The Prevalence of Vertebral Fractures in San Juan, Puerto Rico: a Population-based Study among Females Aged 50 Years and Over

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Objective: The participation of Puerto Rico in the Latin American Vertebral Osteoporosis Study (LAVOS) has allowed us to study the magnitude of the problem of osteoporosis in the female population residing in San Juan. The objective of LAVOS was to estimate the prevalence of vertebral fractures in Latin American women using a random sample of females selected from cities across five Latin American countries.

Methods: A probability cluster design was employed to select a random sample of households in San Juan, Puerto Rico, in order to interview 400 females aged 50 years and over. A 30-minute face-to-face interview gathered data on demographics, risk factors, and life styles. Data regarding bone mineral densities of the spine and hip by DXA and lateral dorsolumbar X-rays were obtained using international protocols; digital morphometry was used to determine vertebral deformities, with the results being classified according to Eastell criteria. This article summarizes the main findings observed in San Juan, Puerto Rico.

Results: Overall weighted prevalence of vertebral fractures was 11.2% (95% CI: 8.5%, 14.7%). Age-specific prevalence of vertebral fractures was as follows: 5.4% (95% CI: 2.7%, 10.7%) in the 50-59 years age group, 8.3% (95% CI: 4.4%, 15.1%) in the 60-69 years group, 16.2% (95% CI: 10.5%, 25.0%) in the 70-79 years group, and 22.4% (95% CI: 13.3%, 35.1%) in participants ≥80 years. Factors significantly associated with vertebral fractures were being 70-79 years old (adjusted $POR_{70\text{-}79 \text{ vs. } 50\text{-}59}$ = 2.9; 95% CI: 1.1, 7.4), being ≥80 years old (adjusted $POR_{\geq 80 \text{ vs. } 50\text{-}59}$ = 3.3; 95% CI: 1.2, 9.4), and a T-score ≤-2.5 in the lumbar spine (adjusted POR = 2.5; 95% CI: 1.5, 5.7) and in the femoral neck (adjusted POR = 3.5; 95% CI: 1.5, 8.0). Personal history of fractures was marginally associated with vertebral fractures after adjusting for the remaining risk factors (adjusted POR = 2.0; 95% CI: 1.0, 4.0). Nearly 94% of the women with vertebral fractures were not aware of their bone status. Using the WHO classification, we determined that 71% had osteoporosis, 21%, osteopenia, and 8%, normal bone mineral densities. Bone mineral densities in the lumbar spine and femoral neck were significantly lower in women with vertebral fractures. Non-vertebral fractures were more common in women with a personal history of prior vertebral fractures. The prevalence of the most common non-vertebral fractures were hip, 1% (95% CI: 0.4%, 2.7%), and wrist, 5.9% (95% CI: 4.0%, 8.7%), respectively.

Conclusion: This is the first population-based study of osteoporotic fractures in Puerto Rico and should serve as a guide to health providers and policy makers in the prevention and treatment of this disease. [*P R Health Sci J 2010;4:377-384*]

Key words: Vertebral fracture, Non-vertebral fracture, Risk factors, Osteoporosis, Bone mineral density, LAVOS, Puerto Rico

Epidemiologic studies regarding the prevalence of vertebral or other types of fractures among Latin American women are largely lacking. Haddock and colleagues described the reference values for the bone mineral densities of the lumbar spine and the proximal femur in a sample of 131 healthy Puerto Rican females aged 20 to 69 years (1). The prevalences of osteoporosis and osteopenia in a subsample of 59 women aged

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50 to 69 years in which the only risk factor was menopause were 12% and 56%, respectively (2).

