,172,898	7,241,705	7,312,577	7,438,286	7,611,394	7,793,801	7,980,564	8,163,790	8,314,770	8,475,465	8,629,431	21.3
Crude incidence rate (each year population) /10^6 PA	60–74	1560	1524	1447	1409	1386	1341	1270	1225	1212	1187	1143	1171	− 24.9
	75–84	8609	8739	8898	8713	8309	8052	7762	7602	7338	7163	6924	6887	− 20
	> 84	32,779	30,430	27,428	28,030	26,533	25,649	24,986	24,166	23,880	23,331	23,087	23,403	− 28.6
	> 59	6929	6797	6557	6594	6498	6427	6312	6201	6136	6005	5925	5987	− 13.6
Age-adjusted incidence rates (2013 population)/10^6 PA	> 59	8052	7726	7288	7302	6959	6734	6516	6326	6205	6062	5935	5987	− 25.6

Table 2 Incidence rates of hip fracture of each year between 2002 and 2013 in men, based on the population of each year (crude incidence[16]) and after direct standardization on 2013

Year		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Variation 2002–2013 (%)
Hospitalization (*n*)	60–74	3130	3065	2848	2991	2937	2913	3086	3034	3270	3243	3145	3324	6.2
	75–84	5076	5536	5581	5670	5527	5591	5823	5569	5606	5330	5204	5293	4.3
	> 84	4510	4248	4026	4408	4744	5276	5557	5877	6209	6349	6446	6865	52.2
	> 59	12,716	12,849	12,455	13,069	13,208	13,780	14,466	14,480	15,085	14,922	14,795	15,482	21.8
Population	60–74	3,580,072	3,584,051	3,601,632	3,626,588	3,642,824	3,753,357	3,879,156	4,017,748	4,148,471	4,271,721	4,381,475	4,495,822	25.6
	75–84	1341 534	1386 325	1,428,569	1,474,549	1,506,484	1,526,811	1,554,441	1,571,767	1,594,086	1,609,117	1,627,053	1,640,001	22.2
	> 84	273,031	282,146	290,744	300,102	338,038	376,455	408,014	437,037	462,671	494,427	523,432	547,150	100
	> 59	5,194,637	5,252,522	5,320,945	5,401,239	5,487,346	5,656,623	5,841,611	6,026,552	6205 228	6,375,265	6,531,960	6,682,973	28.7
Incidence (each year population)/10^6 PA	60–74	874	855	791	825	806	776	796	755	788	759	718	739	− 15.4
	75–84	3784	3993	3907	3845	3669	3662	3746	3543	3517	3312	3198	3227	− 14.7
	> 84	16,518	15,056	13,847	14,688	14,034	14,015	13,620	13,447	13,420	12,841	12,315	12,547	− 24.4
	> 59	2448	2446	2341	2420	2407	2436	2476	2403	2431	2341	2265	2317	− 5.4
Age-adjusted incidence rates (2013 population)/10^6 PA	> 59	2869	2788	2624	2701	2592	2568	2570	2478	2492	2375	2276	2317	− 19.2

