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ORIGINAL ARTICLE

Incidence and excess mortality of hip fractures in a predominantly Caucasian population in the South of Brazil

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Abstract

Introduction Osteoporosis is a very common disease, and data on its epidemiology is important for health care strategy implementation. Brazil is a developing country; its population is aging, leading to an expected increase in hip fractures and their undesirable consequences.

Objective Assess the incidence of osteoporotic hip fractures and subsequent mortality in Southern Brazil as part of a large epidemiological study aiming to reinforce the data for FRAX Brazil.

Study design This study evaluated all admissions for fragility hip fractures between April 1, 2010, and March 31, 2012, in the city of Joinville, including both genders of patients 50 years old or older, which corresponded to 19.2% of the local population. Joinville was chosen because it is the third largest city in the south of Brazil, with a representative population predominantly composed of descendants of European immigrants.

Results There were 213 cases of hip fractures, predominantly in Caucasians (n = 204, 96.7%) whose mean age was 77.7, ± 10.5, of which 143 (67.1%) were women (79.5 ± 9.6 years) and 70 (32.9%) were men (74 ± 11.3 years). The annual incidence of hip fractures was 268.8 for women and 153.0 for men/100,000 inhabitants. In the 60 to 64-year group, the overall incidence was 92.1/100,000, with an age-related increase of 1410.1/100,000 in the 80 to 84-year group. The mortality rate during hospitalization was 7.5%, and 25% died during the 12 months following their fractures.

Conclusion The incidence of hip fractures among the oldest in this predominantly Caucasian population living in Southern Brazil was similar to that of European populations from the northern hemisphere. The annual incidence of fragility hip fractures among people in their 80s was 59 times higher than that among people in their 50s. The mortality rate was 4.3 times higher in the first year after hip fracture than in the age-related local population.

Keywords Epidemiology · Hip fracture · Osteoporosis · Incidence of hip fracture · Mortality after hip fracture

Sergio Ragi Eis is deceased. This paper is dedicated to his memory.

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Introduction

Osteoporosis is a common disease in developed countries and is expected to become increasingly important in emerging countries such as Brazil, where longevity is increasing rapidly. The average life expectancy for Brazilian women has increased over the past three decades from about 65 years in the 1970s to around 72 years in 2000, and it is expected to exceed 80 years in 2050 [1]. According to the United Nations, based on data up to 2012 and a Bayesian probabilistic methodology, developing countries with young populations but lower fertility (e.g., China, Brazil, and India) are likely to face the problems of aging societies before the end of the century [2].The number of people 70 and older was 7.7 million (4.1% of total Brazilian population) in 2004, and it is believed that

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this figure will have increased by almost five times, reaching 34.3 million, in 2050 [1].

In 1990, about half of hip fractures occurred in elderly individuals in Europe and North America [3]. At present, hip fractures occur in 280,000 Americans and 36,000 in Canadians each year, and this number is expected to rise to 80,000 by 2040 [4]. In 2050, with the rapid aging of the Asian and Latin American populations, the contribution of Europe and North America to this statistic is expected to fall to 25%. More than half of hip fractures will occur in Asia and about 25% in Latin America, where Brazil is the most populous country [3]. Hip fractures are associated with a 30% mortality rate and profound temporary and sometimes permanent impairment of independence and quality of life [4]. It is evident, therefore, that osteoporosis has become a global problem in the last 50 years and urgent action is needed to counteract this trend and prepare health systems to deal with this new reality.

The incidence of osteoporotic fractures varies widely among countries and regions. It is primarily related to differences in population' characteristics, including life expectancy and use of health services and resources [5–17]. In Latin America, the prevalence of hip fractures varies between 40 and 362 per 100,000 inhabitants [18]. However, few studies have examined the epidemiology of osteoporosis in the Brazilian population [5, 19–21].