Vertebral fractures are the most common osteoporotic fractures and are considered to be the hallmark of osteoporosis. Only about one-third come to medical attention, and in the evaluation of osteoporosis, seldom do physicians order radiographic examination of the thoracolumbar spine (3,4). In addition, there is a failure to recognize radiographic vertebral fractures in a clinical setting (5-6). Their presence predicts future vertebral and non-vertebral fractures (3-4, 7-13). Though emphasis has been given in the world literature to hip fractures because of their high morbidity and mortality (14-19), vertebral fractures are associated with back pain, deformities of the spine, emotional and physical disabilities, impaired quality of life, and increased mortality (20-23). So far no population-based studies of vertebral fractures have been available in Latin America. The need to assess the burden of osteoporosis in the Latin American community was broached in Mexico during a meeting of the Latin American Vertebral Osteoporosis Study (LAVOS) in which members from five Latin American cities (Puebla, Mexico, Buenos Aires, Argentina, Vitória, Brazil, Barranquilla, Colombia, and San Juan, Puerto Rico) participated (24).

The primary objective of LAVOS was to determine the prevalence of morphometric vertebral fractures in a female population aged 50 years and over in a number of urban cities in Latin America and evaluate the strength of its association with conventional risk factors for fractures and osteoporosis. Secondary objectives included ascertaining both the prevalence of non-vertebral fractures in and the average bone mineral density of women 50 years and over in several Latin American cities. We used morphometry to classify the vertebral deformities in order to compare our findings with those of the Study of Osteoporotic Fractures (SOF) and Beijing's Osteoporosis Project (8, 25).

The aim of this publication is to report the prevalence estimate of morphometric vertebral fractures and their statistical association with conventional risk factors among females living in San Juan, Puerto Rico, using the framework of LAVOS. Prevalence of hip and wrist fractures as well as the mean bone mineral densities in the groups with and without vertebral fractures are also summarized.

Material and methods

Target population

The target population was composed of non-institutionalized females aged 50 years and older residing in San Juan, Puerto Rico. In order to estimate the prevalence of vertebral fractures in this population, a complex sampling design for households was defined. This design included eight strata, formed by four age groups (50-59, 60-69, 70-79, ≥80 years), and two levels of socioeconomic status (based on median household value according to the Census 2000): above the median and at or below the median. The minimum sample size was estimated to be 400 females distributed equally in each stratum. To determine the overall minimum sample size, the following parameters were assumed: an expected prevalence of morphometric vertebral fracture of 15%, a desired precision of 3.5%, and a 95% confidence level. The sampling frame was determined using the maps of Census tracts of the municipality of San Juan provided by the Puerto Rico Planning Board (26). Taking into consideration this information, the sampling procedure was based on a cluster design (27) where the primary units were the block groups, defined by blocks of households in a specific geographical area.

The first step was the systematic selection of block groups by socioeconomic status and median age. Once the block groups were selected, a random selection of blocks was made in each selected group. Using this method, 50 blocks were selected, ensuring a balanced representation of the two levels of socioeconomic status. For each of the selected blocks, a visit was made to verify the actual number of households. Then, in the selected blocks, eight females were selected among the adult residents, ensuring that the four age groups would be equally represented. In order to attain this equal representation, the number of persons to be interviewed in each selected block was based on the goal of acquiring two females per age group as participants. If more than two females in each group were found, a simple random selection was made; if fewer than two females in a particular age group in a particular block were found, the number in the next block was increased to compensate. At the end of the study, we expected to have an approximately equal number of subjects in each age group.

Data collection

All interviewees were invited to come to the Medical Sciences Campus to fill in the study questionnaire and undergo the following procedures: lateral X-rays of the thoracic and lumbar spine (at the Radiology Department facilities of the Intramural Practice), blood sampling (in the Clinical Research Center), and bone densitometry (at the Endocrinology Unit of the Department of Medicine). All interview data were quality checked upon arriving at the research office. Whenever necessary, participants were recontacted to complete any items in the questionnaire that, for whatever reason, remained unfinished. Each site entered its data using a specifically designed Excel program that was provided by the Coordinating Center in Mexico, after which the files were sent to Mexico.