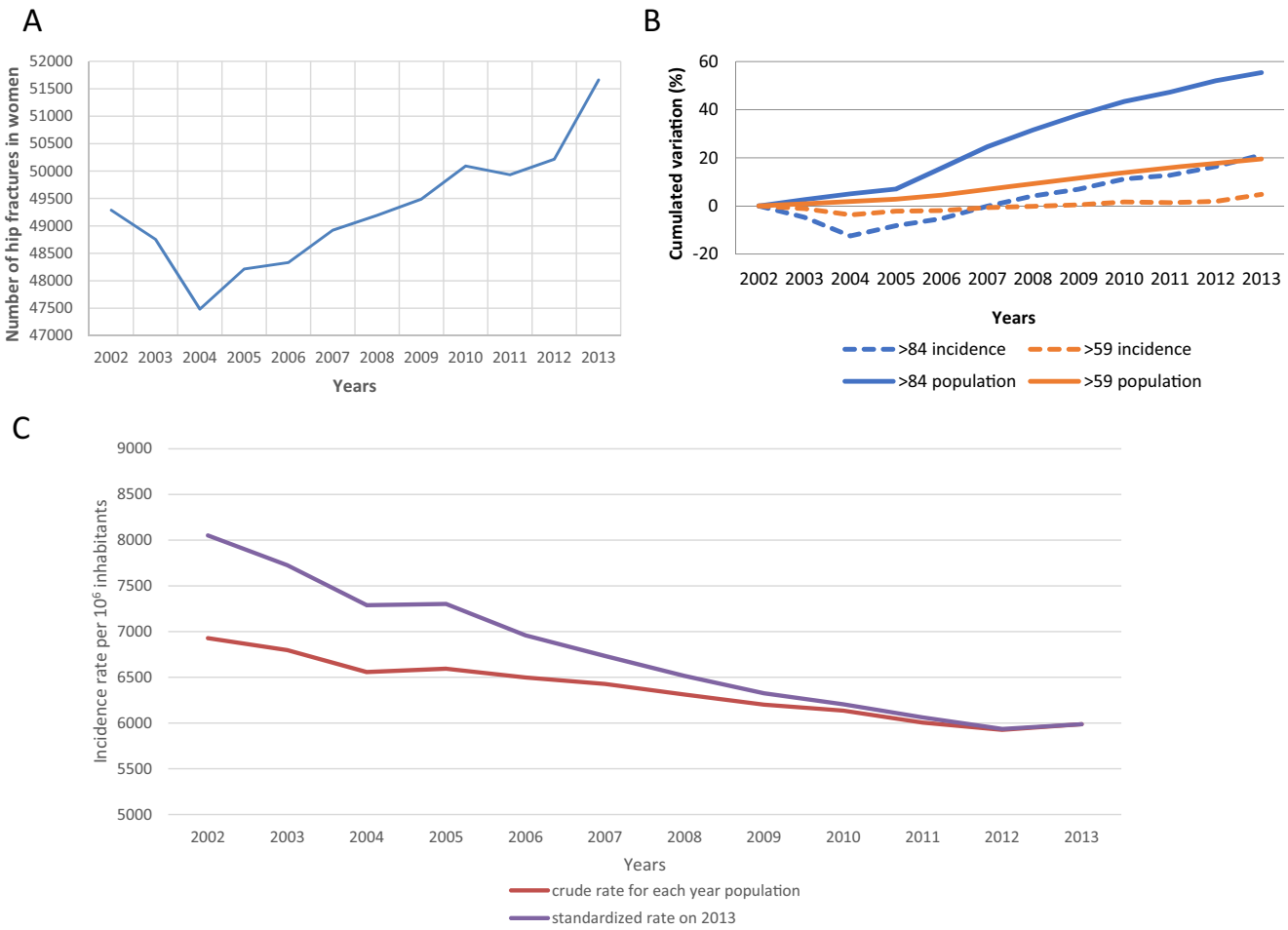

Fig. 1 Trends of incidence, incidence rates of hip fracture, and variation in women. **a** Incidence of hip fracture in women over 59 years in France between 2002 and 2013. **b** Cumulated variation of general population and incidence of hip fracture in women aged over 59 and over 84 years in France between 2002 and 2013. **c** Evolution of crude and standardized incidence (direct standardization on age and sex of 2013 population) rate of hip fracture in women aged over 59 years between 2002 and 2013 per year per 10^6 inhabitants

in women aged over 84 years (+ 21.2%). Meanwhile, the cumulating population of women aged over 59 years grew (+ 9.5%), with a particular 55% increase in women over 84 years, illustrating a variation in the demographic characteristics of the women population. In women over 59 years, between 2002 and 2013, the cumulating variation of hip fracture was + 4.8% whereas the cumulating variation of the population was + 19.5% (Fig. 1b).

