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The burden of fractures in Brazil: A population-based study

Fernando Vinholes Siqueira*, Luiz Augusto Facchini, Pedro Curi Hallal

Post-graduate Program in Epidemiology, Federal University of Pelotas, Brazil

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Abstract

Introduction. The elderly population is growing fast worldwide, and therefore, investigation of health outcomes peculiar to these individuals is a public health priority nowadays. The decade between 2000 and 2010 is denominated as the Bone and Joint Decade, and researchers are encouraged to quantity the burden of musculo-skeletal disorders worldwide. This is particularly relevant to developing countries, where the burden of these diseases is not well known. This study aims to evaluate the prevalence of fractures (lifetime and previous year) and its association with socio-demographic variables and medical diagnosis of osteoporosis.

Materials and methods. Population-based cross-sectional study including a multiple-stage sample of individuals aged 20 years or more living in Pelotas, a southern Brazilian city. Both the lifetime prevalence of fractures and the proportion of fractures in the year prior to the interview were investigated. Sex, age, skin color, socioeconomic level, schooling level and medical diagnosis of osteoporosis were used as independent variables. After descriptive and crude analyses, a Poisson regression was carried out in order to provide prevalence ratios including adjustment for confounding.

Results. The lifetime prevalence of fractures was 28.3%, and 2.3% of the individuals broke a bone in the year prior to the interview. Among men, most fractures were caused by sports practice and happened in leisure-time outside home. Among women, most fractures occurred inside home and were caused by falls. The lifetime prevalence of fractures was positively associated with male sex and white or mixed skin color. The prevalence of fractures in the year prior to the interview was greater among poor individuals and those with a medical diagnosis of osteoporosis. Among all fractures happened in older adults (60 years or more) in the 12 months prior to the interview, 83.3% were caused by falls.

Conclusions. Data of this investigation might help policy makers to reduce the burden of fractures, particularly among women and older adults, by stimulating prevention against household falls and osteoporosis. Special attention should be given to the poorest individuals, who have a greater likelihood of developing several negative health outcomes and presented a higher risk of fractures in the present study.
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Keywords: Fracture; Osteoporosis; Epidemiology; Falls; Musculo-skeletal disorders

Introduction

Musculo-skeletal disorders are the major global cause of severe long-term pain and physical disability, considerably reducing quality of life. The population aged >50 years is predicted to double between 1990 and 2020, and older age is related to a higher risk of osteoporotic fractures [1]. Specifically in Brazil, 11% of the population is predicted to be elderly (60 years or more) in 2020 [2]. Fragility fractures have doubled in the last decade [3]. These factors motivated several institutions, including the World Health Organization (WHO), to denominate the decade 2000–2010 as the "Bone and Joint Decade" [4]. The main goals of this initiative were (a) to reduce the social and financial cost of musculo-skeletal disorders to society; (b) to improve prevention, diagnosis and the treatment of patients; (c) to advance research on the prevention and treatment of these disorders; (d) to empower patients to make decisions about their care [4]. Unfortunately, the burden of these diseases is

* Corresponding author. Programa de Pós-graduação em Epidemiologia-Faculdade de Medicina-Universidade Federal de Pelotas-Duque de Caxias, 250-CEP: 96030-002. Fax: + 55 53 271 2645.

E-mail address: fcvsiqueira@uol.com.br (F.V. Siqueira).

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not well quantified in some regions, particularly in developing countries, where the elderly population is growing rapidly, and the health system is not ready to deal with this new age distribution [5].

A German study (age range 25–74 years) found a lifetime prevalence of any fracture of 45% for men and 31% for women [6]. In England and Wales, fracture incidence was greater among men than women until age 50 years when the gender ratio reversed [7]. Low bone density is a major determinant of fracture risk [1,8]. The lifetime prevalence of a hip fracture (known as an osteoporotic fracture) among American women aged 50 years or more was 17%, while the equivalent percentage for men was only 6% [9]. Few data on fracture frequency and related risk factors are available outside developed countries.

It was previously shown [10] that fractures could be remembered years after the event with sufficient reliability and validity (kappa value: 0.77–0.89). Furthermore, the agreement between self-reported and confirmed hip fractures was excellent (kappa: 0.80) in another study [11]. In our study, the aim was to estimate (a) the lifetime prevalence of fractures and (b) the prevalence of fractures in the previous 12 months; (c) to explore the relationship between prevalence of fractures and sex, age, skin color, socioeconomic level, schooling and medical diagnosis of osteoporosis.