Interview

Face-to-face interviews were done using a standardized questionnaire that elicited demographic information, lifestyles, past and present clinical data, personal and family history of fractures, dietary intake of calcium, and quality of life. The same questionnaire was used by all the participating sites of LAVOS

and was based on the questionnaires used in the SOF in the United States, the Study of Vertebral Fractures in Beijing, and the European Vertebral Osteoporosis Study (EVOS).

Radiographs

Lateral radiographs of the thoracic and lumbar spine were taken with a 40" tube-to-film distance, using the same protocols employed in the SOF (28) and in accord with guidelines issued by the National Osteoporosis Foundation Group on Vertebral Fractures (29). Each center sent a package with the thoracic and lumbar X-ray films properly identified for morphometry to Mexicali, Mexico.

Morphometry

For all study sites, morphometric measurements were done by the same center in Mexicali, Mexico. Vertebral dimensions were measured according to the procedure used in the SOF, which procedure consists of the placement of six points defining the margins of each vertebral body using a cursor and backlit digitizing board (8, 30). As part of the study, two investigators from the morphometry center in Mexicali were trained at the University of California in San Francisco, in order to be able to perform the same standardized methodology that was used in the above-mentioned studies. A random sample of 40 X-ray sets was analyzed by both centers to assure quality control after the training, and an inter-observer variation was measured. Using the same set of X-rays, a definition of normal values for morphometry of the different populations at the different sites was expected to be generated during the study.

Bone densitometry

In Puerto Rico, left hip and spine bone densitometry was performed at the Endocrinology Unit (University Hospital in San Juan, Puerto Rico) using a Hologic QDR 1000W. Each study center performed its own quality control program, and cross-calibration was done using the same spine phantom. The coefficient of variation for the spine phantom in the San Juan clinic was 0.41%. The Quality Control Center for Bone Densitometry, coordinated by Dr. Sergio Ragi in Vitória, Brazil, periodically supervised the centers to assure a level of quality control in accordance with the Latin American Society of Densitometry Quality Control Program. The principal investigator and two technicians were certified by the International Society of Clinical Densitometry.

Biochemical measurements

Blood specimens were collected from participants in a sitting position by certified phlebotomists and shipped to a local reference laboratory accredited by the Clinical Laboratory Improvements Amendments Program. Complete blood count, chemistries (using a multichannel analyzer), and third-generation TSH levels were determined. All study procedures were approved by the Institutional Review Board (IRB) of the University of Puerto Rico, Medical Sciences Campus.

Statistical analysis

Overall and age-specific prevalences of vertebral fractures and osteoporosis were estimated using a logistic regression model, as follows: $p=1/[1+\exp(-\beta o)]$. The parameter estimation of this model (ßo) was performed using a generalized estimating equation to control for the intraclass correlation between subjects of the same block (31). The logistic regression model was also used to estimate the crude and adjusted prevalence odds ratios. The crude prevalence odds ratios (PORC) were estimated with 95% confidence and weighted by the inverse of the probability selection of an individual, defined for each block. The adjusted prevalence odds ratios (PORA) were validated by assessing the interaction terms in the model using the likelihood-ratio test (32). Data management and all statistical analyses were performed using the Stata statistical package for Windows, release 9 (33).

Results

A total of 515 women were invited to participate in the study, 400 (78%) of whom agreed to participate and completed all of the study procedures. Due to the difficulty in recruiting women aged 80 years and over, only 67 subjects in this age group were studied, as a result of which, the other age groups were expanded in order to reach the sample size of 400. The final age distribution of the sample was 112 participants (28%) in the 50 to 59 years age group, 109 (27.3%) in the 60 to 69 years age group, 112 (28%) in the 70 to 79 years age group, and 67 (16.7%) in the 80 years and over age group (Table 1).