Table 1 and Fig. 1c show the incidence rates of hip fracture in women aged over 59 years, crude incidence rates, and after direct age-class standardization on 2013 population. The crude incidence rates of hip fracture based on each year population show a global decrease between 2002 and 2013 of − 13.6%, thus − 1.1% of annual variation of incidence rates. We observed an increase between 2012 and 2013 in the crude incidence rates, confirmed with adjusted population for age and sex on 2013 (Table 1).

The same trend of decrease in incidence rates was found between 2002 and 2013 for age-standardized population of 2013. However, the variation differed after standardization, with a variation of − 25.6% (− 2.1% per year) on 2013 age-standardized population. Thus, the decrease observed after standardization is even greater than the crude incidence rates. The curve based on standardized population (2013) is not parallel to the curve of crude incidence and have a greater range of variation (Fig. 1c).

Trends of hip fracture incidence in men

Table 2 shows the total number of hip fracture in men aged over 59 years between 2002 and 2013 for each year with the corresponding population and therefore the incidence rates [24, 25]. There is a global increase in the number of hip fracture in men (Fig. 2a), from 12,716 in 2002 to 15,482 in 2013, with an increase in each age-class (Table 2). The population of men aged over 59 years has also increased, from 2002 to 2013. Calculating the crude incidence rate based on each year

