Does Back Pain Predict Subsequent Fracture in Postmenopausal Women?

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Abstract

This longitudinal study was undertaken to determine if back pain of postmenopausal women can well predict fragility fracture during 7-year follow-up. In 1983-84, 434 Caucasian women aged 55-80 years were examined at baseline. The incidence of fractures that occurred in the following 7 years and changes of radial bone mineral density (BMD) over 5 years were obtained. There was no significant association between baseline back pain and 7-year fracture incidence after baseline assessment (OR=1.137, [95%CI 0.674, 1.916]). However, the odds ratio in the association between 7-year fracture incidence and a prior history of back pain was 1.686, [95%CI 0.925, 3.073]. This association was statistically significant (OR=2.126, [95%CI 1.409, 2.844]) when age, baseline BMD, constitution, physical activity levels, and baseline back pain were taken into account. Although pain is subject to information bias in its reporting, it is suggested that a history of previous back pain could be a good predictor for postmenopausal fracture.

Key words: Back pain, Bone mineral density, Fragility fractures, Longitudinal study, Postmenopausal osteoporosis

Introduction

Age-related fractures due to osteoporosis are a significant public health problem in the United States in terms of both the health risk and the medical cost.¹⁾ Much effort has been devoted to the search for risk factors for osteoporosis.

Back pain may be an important predictor for fracture risk but has not been widely evaluated. Few epidemiological studies have evaluated the relationship between back pain and bone mineral density (BMD) or fracture and these assessments typically use data from cross-sectional designs.^{2, 3)} No investigator has examined the longitudinal relationship or tested whether back pain could be a predictor of both BMD change and fracture incidence.

Back pain could be associated with fracture incidence through several mechanisms. It may lead to declining mobility and less mechanical strain on bones. Likewise, it could be a marker for existing low bone density being expressed as vertebral compression fractures. There is even the potential that some medications used to treat pain may exacerbate bone loss and

expand the environment for subsequent fracture. These are highly speculative hypotheses whose rationale for more intensive investigation requires that back pain be associated with lower BMD and risk of subsequent fractures.

The goal of this study is to examine whether chronic back pain self-reported by older women can be a good predictor of future fragility fractures.

Materials and Methods

1. Study Design

This study, in terms of directionality, used a prospective cohort study design, which enabled us to examine relationships with appropriate temporal direction. The primary exposure variables of this study were a report of current chronic back pain at baseline and self-report of previous chronic back pain, which we labeled 'historical back pain' in this paper. The outcome, fracture, would have occurred between baseline examination and follow-up examination 7 years later.

2. Sample population

In 1983-84, three rural communities in northwest Iowa were selected and initial baseline examinations were done. Women from two communities were evaluated in 1983 and evaluation in the third community was completed in 1984. The

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decision to sample from those communities was made because they were demographically similar with respect to population size, age distribution, proportion of foreign-born residents, mean income, and occupational categories, but had differences in the water mineral content of calcium and fluoride. The drinking water of the higher-fluoride community had a mean fluoride concentration of 4mg/l and a mean elemental calcium concentration of 15mg/l; the drinking water of the higher calcium community had 1mg/l fluoride and 375mg/l calcium; and the drinking water of the control community had 67mg/l calcium and 1mg/l fluoride. The population of each community was less than 2,000.

Women who had lived in their respective communities for at least the previous five consecutive years were eligible for the baseline examination. All participants were of northern European descent between the ages of 20 and 80, ambulatory, and not pregnant. Women who had experienced wrist or forearm fractures in the previous two years before baseline did not participate in this study because their bone remineralization might have biased measurement of radial bone mass. To meet the criteria of this study, eligible women were required to be between the ages of 55 and 80, and postmenopausal. Of the 787 eligible postmenopausal women, 70% completed the baseline interviews and BMD measurement. A fracture history was taken at the time of this baseline interview.

Radial BMDs were reexamined in 1988 or 1989, 5 years after the initial examination using the same procedure as the initial examination. Of the 551 postmenopausal women with baseline data, follow-up data were available from 434. Additionally, in 1990, a fracture history was again taken from these 434 to provide a history for a 7-year time span.