Characteristics of the study group

Approximately 73% of participants had 12 or fewer years of schooling, 34.3% were married or cohabitating at the time of the interview, 82% reported an annual household income below $20,000, and the majority (95.3%) had medical insurance (Table 1). The diseases/conditions most frequently self-reported were hypertension (35.3%), osteoarthritis (23.8%), type 2 diabetes mellitus (23%), and osteoporosis (20.5%) (data not shown). Two conditions in which low bone mass can be seen, namely malabsorption and hyperthyroidism, were reported by 11 (2.8%) and 3 (0.8%) participants, respectively. When hypertension was defined as having a history of taking antihypertensive medication, the prevalence increased to 45%. The prevalence of obesity, defined as having a body mass index of at least 30.0 kg/m2, was high (40.8%), whereas that of type 2 diabetes, characterized by a fasting blood glucose of at least 126 mg/dl, was 28.8%. Around 10% of the participants self-reported cardiovascular disease, defined as having a history of angina, nitroglycerine use, coronary artery bypass grafting, myocardial

infarction, stroke or peripheral vascular disease, or percutaneous transluminal coronary angioplasty.

Table 1. Sociodemographic characteristics of the study group (n = 400)

Characteristics	n	%
Age group (years)		
50-59	112	28.0
60-69	109	27.3
70-79	112	28.0
≥80	67	16.7
Years of schooling		
0	14	3.5
1-6	84	21.0
7-12	193	48.3
>12	105	26.2
Refused to answer	4	1.0
Medical insurance		
Yes	381	95.3
No	19	4.7
Marital status		
Never married	34	8.5
Married/Cohabitating	137	34.3
Separated	14	3.5
Divorced	77	19.2
Widowed	138	34.5
Annual household income		
<$10,000	242	60.5
$10,000-$19,999	86	21.5
≥$20,000	59	14.7
Refused to answer	13	3.3

Risk factors for fractures and osteoporosis

The prevalence of a self-reported personal history of fractures was 23.7%, and a similar prevalence was self-reported for a family history of fractures (24.3%) (Table 2). The distribution of lifestyle factors was the following: 11.8% were smokers, 25.7% had been smokers, 85.3% had never consumed an alcoholic beverage, and 5.6% consumed more than 10 grams of alcohol daily, 2% were underweight (BMI<18.5 kg/m2), 65.2% had never taken hormones, 9.1% currently were taking hormones, 37.9% had had an early menopause, 56.3% had a sedentary life, 18.7% had a history of falls, and 1.5% had a lifetime history of steroid use.

Prevalence of vertebral fractures

Overall prevalence of morphometric vertebral fractures was 11.2% (95% CI: 8.4%, 14.7%) when the age distribution of the population (according to the Census 2000) was considered (Table 3). Prevalence of fractures increased with age, from 5.4% (95% CI: 2.7%, 10.7%) in the 50 to 59 years age group, to 22.4% (95% CI: 13.3%, 35.1%) in the 80 years and older age group. Of the 48 subjects with morphometric vertebral fractures, 34 (70.8%) had only one fracture, and 14 (29.2%) had 2 or more fractures. Nineteen women had had an early menopause, with an average age at menopause of 39.0±4.7 years. Among these, seven had taken hormones in the past, and three were currently taking hormones. Two women were on steroids, one for rheumatoid arthritis and one for systemic lupus erythematosus. Two had malabsorption, and one had cancer of the cervix and the colon without any clinical evidence of bone metastasis.

Table 2. Distribution of established risk factors for osteoporosis (n = 400)

Risk Factors	n	%
Family history of fractures		
Yes	97	24.3
No	292	73.0
Do not know	11	2.7
Personal history of fractures		
Yes	95	23.7
No	205	76.3
Previous history of hormonal therapy*		
Current	35	9.1
In the past	97	25.2
Never	251	65.2
Do not know	2	0.5
Smoking		
Current	47	11.8
In the past	103	25.7
Never	250	62.5
Alcohol intake		
Never	341	85.3
1-10 g/day	37	9.3
11-40 g/day	19	4.8
>40 g/day	3	0.8
Body mass index (kg/m2)		
<18.5	8	2.0
18.5-24.9	70	17.5
25.0-29.9	159	39.7
≥30.0	163	40.8
Early menopause*		
≤45 yr	146	37.9
>45 yr	239	62.1
Activity		
Sedentary	225	56.3
Active	175	43.7
History of falls		
Yes	75	18.7
No	325	81.3
Steroid therapy		
Yes	6	1.5
No	394	98.5

*15 women did not answer the question (n = 385) because they had not yet reached menopause.