FRAX® (http://www.shef.ac.uk/FRAX) is a tool used to calculate the risk of fractures with or without densitometry [22]. The current version of FRAX for Brazil was based on four epidemiological studies [23], which included the cities of Porto Alegre, RS, in the South [5], Sobral, CE, and Fortaleza, CE, in the Northeast [19, 20], and Marilia, SP, in the Southeast [21]. Brazil has five major regions with various individual and population characteristics. To corroborate existing epidemiological data in Brazil, a study was conducted to retrospectively investigate the incidence of hip fractures and mortality rates after hip fractures in women and men over 50 in three Brazilian cities (Belem in the North, Vitoria in the Southeast, and Joinville in the South Region). Our report describes the details of that evaluation from Joinville's hospital records collected between April 1, 2010, and March 31, 2012.

Study design The study was conducted to estimate the incidence of hip fractures through the survey of all hospital records in the city of Joinville (including public or private facilities, when applicable), assisting this situation. The survey took place for 2 years, from April 2010 to March 2012. Only patients living in Joinville entered the study. For the record, hospital transfers and readmissions were not counted as new fractures.

Study setting for the geographical information As part of the national study, Joinville was chosen to represent the southern region of Brazil because it is the third largest city in the region and provided centralized medical care for a well-defined population of 515,288 inhabitants in 2010 without requiring patient transfers to other cities for treatment [24]. Joinville has five major hospitals: two public, two private, and one that provides both service types. Three of them perform surgery for proximal femoral fractures, and the largest one is a public service (it conducted 87.3% of hip fracture treatments).

Study population The study population comprised men and women 50 or older admitted to hospitals between April 1, 2010, and March 31, 2012, with a fragility hip fracture (ICD-10 code = S72.0 femoral neck fracture, S72.1 peritrochanteric fracture (intertrochanteric fracture and trochanteric fracture), and S72.2 subtrochanteric fracture). Each case's medical charts and operating room records were reviewed. The presence of a hip fracture was confirmed when this diagnosis was mentioned in the medical records or operative report. If the diagnosis in the records was uncertain, the fracture was confirmed by radiography. Patients with fractures associated with arthroplasties, cancer or bone metastases, accidents, or uncharacteristic frailty trauma and patients living in other cities but treated in Joinville were excluded.

Ethics committee The three hospitals' Research Ethics Committees approved the study. Cases were analyzed after we obtained the informed consent form by telephone.

Statistical analysis Patients with fractures were grouped into 5-year age ranges (50–54, 55–59, 60–64, 65–69, 70–74, 75–79, 80–84, 85–89, 90–94, and 95 or older) and by gender. Fracture incidence was expressed per 100,000 people as crude incidence and age-standardized for gender group according to the official census data available at the IBGE for 2010 [24], and for purposes of comparison with other studies was calculated the annual incidence of 2011. Quantitative variables were expressed as mean, median, minimum, maximum, and standard deviation (SD), and qualitative variables were presented as frequencies and percentages. The overall survival time was described by the Kaplan-Meier curve.

Results

During the 2-year study, 222 patients were hospitalized for fragility hip fractures. Of these patients, 9 had to be excluded: 8 did not live in Joinville, and 1 did not meet the fragility criteria, resulting in a final study population of 213 individuals. The mean age was 77.7 ± 10.5 years; the mean age was 79.5 ± 9.6 years for women and 74 ± 11.3 years for men. The proportion of the study population that was Caucasian was 96.7% (204 individuals), female 67.1% (143), and male 32.9% (70) (Table 1).

Table 1 Demographics of the study population

	% of the population	Population, *n* (%)
Race		
Caucasian	83.97	204 (96.7)
Black	2.94	2 (0.9)
Mulattos	12.4	5 (2.4)
Asian	0.41	0
Indigenous	0.25	0
Unknown race		2 (0.9)
Total	100	213 (100)
Number		213 (100)
Age (years)		
Mean		77.7 ± 10.5
Median		80.0
Minimum		52.0
Maximum		99.0
Sex		
Female		143 (67.1)
Male		70 (32.9)

The annual overall incidence of hip fractures in Joinville was 215.3/100,000 inhabitants (268.8 in women and 153.0 in men) (Table 2). The incidence increased with advancing age, from 92.1 cases in the 60–64 group to 1410.1 in the 80–84 group. The ratio of women to men was 0.47 for those under 60, 0.69 for those 60–69, 1.56 for those 70–79, 1.94 for those 80–89, and 3.45 for those over 90.