Materials and methods

A multi-purpose health survey was carried out in Pelotas, a medium-sized southern Brazilian city (~320,000 inhabitants). Several health outcomes were evaluated, including voiding habits and food preferences among children, prevalence of overweight among adolescents and history of fractures among adults.

The sample was selected following a multiple-stage protocol. The primary sample units were the census tracts (CT) delimited by the Brazilian Institute of Geography and Statistics in 2000. Each of these CTs comprises approximately 300 households. After stratification for the average income of family heads, 144 CTs were sampled. Within each selected CT, the number of households was defined taking into account the size of the CT. Households were sampled within each CT following a systematic protocol. Within each sampled household, all residents aged 20 years or above were eligible for the investigation of fractures.

Estimating a reported prevalence of fractures in the previous 12 months of 2.5%, with a margin of error of 0.5 percentage points, it would be necessary to interview approximately 2500 individuals, with an excess of 10% to accommodate non-response. We also calculated the sample size required to study the association between the outcome and the independent variables, using the following parameters: confidence level of 95%, power of 80%, prevalence of fractures within the 12 months prior to the interview of 2.5%, exposure prevalence ranging from 10 to 50%, relative risk of 2.0, excess of 10% for non-response and 15% for multivariable analysis.

The outcome variables were: (a) the reported lifetime prevalence of fractures; (b) the prevalence of fractures in the 12 months prior to the interview. Among individuals who reported any fracture, we also investigated: (a) the number of fractures throughout life; (b) the anatomical location of the last fracture; (c) the place where the subject was when the fracture happened (workplace, leisure-time outside home, at home, in traffic, at school university); (d) the cause of the last fracture (sports practice, traffic accident, violence, fall, work accident).

The independent variables used were sex, age, skin color (as observed by the interviewer; this strategy is in accordance with the Brazilian Institute of Geography and Statistics studies [2]), socioeconomic level (using the classification of the National Agency of Research Institutes, which considers household assets and education of the family head, and where A is the wealthiest group), duration of schooling (highest degree completed) and medical diagnosis of osteoporosis.

Trained interviewers applied the questionnaire by face-to-face interview for each resident of the sampled households. Interviewers were not aware of the objectives and hypothesis of the investigation. For non-respondents, data on sex and age were gathered. A randomly selected sample of 10% was re-interviewed within 1–2 weeks of the original interview. This quality control aimed: (a) to supervise the interviewers' job; (b) to evaluate reliability of selected questions of the questionnaire. For this specific investigation, the question included was "Have you ever broken any bone of your body"? The kappa statistic was calculated for this question.

After descriptive and crude analyses, a multivariable Poisson regression was carried out, with estimation of adjusted prevalence ratios and 95% confidence intervals [12]. All analyses took the clustering of the sample into account.

The Ethical Committee of the Medical School of the Federal University of Pelotas approved the research protocol, and informed consent was obtained from each individual.

Results

Within the 1530 sampled households, 3214 eligible individuals were found. The non-response rate was 3.5%; therefore analyses were carried out for 3100 subjects. Non-response did not significantly differ according to age, but was more frequent (P = 0.01) among men (4.5%) than women (2.8%). However, these gender differences in non-response rates had no important effect on our prevalence estimates and analyses of variables associated with fractures.

The reported lifetime prevalence of fractures was 28.3% ($CI_{95\%}$ 26.7; 30.0). The design effect (deff) for this variable

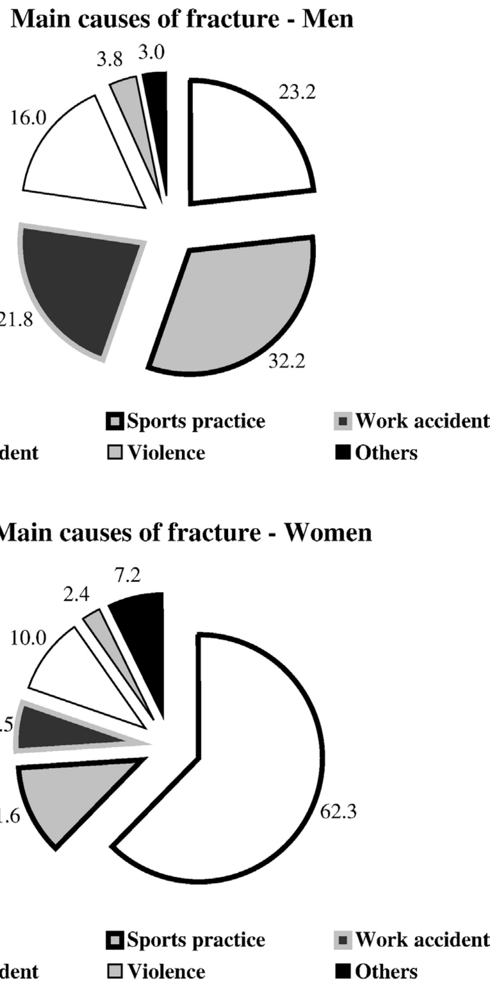

Fig. 1. Main causes of fractures for men and women.