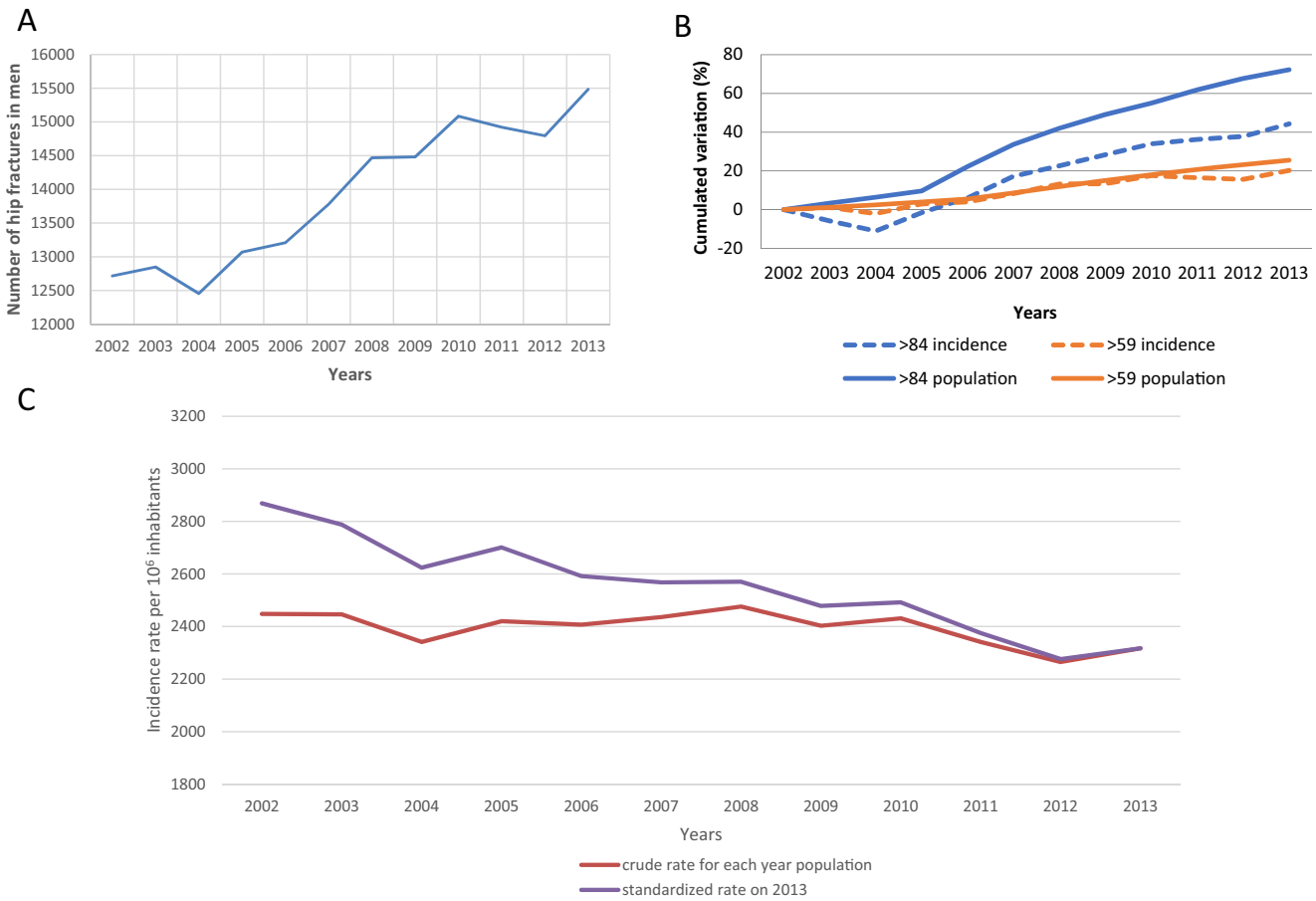

Fig. 2 Trends of incidence, incidence rates of hip fracture, and variation in men. **a** Incidence of hip fracture in men over 59 years in France between 2002 and 2013. **b** Cumulated variation of general population and incidence of hip fracture in men aged over 59 and over 84 years in France between 2002 and 2013. **c** Evolution of crude and standardized incidence (direct standardization on age and sex of 2013 population) rate of hip fracture in men aged over 59 years between 2002 and 2013 per year per 10^6 inhabitants

population fell from 2002 to 2013. In men as well, there was however a slight increase between 2012 and 2013.

The cumulated variation of incidence of hip fracture showed an increase between 2002 and 2013 (Fig. 2b), especially in men aged over 84 years (+44%). In addition, the cumulated population of men aged over 59 years grew between 2002 and 2013 (+25.5%). Among the age-classes, the over 84 year-class increased by 72%, illustrating the aging of the population of men. In men over 59 years between 2002 and 2013, the cumulating variation of hip fracture was +20.3% whereas the cumulating variation of the population was +25.5% (Fig. 2b).

Table 2 and Fig. 2c show the incidence rates of hip fracture in men aged over 59 years, crude incidence rates, and after direct age-class standardization on 2013 population. The incidence rates of hip fracture based on each year population (crude incidence rates) show a global decrease between 2002 and 2013 of −5.4%, thus −0.4% of annual variation of incidence rates.

We observe the same trend of global decrease in incidence rates between 2002 and 2013 for age-standardized population in 2013. The total variation from 2002 to 2013 is −19.2% (−1.6%) age-standardized population in 2013. Consistent with the data observed in women, the decrease is much larger when using a standardized population instead of each year population.

Discussion

Using the French database, we showed that the absolute number of hip fracture continues to grow despite a reduced incidence rate throughout a 12-year period in women and men aged 60 years and older. This decrease is even greater after standardization on age, suggesting that this is not only due to a change in the age structure of the population from 2002 to 2013, the population of both men and women aged over 59 years increased more than the increased incidence of hip fracture. Therefore, expressing incidence rates after a direct standardization unveils their true evolution as this allowed removing the differences in age distribution of the populations. Indeed, the variation of incidence rates of hip fracture

between 2002 and 2013 were twofold in women (− 13 versus − 26%) and fourfold in men (− 5 versus − 19%) after direct standardization.