Prevalence of non-vertebral fractures

Among the study group, 90 (22.5%) reported having had at least one fracture, of which 5 had a hip fracture, 25 had had a wrist fracture, 6 had had a rib fracture, and 62 had had another type of fractures (i.e., foot, arm) (Table 4). Among women who reported having had one or more vertebral fractures, 19 reported had had fractures: 2 had had a hip fracture, 4 had had a wrist fracture, 3 had had a rib fracture, and 11 had had a finger

fracture (Table 4). Among women without vertebral fractures, 70 (20%) reported having had fractures: 3 had had a hip fracture, 20 had had a wrist fracture, 3 had had a rib fracture, and 51 had had other types of fractures. The three who had sustained hip fractures were 76, 83, and 89 years at the time of the interview and had had the fractures at ages 66 (2 hip fractures, 9 months apart from each other), 60, and 87 years, respectively. All had sustained their fractures after a fall, but did not report suffering any other fractures related to that fall. The women who had suffered wrist fractures sustained those fractures anywhere from 1 to 20 years prior to the interview.

The overall weighted prevalence of non-vertebral fractures was 21.7% (95% CI: 17.9%, 26.0%) (Table 5). The weighted prevalence estimate of hip fracture and wrist fracture for the overall group was 1.1% (95% CI: 0.4%, 2.7%) and 5.9% (95% CI: 4.0%, 8.7%), respectively. Among the 80 years and older age group, the prevalence of hip fracture was 4.5% (95% CI: 1.3%, 14.2%).

Table 3. Weighted prevalence estimate of vertebral fractures

Age group (years)	Prevalence (%)	95% CI†
50-59 (n = 111)	5.4	2.7-10.7
60-69 (n = 109)	8.3	4.4-15.1
70-79 (n = 111)	16.2	10.1-25.0
≥80 (n = 67)	22.4	13.3-35.1
Overall (n = 398)	11.2	8.4-14.7

†Using logistic regression model weighting for the population size according to the Census 2000

Table 4. Distribution of self-reported non-vertebral fractures

Study group	Type of non-vertebral fracture	Number of subjects (n)	Percent (%)
Total group (n = 400)	Overall	90	22.5
	Hip	5	5.7
	Wrist	25	27.8
	Rib	6	6.7
	Other	62	68.9
With vertebral fractures (n = 48)	Overall	19	39.6
	Hip	2	10.5
	Wrist	4	21.1
	Rib	3	15.8
	Other	11	57.9
Without vertebral fractures (n = 350)	Overall	70	20.0
	Hip	3	4.3
	Wrist	20	28.6
	Rib	3	4.3
	Other	51	72.9

Bone mineral densities

Table 6 compares the combined bone mineral densities in subjects with and without vertebral fractures in the lumbar spine and the femoral neck. Mean bone mineral densities at both sites were significantly ($p<0.05$) lower in the subjects with vertebral fractures. This difference in bone mineral density was found only in the 70 to 79 years age group and consisted of 0.122 g/cm^2 for the lumbar spine and 0.072 g/cm^2 for the femoral neck ($p<0.05$). According to the World Health Organization classification system (using the T-score), 71% of the women had osteoporosis, 21% had osteopenia, and 8% were normal.