was 1.18; the intraclass correlation was 0.010. The kappa statistic for this outcome variable was equal to 0.83. The prevalence of fractures in the 12 months prior to the interview was 2.3% ($CI_{95\%}$ 1.8; 2.9; deff 1.13).

Women comprised slightly more than half of the sample (56.6%). The average age was 43.2 (SD 16.1) years. Eighty-one percent of the subjects were classified as "white" in terms of skin color; 11% were "black"; and 8% were "mixed". While 25% of the sample subjects were classified in the wealthiest socioeconomic groups (A or B), 42% were classified in the poorest groups (D or E). The average duration of schooling was 7.7 (SD 4.4) years; 7.2% of subjects had never attended school. The prevalence of smoking was 26.7% ($CI_{95\%}$ 24.7; 28.6). The prevalence of medical diagnosis of osteoporosis was 8.0% ($CI_{95\%}$ 7.0; 9.1); 2.5% in men and 12.2% in women.

Categorizing the anatomical location of the last fracture according to four main parts of the body, hand and forearm accounted for 48.3% of all fractures; foot and leg accounted for 35.6%; trunk fractures comprised 7.1%; and head fractures accounted for 6.3%.

More than 37% of fractures occurred during leisure-time outside the home; 26% happened inside the home; 19% at the workplace; 13% in traffic. Among men, 24.2% of all fractures occurred at the workplace, 41.0% in leisure-time outside home and 15.4% inside home. Among women, the equivalent values were 11.0%, 31.5% and 40.1%, respectively.

Fig. 1 shows the main causes of fractures for men and women separately. For the whole sample, falls accounted for 39.9% of fractures; sports practice was responsible for 23.9%; work accidents comprised 15.3%; and traffic accidents accounted for 13.4%. The proportion of fractures caused by sports practice was three times higher in men (32.2%) than among women (11.6%). On the other hand, the contribution of falls to fractures was almost three times higher in women (62.3%) than among men (23.2%). Work accidents accounted for 21.8% of male fractures and only 6.5% of female ones.

The causes of fractures in the previous 12 months were markedly different according to current age. Among those aged 20–39 years, 26.7% of all fractures were caused by sports practice, while these percentages were 10.0% and 0.0% among those aged 40–59 years and 60 years or more, respectively. Among all fractures happened in older adults ($\geq$60 years) in the 12 months prior to the interview, 83.3% were caused by falls. The equivalent proportion for those aged 20–39 was 16.7%, and it was 43.3% for those aged 40–59 years.

Table 1 shows the reported lifetime prevalence of several types of fracture in the whole sample and among men and women separately. This analysis is restricted to individuals with fewer than two fractures throughout life (n = 2851;

Table 1
Reported lifetime prevalence of several types of fracture according to sex

Variable	Anatomic localization[a]							
	Foot	Ankle	Leg[b]	Hand	Wrist	Arm[c]	Clavicle	Rib
Sex[d]	P = 0.09	P = 0.82	P = 0.01	P < 0.001	P = 0.24	P < 0.001	P < 0.001	P = 0.13
Men (n = 1192)	4.5%	1.4%	3.6%	4.3%	2.4%	6.3%	3.1%	1.5%
Women (n = 1659)	3.3%	1.3%	2.1%	1.8%	1.8%	2.9%	1.0%	0.9%
Overall (n = 2851)	3.8%	1.4%	2.7%	2.8%	2.1%	4.3%	1.9%	1.2%

[a] This analysis is restricted to individuals with less than two fractures in life (92.0% of the sample).
[b] Leg, knee or femur.
[c] Arm or forearm.
[d] P values calculated using the Wald test for heterogeneity.

92.0% of the sample). Subjects who reported two or more fractures throughout life were not included in this specific analysis because we restricted the investigation of anatomical location, place of occurrence and cause to the last fracture. Fractures of the upper arm and foot were the most prevalent. Men had a significant greater likelihood of leg (including knee and femur), hand, arm (including forearm) and clavicle fractures than women. Compared to females, males were also more likely to present foot fractures, but the difference failed to reach significance.