The average hospital stay length was 14.1 days (SD = 11.3, range 1–104 days). Surgery was the treatment for 208 patients (98.1%). Five patients died before surgery due to previous poor health conditions. The total in-hospital mortality rate was 7.5% (7.6% in women and 7.1% in men). The mortality rate 36 months post-fracture was 31.9% (32.5% in women and 30% in men). About 25% of deaths had occurred over 12 months (Fig. 1). Of the 68 deaths, 59 (86.8%) were due to the consequences of fractures, as such thromboembolism, immobilization, and complications of surgery, and 9 (13.3%) were from other causes.

The largest number of fractures occurred in winter, July to September ($n = 64$; 30.3%), followed by spring, October to December ($n = 60$; 28.4%), and fall, April to June ($n = 51$; 24.2%), whereas the lowest number occurred in summer, January to March ($n = 36$; 17.1%) ($p = 0.032$; chi-square test). Two patients did not have an exact fracture date.

There were 49 (23%) patients who reported knowledge of a previous diagnosis of osteoporosis, 145 (68%) had no knowledge, and 19 (8.9%) had no record. Only 19 (8.9%) patients were taking medication for osteoporosis (18 bisphosphonates and 1 raloxifene), and 47 (22%) were using calcium, vitamin D, or both.

Discussion

This study aimed to increase our understanding of fragility fractures in Southern Brazil, represented by Joinville, SC, and our comprehension of the country's epidemiology of osteoporosis. The FRAX in Brazil was designed over 4 epidemiological studies. The country has ethnic differences and various fracture incidence rates between the North and South. We must better understand these variations to define osteoporotic fracture prevention strategies. The data was collected from a historical cohort study to assess the incidence and mortality rates.

A hip fracture is a realistic way to capture clinical situations due to the need for referral services for care. Several studies have

Table 2 Annual incidence of hip fractures per 100,000 inhabitants (in the year 2011) according to age and gender

Age groups	Women			Men			All		
	Population* in 2010	New hip fractures	Incidence per 100,000	Population* in 2010	New hip fractures	Incidence per 100,000	Population* in 2010	New hip fractures	Incidence per 100,000
50–54 years	15,168	2	13.1	14,761	2	13.5	29,929	4	13.3
55–59 years	12,278	4	32.5	11,325	8	70.6	23,603	12	50.8
60–64 years	8642	9	104.1	7633	6	78.6	16,275	15	92.1
65–69 years	5720	6	104.8	4773	10	209.5	10,493	16	152.4
70–74 years	4521	10	221.1	3376	8	236.9	7897	18	227.9
75–79 years	3189	30	940.7	2064	11	532.9	5253	41	780.5
80–84 years	2174	34	1563.9	1088	12	1102.9	3262	46	1410.1
85–89 years	1035	32	3091.7	516	8	1550.3	1551	40	2578.9
90–94 years	375	13	3466.6	161	3	1863.3	536	16	2985.0
95–99 years	78	3	3846.1	34	2	5882.3	112	5	4464.2
Total	53,197	143	268.8	45,739	70	153.0	98,936	213	215.2

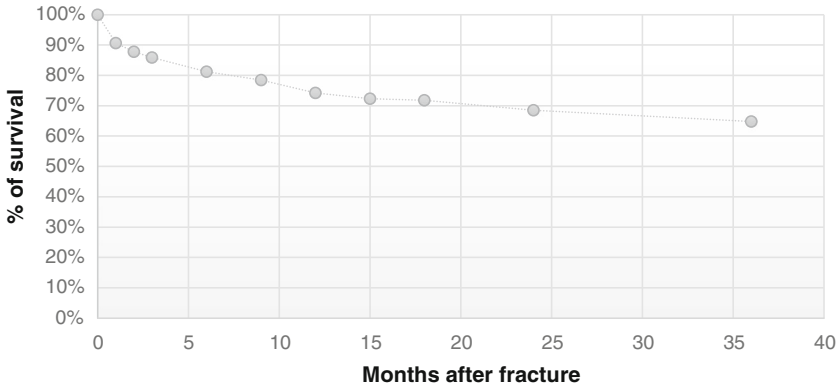

Fig. 1 Survival rates estimated by the Kaplan-Meier method

used this feature to validate risk factors for fragility fractures and to calculate their incidence rate [5–17]. The risk of osteoporotic fractures is increasing despite better health services. People are living longer, but their bone mineral density is likely to deteriorate with age or the presence of other secondary causes [25].