Table 5. Weighted prevalence estimate of non-vertebral fractures

Variable	Prevalence (%)	95% CI[a]
Overall (n = 400)	21.7	17.9-26.0
50-59 (n = 112)	16.1	10.8-23.2
60-69 (n = 109)	19.3	12.9-27.7
70-79 (n = 112)	23.2	15.8-32.7
≥80 (n = 67)	37.3	27.6-50.5
Hip (n = 400)	1.1	0.4-2.7
50-59 (n = 112)	-	-
60-69 (n = 109)	-	-
70-79 (n = 112)	1.8	0.4-7.6
≥80 (n = 67)	4.5	1.3-4.2
Wrist (n = 400)	5.9	4.0-8.7
50-59 (n = 112)	4.5	2.0-9.5
60-69 (n = 109)	3.7	1.4-9.4
70-79 (n = 112)	7.1	3.4-14.3
≥80 (n = 67)	11.9	5.7-23.3

[a]Using logistic regression model weighting for the population size according to the Census 2000.

Risk factors for vertebral fractures

Multiple logistic regression was used to model vertebral fractures as a function of age, family history of fractures, personal history of fractures, previous history of hormonal therapy, and body mass index. A likelihood-ratio test showed no significant interaction terms ($p = 0.13$). Vertebral fractures were significantly associated with the 70-79 years age group (adjusted POR 70-79 vs. 50-59 = 2.9, 95% CI: 1.1, 7.4) and the ≥80 years age group (adjusted POR ≥80 vs. 50-59 = 3.3, 95% CI: 1.2, 9.4) and was marginally associated with personal history of fractures (adjusted POR = 2.0, 95% CI: 1.0, 4.0) (Table 7). Family history of fractures, no history of hormonal therapy, and a BMI<30.0 kg/m2 were not significantly ($p>0.05$) associated with vertebral fractures. Laboratory parameters such as TSH, elevated fasting glucose, alkaline phosphatase, serum creatinine, and serum calcium were not associated with vertebral fractures ($p>0.05$). The statistical association between vertebral fractures and the T-score in the lumbar spine and the femoral neck was also assessed (the 15 patients who still had their menses were excluded in this analysis), and a significant association was found in those patients who had a T-score of ≤-2.5 in the lumbar spine (adjusted POR = 2.5, 95% CI: 1.5, 5.7) and femoral neck (adjusted POR = 3.5, 95%CI: 1.5, 8.0) (data not shown).

Table 6. Comparison of the combined bone mineral density measurements in the lumbar spine and femoral neck in the groups without and with vertebral fractures

Group	n	Mean (g/cm)	SD	95% CI
Lumbar Spine				
No fractures	343	0.91	0.17	0.89, 0.92
Fractures	48	0.82	0.19	0.77, 0.88
Difference		0.09		0.03, 0.13*
Femoral Neck				
No fractures	341	0.71	0.13	0.89, 0.92
Fractures	46	0.62	0.13	0.59, 0.66
Difference		0.09		0.05, 0.13*

*Two-sample t-test with equal variances ($p<0.05$)

Table 7. Logistic regression models for vertebral fractures and selected risk factors (n = 386)*

Risk Factors	$\hat{O}R_{crude}$	95% CI†	$\hat{O}R_{adjusted}$‡	95% CI†
Age (years)				
50-59	1.0	-	1.0	-
60-69	1.6	0.6-4.3	1.5	0.6-4.3
70-79	3.2	1.3-8.2	2.9	1.1-7.4
≥80	4.7	1.8-12.4	3.3	1.2-9.4
Family history of fractures				
No	1.0	-	1.0	-
Yes	0.9	0.4-1.8	1.1	0.5-2.4
Personal history of fractures				
No	1.0	-	1.0	-
Yes	2.4	1.2-4.7	2.0	1.0-4.0
Previous history of hormonal therapy				
Yes	1.0	-	1.0	-
No	2.0	1.0-4.2	1.6	0.7-3.6
Body mass index (kg/m^2)				
≥ 30.0	1.0	-	1.0	-
< 30.0	1.4	0.7-2.8	1.3	0.7-2.7

*Excluding 10 women who answered "do not know" regarding family history of fractures, 1 woman who answered "do not know" regarding previous history of hormonal therapy, and 1 woman who answered "do not know" to both questions.
†Using a logistic regression model weighting for the population size according to the Census 2000.
‡Each variable was adjusted for the others in a logistic regression model.