Informed consent was received prior to initiation of all interviews and all the BMD measurements. These procedures were approved by the Human Experimentation and Radiation Protection Subcommittees of the University of Michigan prior to the beginning of the process. The methods and materials of the examination have been previously described in the Iowa bone density study.^{4,5)}

3. Measurements

This was a survey of all homes in the community and all postmenopausal women from each household were eligible for enrollment. The women were interviewed at baseline and at the two following contacts. These interviews provided information that might be related to bone density such as demographic characteristics, reproductive history, medical history, current medication including estrogen therapy, and so on. The presence or absence of chronic back pain in the past year (baseline back pain) and chronic historical back pain were reported. A series of questions eliminated pain due to reproductive, menstrual or traumatic events. Details of the pain questions have been published.⁶⁾

BMDs of radius were measured at the initial examination in 1983 or 1984 and the reexamination in 1988 or 1989 by photon absorptiometry (Norland 278, Madison, WI). Radial BMD, which was expressed as the bone mineral to bone width ratio (g/cm²), was measured distally at a site one-third of the distance between the styloid process of the radius and the olecranon. Details in the BMD measurements have been described by Sowers.^{4,5)}

Fractures during the follow-up were recorded with information about their specific sites and dates. Each person was asked if

she had had a fracture and if that fracture was diagnosed by a physician. If the fractures were diagnosed by a physician, we went to the doctor's office to examine the medical records and get copies of any films which were taken. If the medical records indicated that the reported fracture was indeed a fracture, then it was analyzed as such. Data were also available to ascertain if the fracture was the result of a traumatic event.

To estimate usual physical activity of the participants, METS (ratio of working metabolic rate/resting metabolic rate) was measured by interview on the basis of seven-day total activity recall of each individual. Sallis's classifications by estimated METS⁷⁾, which we label the 'METS index' in this paper, were used for the evaluation of levels of physical activity. Each participant was measured for height and weight by a single trained observer according to standardized procedures. Height was measured to the nearest 1mm using an anthropometric plane and scale. Weight was measured to the nearest 100g using a balance beam scale. The Quetelet index was calculated by weight (kg) divided by the square of height (m²).

4. Statistical analysis

Normality of distribution was assessed for all variables with univariate analysis. Student's t-test was used to test differences of two continuous variables. The z statistic was used to compare the numbers of subjects in pairs of groups. A two-sided test was used to test the hypotheses of this study. Fracture prediction was made by using logistic regression analysis. The data were analyzed utilizing the SAS (Ver. 5. 1) statistical package.⁸⁾

Results

The age, body size characteristics, and physical activity level, at baseline, of subjects who reported current chronic back pain at baseline are shown in Table 1. Mean and standard deviation values of the two groups are presented. There were no statistically significant differences in any of those characteristics comparing women with and without chronic baseline pain.

The association between the presence of chronic baseline back pain and two dichotomous variables, change of bone mineral density over 5 years (lower or higher than the average value) and incidence of fracture (absent or present) over 7 years, are shown in Table 2 (left). The odds ratios and their 95% confidence intervals (CI) were 0.985 (95%CI 0.672, 1.445) for the 5-year change of BMD (Δ BMD) and 1.137 (95%CI 0.674, 1.916) for the incidence of fracture. There were no statistically significant

Table 1 Characteristics of women aged 55-80 years with and without current self-reported chronic back pain at baseline examination.

Characteristics	Mean (SD)			
	n	Pain* (-)	n	Pain* (+)
Age (years)	254	66.8 (7.1)	180	66.9 (7.1)
Weight (kg)	254	70.54 (14.21)	180	70.26 (12.73)
Height (cm)	254	159.1 (5.5)	180	159.1 (5.6)
QI† (kg/m ²)	254	27.86 (5.39)	180	27.77 (4.92)
BMD (g/cm ²)	254	0.616 (0.097)	180	0.627 (0.102)
METS‡ index	251	298.5 (21.6)	179	296.8 (21.0)

*Pain: chronic baseline back pain

†QI: Quetelet index

‡METS is a multiple of the resting metabolic rate.

Table 2 Contingency table of the changes in BMD (low or high) and incidence of fracture against presence of baseline back pain and historical back pain.

	Baseline pain		Odds Ratio	95% CI	Historical Pain		Odds Ratio	95% CI
	(-)	(+)			(-)	(+)		
Δ BMD*								
Lower group†	119	85	0.985	(0.672, 1.445)	67	137	1.031	(0.690, 1.541)
Higher group‡	135	95			74	156		
Fractures								
Absence	216	150	1.137	(0.674, 1.916)	125	241	1.686	(0.925, 3.073)
Presence	38	30			16	52		

* Δ BMD: change of bone mineral density over 5 years† 'Lower group': group with a lower Δ BMD value than the average‡ 'Higher group': group with a higher Δ BMD value than the average**Table 3** Number of subjects with fractures occurring in the 7-year follow-up by age for those with and without chronic baseline back pain and historical back pain.