According to data from the IBGE Census 2010 (Department of Population and Social Indicators), Brazil had a population of 191 million inhabitants, with a slight female predominance (51.6%), consisting mainly of people of mixed-race ethnicities. Caucasians are about half of the population (49.3%) [24]. As a country of continental dimensions, its colonization has led to ethnic differences between regions. The 2010 census highlighted the persistence of differences in the distribution of ethnic different groups [24], with a higher concentration of African descendants in the North and Northeast and whites in the Southeast and South. Joinville represents the characteristics of colonization in Southern Brazil well. Its population is primarily Caucasian (83.9%), the result of colonization by Portuguese, German, Italian, Norwegian, and Austrian people, in agreement with the distribution of fractures among the patients evaluated (204 Caucasian patients, 96.7% of the sample).

In fact, Joinville's population is very young; only 19.2% of its inhabitants are over 50 years old. The care of patients with hip fractures largely occurred in the public health sector (186 patients, 87.3%). Although the people are still very young, by 2015, Santa Catarina, where Joinville is located, was the Brazilian State with the highest life expectancy (78.7 years). The state also had the highest life expectancy for men (75.4) and women (82.1) (http://www.brasil.gov.br/governo/2016/12/expectativa-de-vida-no-brasil-sobe-para-75-5-anos-em-2015 accessed in January 2018). This study revealed an increased incidence of hip fractures with increasing age. The analysis of the impact of hip fractures per decade showed an increase after 70 years of age. The annual incidence of fragility hip fractures was 268.8 women and 153.0 men/100,000 inhabitants. The incidence among people in their 80s was 59 times that of people in their 50s and is comparable to the highest rates of hip fracture incidence in North America and the Northern European countries [3, 7–9, 26, 27]. Those over 80 years old contributed to more than 50% of these fractures. These data agree with statistics from other countries with large young populations that showed an increased incidence of osteoporosis and fractures as their populations aged [3–5, 18, 26, 28, 29].

Even in countries such as Sweden, where the hip fracture incidence is high, the annual number of hip fractures will almost double between 2002 and 2050, resulting in roughly 30,000 fractures in 2050 [27]. This explosion of new cases of hip fractures will raise health system costs. By 2040, for example, North America is expected to incur health care costs exceeding ten billion dollars a year [4]. The explosion of hip fractures will also be a reality in Joinville and the Brazilian Southern region, which will lead to high health system costs, but there is still time to establish prevention programs.

The incidence of hip fractures in Joinville was higher than that in Northern Brazil (Fig. 2) and most Latin American countries [18–20, 30] but shows the similar trends seen in Mexico, with important increase after the age 75 [31]. However, it is still low above 50 years (Table 3). In the reference studies used to build the FRAX, the annual incidences in the cities of Sobral and Fortaleza, both in the Northeast, were approximately four times lower than reported in Caucasian populations in the Northern Hemisphere [6, 7, 9, 10]. Porto Alegre in the South [5] and Marilia in the Southeast had moderate incidences [21], but the crude incidence rate of proximal femur fractures in Marilia was significantly higher among women and people 70 or older. The difference in the incidence of hip fractures between North and South Brazil could be explained by ethnic diversity background, and it may have implications for FRAX.