Discussion

This is the first population-based study in Puerto Rico to estimate the prevalence of morphometric vertebral and non-vertebral fractures in the female population aged 50 and over living in San Juan. The overall prevalence of morphometric vertebral fractures is lower than that found in the other participating sites of LAVOS (24). However, the prevalence is similar to that reported in SOF and in Beijing although lower than that reported by other European countries (34). The genetic composition of the Puerto Rican population is an admixture of Amerindian, European and African ancestors. Among the study population, 53% classified themselves as Whites, 9.3% as Blacks and 37.8% as Hispanics, replicating the American habit of labeling as Hispanic any individual belonging to any Latin American immigrant population regardless of country of origin or ethnic background. In the 2000 Census, 80% of the population in Puerto Rico stated that their race was White. With the admixture of the various races and the progressive lightening of the skin, it is very difficult to distinguish the race to which any one individual belongs, which is why such differentiation among races has not been made in this study.

Puerto Rican women have frames similar to those of Chinese women, and it is interesting that vertebral fracture prevalence is similar in both groups (ages 50 to 79 years). In the 80 years or older age group, the prevalence is lower than that of both the Chinese (27.1%) and the Caucasian American (33.9%) populations but similar to that of the African American (17.3%) population. In Puerto Rico, 28% of the eligible women refused to participate in the study, many of whom corresponded to the elderly group. Even though the same problem is encountered in many epidemiological studies, this may have resulted in an underestimation of the true prevalence of fractures in the very elderly.

Only 2 (4.2%) of the 48 patients reported having had a vertebral fracture, indicating that 95.8% of these fractures were silent, a much higher percentage than that quoted in the literature. Sixteen had an early menopause, and only two of these subjects took hormones. Since the group without vertebral fractures was larger, a higher number of non-vertebral fractures were reported by this group; nevertheless, percentagewise there was a significant increase in non-vertebral fractures in the group with vertebral fractures. The weighted prevalence for hip fractures was 1.1%, and for wrist fractures, it was 5.9%. This is consistent with previous observations that patients with vertebral fractures are more prone to develop other fractures. As observed in other populations (4,20,25,35-39), the odds of osteoporotic fractures increased with age, low bone mineral density, and history of previous fractures ($p<0.05$). Cooper and colleagues (4) found that women with vertebral fractures had an earlier menopause, fewer births, and a higher prevalence of clinically diagnosed hyperthyroidism. Even though this was not the case in our study, it is clinically significant that 16 women had an early menopause. In order to elucidate the pathogenesis of fractures, a clinical history and blood samples for chemistries, complete blood cell count, and serum level of thyroid stimulating hormone were taken. No association was found with TSH, alkaline phosphatase, serum creatinine, serum calcium, liver enzymes level, or fasting hyperglycemia. Of the 48 fractures, 3 could be classified as having been due to trauma, while the rest were osteoporotic fractures. The

combined bone mineral densities in the lumbar spine and the femoral neck were significantly lower in the group with vertebral fractures ($p<0.05$). When the World Health Organization (WHO) criteria were applied to the bone mineral densities of the group with vertebral fractures, it was determined that 71% had osteoporosis, 21% had osteopenia, and 8% had normal bone mineral densities. Thus, osteoporotic fractures may occur with normal, osteopenic, and osteoporotic bone mineral densities, as has been shown by the National Osteoporosis Risk Assessment study (40) and the SOF study (41). While in our small group of females the majority had osteoporosis, in the latter group of female populations, the majority had osteopenia. The statistical association between fractures and the T-score in the lumbar spine and femoral neck was also assessed with the logistic model. A significant association was found with a T-score of ≤-2.5 in the lumbar spine and femoral neck, again showing that the vast majority of the group was osteoporotic at the time of each one's individual fracture.