The lifetime prevalence of fractures was 37.5% among men and 21.3% among women ($P < 0.001$). These proportions among white, mixed and black subjects were, respectively, 28.8%, 31.2% and 22.3% ($P = 0.03$). Lifetime prevalence of fractures was not associated with socioeconomic level ($P = 0.42$). The association between skin color and lifetime prevalence of fractures was significant ($P = 0.02$) even after adjusting for socioeconomic level.

Table 2 shows the prevalence of fractures within the previous 12 months according to sex, age, skin color, socioeconomic level, duration of schooling and medical diagnosis of osteoporosis. Men presented a 50% higher risk of fractures in the previous 12 months than women, but this difference was not statistically significant ($P = 0.09$). Age, skin color and schooling were not related to the risk of fractures in the 12 months prior to the interview. Individuals in the poorest socioeconomic groups presented a greater likelihood of fractures, as confirmed by the test for trend ($P = 0.009$). Individuals with a medical diagnosis of osteoporosis presented 146% more fractures than those without this diagnosis ($P = 0.009$).

Discussion

In a population-based sample of Brazilian adults and elderly (20 years or above), 28% of all individuals reported one or more fractures throughout life. Male sex and white or mixed skin color were significant risk factors for experiencing a fracture throughout life. Low socioeconomic level and medical diagnosis of osteoporosis were risk factors for fractures in the year prior to the interview. Arm/forearm fractures had the highest lifetime prevalence followed by foot, hand and leg (including knee and femur). Among men,

Table 2
Prevalence of fractures in the 12 months prior to the interview and its risk factors—crude and adjusted analyses

Variable	Crude analysis			Adjusted analysis[a]	
	%	PR ($CI_{95\%}$)	P value	PR ($CI_{95\%}$)	P value
Sex			0.07[b]		0.09[b]
Men (n = 1340)	2.8%	1.47 (0.97; 2.21)		1.43 (0.95; 2.16)	
Women (n = 1757)	1.9%	1.00		1.00	
Age (years)			0.51[c]		0.47[c]
20–29 (n = 759)	1.7%	1.00		1.00	
30–39 (n = 644)	2.6%	1.54 (0.78; 3.05)		1.64 (0.85; 3.17)	
40–49 (n = 680)	2.8%	1.63 (0.85; 3.14)		1.70 (0.90; 3.22)	
50–59 (n = 493)	2.2%	1.30 (0.60; 2.83)		1.34 (0.63; 2.83)	
60–69 (n = 274)	1.5%	0.85 (0.27; 2.65)		0.88 (0.28; 2.74)	
≥70 (n = 247)	3.2%	1.89 (0.78; 4.61)		1.92 (0.81; 4.54)	
Skin color			0.32[b]		0.50[b]
White (n = 2510)	2.2%	1.00		1.00	
Black (n = 357)	2.5%	1.14 (0.57; 2.27)		0.97 (0.48; 1.95)	
Mixed (n = 260)	3.9%	1.79 (0.84; 3.80)		1.54 (0.73; 3.28)	
Socioeconomic level[d]			0.007[c]		0.009[c]
A (wealthiest) (n = 149)	2.0%	1.00		1.00	
B (n = 626)	2.1%	1.03 (0.23; 4.59)		1.04 (0.23; 4.63)	
C (n = 1015)	2.0%	0.98 (0.24; 3.91)		0.99 (0.25; 3.97)	
D (n = 1092)	2.1%	1.05 (0.26; 4.19)		1.06 (0.26; 4.28)	
E (n = 199)	6.5%	3.24 (0.78; 13.48)		3.21 (0.77; 13.41)	
Schooling (years of formal education)			0.35[c]		0.77[c]
0 (n = 223)	4.5%	2.05 (0.83; 5.07)		1.17 (0.38; 3.59)	
1–4 (n = 587)	2.2%	1.01 (0.45; 2.28)		0.72 (0.26; 1.95)	
5–8 (n = 1011)	2.4%	1.09 (0.52; 2.29)		0.92 (0.39; 2.14)	
9–11 (n = 816)	1.8%	0.84 (0.41; 1.74)		0.81 (0.35; 1.89)	
≥12 (n = 458)	2.2%	1.00		1.00	
Medical diagnosis of osteoporosis			0.03[b]		
Yes (n = 248)	4.4%	2.07 (1.07; 3.99)		2.46 (1.26; 4.83)	0.009[b]
No (n = 2845)	2.1%	1.00		1.00	

[a] The effects of sex, age, skin color, socioeconomic level and schooling were adjusted to all other variables, except medical diagnosis of osteoporosis. The effect of medical diagnosis of osteoporosis was adjusted to all other variables with P value below 0.20.
[b] Wald test for heterogeneity.
[c] Wald test for trend, PR: prevalence ratio, CI: confidence interval.
[d] Classification of the National Association of Research Institutes, which considers schooling of the family head and household assets.

most fractures were caused by sports practice and happened in leisure-time, while, among women, most fractures were caused by falls and happened inside home.