A gender difference existed in Joinville's hip fracture incidences: after the age of 70, women had twice the incidence of men, similar in Mexico [31]. Meanwhile, a higher number of fractures in men occurred before the age of 70 in this study, justified by the early poor health conditions caused by smoking and alcohol consumption in Caucasian men and their higher susceptibility to accidents at that age. In Norway, approximately one third to one fourth of fragility hip fractures occurred in men [27]. The females in Taiwan had a lower incidence in the 30–44 age group but a significantly higher

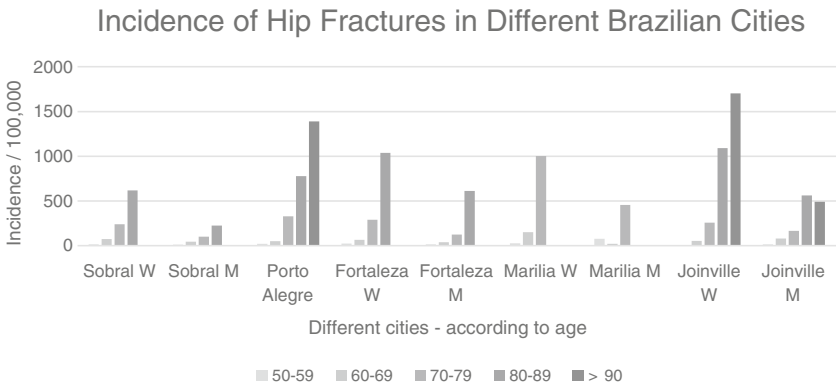

Fig. 2 Incidence of hip fractures in different Brazilian regions per 100,000 inhabitants and according to sex and age (except for Porto Alegre, for which all data are combined). W, women; M, men

incidence than males among those 60 or older [29]. In general, the higher frequency of hip fractures in women in Joinville does not differ from those found in other populations, where approximately 50% of women and 22% of men over the age of 50 will experience an osteoporotic fracture in their lifetimes [25].

Joinville is near the Tropic of Capricorn, and despite being in a region with sufficient sunshine, rainfall and overcast conditions are very common in the winter and spring months. About 78% of the population has vitamin D lower than 30 ng/dl [32], which should confer a greater risk of fracture related to vitamin D deficiency [33, 34]. A difference was discovered in the number of fractures between summer and winter, remaining high after winter. In Norway, in a population-based study, a significant seasonal variation was discovered in hip fractures occurring in outdoor areas, especially in the winter [27]. In Taiwan, a place with low weather variation throughout the year, a small difference exists in the number of fractures between the seasons [29]. Pasco et al., in the Geelong Study, showed that, in the cold months, less frequent exposure to the sun decreased vitamin D and induced the secondary increase of PTH, leading to an increase of bone resorption [35], which would explain the greater number of fractures in the cold months.

Most studies on mortality rates from osteoporotic fractures centered on hip fractures, reporting an increased mortality rate (17.4%–30.5% in 12 months) compared with the general population [36, 37]. These rates were similar in Joinville, where there was an excessive mortality rate in the first year (25.8% in 12 months), similar to others studies that showed an excessive mortality of 20–23.2% in 6 months [38, 39]. The long-term mortality was not the objective of this study, but we analyzed

Table 3 Annual incidence of hip fractures in individuals aged 50 years or more in Brazil, other Latin American countries, and in the international scenario

City, country (reference)	Year	Women/ 100,000	Men/ 100,000
Porto Alegre, RS, South Region, Brazil [5] (SCHWARTZ, 1999). Adjusted for > 50 years	1990–1992	202	104
Sobral, CE, Northeast Region, Brazil [19] (CASTRO DA ROCHA and RIBEIRO, 2003). Adjusted for > 50 years	1996–2000	207	89
Fortaleza, CE, Northeast Region, Brazil [20] (SILVEIRA, 2005). (> 45 years)	2001–2002	275	130
Marília, SP, Southeast Region, Brazil [21] (KOMATSU, 2004). Adjusted for 50 years	1994–1995	290	140
Oslo, Norway [7] (Lofthus, 2001)	1996–1997	1180	440
Rochester, USA [8] (Bacon, 1996)	1988–1989	1140	410
Fune, Denmark [9] (Frandsen, 1983)	1973–1975	900	300
Sheffield, England [10] (Kanis, 2008a)	1993–1995	820	300
Reykjavik, Island [11] (Johnell, 1992)	1990–1992	697	350
Genebra, Switzerland [12] (Nydegger, 1992)	1991	650	160
Picardy, France [13] (Baudoin, 1993)	1987	440	180
Hong Kong, China [14] (Ho, 1993)	1991	428	270
La Plata, Argentina [15] (Bagur, 1994)	1989–1990	380	100
Budapest, Hungary [5] (Schwartz, 1999)	1992	316	250
Beijing, China [16] (Xu, 1996)	1988–1992	96	107
Siena, Italy [17] (Caniggia, 1989)	1975–1985	30	7