This data suggest that the number of osteoporotic hip fractures will dramatically increase in the next years because of the aging population. This should address special care within the year after a fracture, especially the first one because of high mortality rate and risk of second fracture [3, 4]. The prospective Dubbo study found mortality rates of 4.3 per 100 person-years in women (95% CI, 4.1–4.5) and 5.5 per 100 person-years (95% CI, 5.3–5.8) in men in the entire population versus respectively 15.42 (95% CI, 12.88–18.52) and 25.67 (95% CI, 19.46–33.87) in the hip fractured women and men [3]. In addition, the cost of hip fractures is financial burden worldwide as it is in France [5]. The map of trends of incidence rates of hip fracture worldwide showed that the overwhelming majority of countries in Western and Northern Europe and North America experienced a global decrease in the incidence rate of hip fracture whereas incidence rates increased in many Asian countries, in Ecuador and in Germany in 2014 [27]. Reasons for the decline in incidence rates in several countries are unclear. It was suggested that it might be due to the stabilization of urbanization, arguing that hip fractures are higher in urban than in rural area. On the opposite, countries with a growing urbanization could experience an increase in their incidence rates of hip fracture [19]. Some studies showed differences in the trend of the incidence of hip fracture between races, gender, and even region within the same country [25, 28–30]. Indeed, the reduction is higher in women than men and lower in Hispanic and Asian populations [16, 19, 26, 31]. The reduction could be explained by several environmental factors as well as a better awareness of the disease and some prevention guidelines. Among them, one can quote an improved functional ability of elderly people, a decrease in smoking, an increase of the BMI or the physical activities, as well as a better treatment management for osteoporosis [18, 21, 23, 27]. However, Leslie et al. showed that increase in bone mineral density was probably the primary explanation for the observed reduction in fracture rates which could not be explain by the increase in the use of osteoporosis medication, nor by the increase in body mass index as a protective factor of hip fractures [32]. Besides, interestingly, a recent Scandinavian study predicted an increase of the incidence of hip fracture in Denmark and Sweden in the near future, arguing that more recently born cohorts have higher relative risks of hip fracture [22].

Our study helps to assess the trends of osteoporotic hip fractures and the different ways to understand epidemiologic data on the subject, based on the reference values used. It has some limits. First, there was a switch in the way hospitals are getting payed in 2004 in France which allows an exhaustive data collection from this time. Even with this bias, the decrease in the incidence rate of hip fracture is persisted. Second, we did not take into account contralateral fracture if they took place in the same year as the first one, which could have slightly diminished the incidence rates of hip fracture. We were unable to assess such an event before 2006. Since 2006, we identified that 2 to 5% of patients have been hospitalized for a fracture of the opposite hip within the same year [26]. Considering the low rate of recurrent fracture in the same year, we did not take it into account to prevent us from counting two times the same fracture. Ultimately, we were unable to link patients to their treatment, way of life, physical characteristics (like BMI for instance), comorbidities, and BMD.

We chose to express the data with different background populations, i.e., crude and after direct standardization in order to assess the differences that could be induced by this choice. The expression differs among the studies. Indeed, some studies reported only the crude incidence rates [5, 15], and others used a direct standardization [10, 12, 13, 16–24] or an indirect standardization [11]. Our data show that the range of variation differs despite a same trend. Using a direct standardization, the choice of the population of reference differs from every study. In some, the choice was made to use the mean population of the overall period of interest, in others the period of interest (first one, last one, or a random one). There is no recommendation on the choice of the reference population to perform a direct standardization.

We also found an increased from 2012 to 2013 in both gender, suggesting that we might be facing a new increase in the incidence rates of hip fracture in France, but data are needed to confirm this. Prediction tools showed that incidence of hip fractures might be increasing [22]. This could be, in part, due to a lower use of anti-osteoporotic drugs that might be linked to the fear of side effects. Therefore, prevention of osteoporotic fractures should be sustained, especially in the aged population.

In conclusion, our study showed that the absolute numbers of hip fractures continue to grow in relation to a higher number in elderly. However, the incidence rates of hip fracture decrease in both men and women over aged 59 years throughout a 12-year-period and is even more important after adjustment for age and sex. Therefore, the choice of the background population is of significant importance to compare data in relation with the modifications of the age structure of the population.

Compliance with ethical standards

Conflicts of interest None.

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