The lifetime prevalence of any fracture found in this study (28%) was lower than the 38% reported in a German study [6]. In both studies, men were at higher risk for fractures; while in the German study, the crude prevalence ratio was 1.45, the equivalent value in our study was 1.76. In England and Wales [7], the incidence of fractures was higher in men than in women until 50 years of age; thereafter, the ratio was reversed. The different prevalence estimate between our study and the German one [6] probably reflects the fact that the German population has a greater proportion of elderly people than Brazil.

Socioeconomic deprivation was related to an increased risk of fractures among UK young adults but not among middle-aged adults and the elderly [13]. In Brazil, low socioeconomic level was associated with an increased risk of fractures in the 12 months prior to the interview.

Black skin color was related to a decreased risk of lifetime fractures even after adjustment for socioeconomic level. The higher peak bone mass in blacks compared to whites is associated with a reduced risk of bone fracture and may account for this finding [14,15]. Furthermore, blacks have lower incidences of osteoporosis and hip fracture than whites [16]. The mechanism responsible for the greater bone mass of blacks is partially due to a more efficient calcium absorption and retention in blacks compared to whites [14].

Prospective studies [8,17] have shown that low bone density is related to an increased risk of hip, wrist, foot, leg, hand, clavicle and other fractures. We found a positive relationship between medical diagnosis of osteoporosis and the risk of fractures in the year prior to the interview. We did not explore the relationship between the different types of fractures and osteoporosis because of sample size limitations.

It has been previously reported that falls are the main cause of fractures, particularly in older individuals [18]; 90% of all hip fractures in the elderly resulted from a fall [19]. In our study, 83.3% of all fractures happened among older adults ($\geq$ 60 years) in the 12 months prior to the interview were caused by falls. In a German study [6] including individuals aged 25–74 years, 43% of all fractures were caused by falls (59% in women and 33% in men). Restricting our analysis to exactly the same age-range of the study above, the equivalent value was 39% (62% in women and 23% in men).

In Brazil, 42.2% of all women and 74.1% of all men aged 20 years or more work [2]. Occupational accidents accounted for 15% of all fractures, showing their importance in Brazil, where working conditions are often dangerous, especially in the informal sector [2]. Hand and finger fractures were the most frequent at the workplace (23% of all occupational fractures). It has been previously shown that hand and finger fractures were the most frequent anatomical sites injured at work [20].

The main limitation of our investigation is the absence of data on the age of the individual when the last fracture happened. In order to avoid possible biases caused by this absence, we only explored the effects of sex, skin color and socioeconomic on the risk of fractures in the whole life because these variables do not change (or only slightly change) over time. The effects of age, schooling and osteoporosis on the risk of fractures were only explored in terms of fractures happened in the 12 months prior to the interview in order to avoid this bias.

Some strengths of this study should also be appreciated. First, the sampling strategy guaranteed a sample very similar to the last local census in terms of demographic and socioeconomic distribution. For example, in Brazil as a whole, 26% of all families are classified in the socioeconomic groups A or B, while 38% are classified in groups D or E. Within our sample, the equivalent proportions were 25% and 42%, respectively.

The low non-response rate minimizes the possibility of selection bias. Furthermore, our kappa value for the outcome variable confirmed a high degree of reliability, consistently with the German study [10], which also demonstrated that the validity of self-reported lifetime prevalence of fractures was acceptable.

To the best of our knowledge, this is the first population-based study in Brazil (and one of few outside developed countries) investigating the prevalence of fractures and related risk factors. Most studies are restricted to non-populational samples or specific types of fracture. Our data represent an important contribution from Brazil to the “Bone and Joint Decade” because one of the main goals of this initiative is to advance research on this area [4] and to quantify the burden of musculo-skeletal disorders worldwide. Future studies would benefit from asking the age of the individual when the fracture happened. Prospective studies are also warranted, particularly investigating early determinants of fractures.

Acknowledgments

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