up to 36 months after fracture, and remained high. Death occurred in older patients, where the fragility after fracture with several associated comorbidities strongly favors these data. Indeed, the mortality rate in this study was 4.3 times higher in 12 months than that in the general age-related local population (1138 deaths in a population of 98,935 individuals ≥ 50 years in the city, http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sim/cnv/evitb10sc.def accessed in January 2018). Fifty-nine (86%) of the deaths occurred as a result of fracture complications. The average hospitalization period after hip fracture surgery was 14.1 days in Joinville and 30.5 days in Edmonton, Canada [40].

This study did not show a gender difference in the mortality rate, unlike other studies, which showed higher mortality rates among men [41], with some five times higher than those among women [42]. In Joinville, the mortality rate up to 36 months after the fracture in women was 32.5%, with a 7.6% in-hospital mortality rate, and among men, it was 30%, with a 7.1% in-hospital mortality rate. The age at fracture was slightly higher in women than in men (79.5 versus 74, respectively), which could explain the absence of difference between genders, already seen in Austria, a country with one of the largest hip fracture rates in Europe [43], and in São Paulo [41].

In Joinville, patients were not aware of the diagnosis of osteoporosis or were not adequately addressed after discharge even though they underwent surgery in most cases. This situation also occurs in other centers in Brazil [38], where, after a significant event such as a hip fracture, only 13.9% of patients were diagnosed with osteoporosis, and only 11.6% started any treatment at the time of hospital discharge. Similarly, the BRAZOS study showed that about 85% of men and 70% of women with a history of low-impact fractures also did not receive any information about the disease [44]. Nazrum et al. showed that less than 30% of postmenopausal women and less than 10% of men with a prior fracture received prophylactic treatment despite substantial evidence that a prior fracture resulted in an increased risk of a subsequent fracture [25]. Thus, an excellent opportunity to treat osteoporosis and avoid new fractures was lost.

The weakness of this study is its retrospective design and small number of patients due to the low number of hip fractures in the 2-year period. The choice of hip fracture as an incident of osteoporosis favors the search for the need for hospital treatment. A strong point of this study was that it was carried out in a large city that represents the southern region of Brazil well and that assists its population adequately, avoiding outside attendance.

Conclusion

The incidence of hip fractures in Joinville, Southern Brazil, was moderate (268.8 and 153.0/ 100,000 for women and men in 2 years, respectively). This finding was different from those of other national surveys showing regional differences, with a great increase in incidence with aging, similar to Caucasians of the northern hemisphere. This finding confirms the scenario of future increase in fractures in countries with young populations, such as Brazil.

The in-hospital and 12-month mortality rates after hip a fracture were 7.5% and above 25%, respectively. From the calculation of SMR by the indirect method, standardized by age, the number of deaths of patients hospitalized for hip fracture is 4.3 times the number of deaths that would be expected considering the population of Joinville aged > 50 years. This statistic shows the severity of this type of fracture, as well as negligence in the treatment of osteoporotic fractures even after surgical treatment.

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Compliance with ethical standards The three hospitals' Research Ethics Committees approved the study. Cases were analyzed after we obtained the informed consent form by telephone.

Conflicts of interest Dalisbor Marcelo Weber Silva has received research grants from Servier do Brasil; Marise Lazaretti-Castro, Cristiano Augusto de Freitas Zerbini, Vera Lúcia Szejnfeld, and Sergio Ragi Eis are members of the committee for this study; and Victoria Zeghbi Cochenski Borba declares that she has no conflict of interest. This study was supported by the Servier do Brasil Ltda.

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