This study is the first to show the burden of osteoporosis in an elderly female population in San Juan, Puerto Rico and should serve as a guide to health providers and health policy makers in the prevention and treatment of this disease. In order to complete the epidemiological profile of osteoporosis in the community residing in Puerto Rico, it is recommended that this study be extended to the rest of the island due to the prevailing admixture of the population in Puerto Rico. Additional studies should also be designed to assess vertebral fractures in females over 80 years old. Such a study should have a higher number of subjects than the current study due to the fact that the members of this population are at high risk of osteoporosis and fractures.

Resumen

Objetivo: La participación de Puerto Rico en el Estudio Latinoamericano de Osteoporosis Vertebral (LAVOS, por sus siglas en inglés) permitió estimar la magnitud del problema de osteoporosis en mujeres puertorriqueñas residentes de San Juan. El objetivo de LAVOS fue estimar la prevalencia de fracturas vertebrales en una muestra de mujeres latinoamericanas de ciudades de cinco países latinoamericanos. Métodos: Se utilizó un diseño de muestreo probabilístico por conglomerado para obtener una muestra representativa de viviendas en San Juan, Puerto Rico con el objetivo de entrevistar 400 mujeres de 50 años o más. Las participantes completaron una entrevista personal, una radiografía lateral, una densitometría ósea y pruebas de laboratorio. Los datos sobre las densidades de la espina lumbar y de la cadera se obtuvieron mediante una densitometría ósea, y las radiografías dorsolumbares laterales se realizaron utilizando los protocolos internacionales; la morfometría digital se utilizó para determinar las deformidades vertebrales, cuyos resultados se clasificaron utilizando el criterio de Eastell. Resultados: La prevalencia ajustada para fracturas vertebrales fue 11.2% (IC 95%: 8.5%, 14.7%). Resultados: La prevalencia específica por edad fue: 5.4% (IC 95%: 2.7%, 10.7%) en el grupo de 50-59 años de edad, 8.3% (IC 95%: 4.4%, 15.1%) en el grupo de 60-69 años de edad, 16.2% (IC 95%: 10.5%, 25.0%) en el grupo de 70-79 años de edad, y 22.4% (IC 95%: 13.3%, 35.1%) en participantes de 80 años o más. Los factores asociados significativamente con las fracturas vertebrales fueron tener entre 70 y 79 años de edad (POR ajustado$_{70\text{-}79 \text{ vs. } 50\text{-}59}$ = 2.9; IC 95%: 1.1, 7.4), tener 80 años o más (POR ajustado $_{\geq 80 \text{ vs. } 50\text{-}59}$ = 3.3; IC 95%: 1.2, 9.4), y tener una puntuación *T* ≤-2.5 en la espina lumbar (POR ajustado = 2.5; IC 95%: 1.5, 5.7) y en el cuello femoral (POR ajustado = 3.5; IC 95%: 1.5, 8.0). El historial personal de fracturas se asoció marginalmente con fracturas vertebrales (POR ajustado = 2.0; IC 95%: 1.0, 4.0). Utilizando la clasificación de la Organización de la Salud, 71% de las participantes tenía osteoporosis, 21% tenía osteopenia y 8% tenía una densidad ósea normal. Las densidades de la espina lumbar y del cuello femoral fueron marginalmente más bajas en mujeres con fracturas vertebrales. Las fracturas no vertebrales fueron más comunes en mujeres con un historial previo de fracturas vertebrales. Conclusión: Este es el primer estudio poblacional de fracturas osteoporóticas realizado en Puerto Rico y podría utilizarse como una guía para los proveedores de salud y para el gobierno en la prevención y tratamiento de esta enfermedad.

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