Age	Number of subjects with fractures			
	Baseline back pain		Historical back pain	
	(-) n=254	(+) n=180	(-) n=141	(+) n=293
55-59	6/48 (12.5%)	1/37 (2.7%)	3/26 (11.5%)	4/59 (6.8%)
60-64	4/54 (7.4%)	6/31 (19.4%)	0/31 (0%)	10/54 (18.5%)
65-69	9/54 (16.7%)	7/43 (16.3%)	4/24 (16.7%)	12/73 (16.4%)
70-74	9/49 (18.4%)	6/34 (17.7%)	2/28 (7.1%)	13/55 (23.6%)
75-80	10/49 (20.4%)	10/35 (28.6%)	7/32 (21.9%)	13/52 (25.0%)
Total	38/254 (15.0%)	30/180 (16.7%)	16/141 (11.4%)	52/293 (17.7%)

cant associations between the presence of baseline back pain and those two variables. We also conducted similar analyses by using a report of historical chronic back pain as the exposure variable. The odds ratio for women with baseline back pain was 1.686 (Table 2, right).

Mean values of Δ BMD with and without baseline back pain were -0.039 (SD 0.044) g/cm² and -0.045 (SD 0.041) g/cm², respectively. There was no statistically significant difference between self-reported chronic baseline back pain and 5-year Δ BMD. Likewise, mean values of Δ BMD with and without historical back pain were -0.041 (SD 0.042) g/cm² and -0.047 (SD 0.043) g/cm², respectively, with no significant difference. Nor were there significant differences in mean values of 5-year Δ BMD between those with baseline back pain and historical back pain.

The distribution of fractures by sites was previously reported.²⁾ The incidences of fracture for each 7-year age interval for those who had baseline back pain and those who did not, are shown in Table 3 (left). There was no statistically significant relationship between baseline back pain and the incidence of fractures when the data were stratified by age. Table 3 (right) also shows the incidence of fractures for each 7-year age interval for those who had a historical back pain and those who did not. Women with historical back pain tended to have a higher incidence of fractures than those without historical back pain (p=0.086).

Finally, we examined if the probability of developing a fracture in 7 years could be predicted by baseline back pain or historical back pain, after adjusting for variables such as age, baseline BMD, Quetelet index and the METS index by using logistic regression analysis. Table 4 summarizes the models applied and the estimated coefficient with standard error of each variable. The coefficients of 'baseline BMD' and 'historical back pain'

Table 4 Summary of estimated coefficients with standard errors and their p-values in logistic regression analysis to assess the relationship between predictor variables and 7-year fracture incidence.

Predictor Variable	Estimated Coefficient	Standard Error	p-value
Intercept	-0.1296	3.2973	0.9686
Age	0.0333	0.0229	0.1447
Baseline BMD*	-3.9423	1.5710	0.0121
Baseline back pain	-0.2783	0.3227	0.3884
Historical back pain	0.7544	0.3664	0.0395
METS index	-0.0048	0.0075	0.5172
Quetelet index	-0.0153	0.0297	0.6069

*BMD: bone mineral density

were statistically significant in the model.

Discussion

It has been generally agreed that osteoporosis and osteoporotic fractures cause back pain. There were some recent cross-sectional studies which reported the association between back pain and fragility fracture in postmenopausal women. Finsen's study offered little evidence of a significant relationship between these two variables, except among the very old.²⁾ Zetterberg's data showed that the prevalence of back pain among osteoporotic fracture patients was half or less than that of a control group of the same age.³⁾

This study suggested a causal relationship between historical back pain and postmenopausal fracture. One hypothesis, that the presence of back pain accelerates radial BMD loss more rapidly

via declining mobility, might not be appropriate. The experience of having back pain in the past year did not correlate with the METS index. Instead, the causal relationship could be explained by another hypothesis, that microfractures in the osteoporotic vertebra might cause back pain.

Multivariate analysis demonstrated that the relation between fracture and historical back pain held even when data were controlled by age, baseline BMD, baseline back pain, the METS index, and the Quetelet index. This suggests that back pain is independently associated with likelihood of fracture.

Our data demonstrated that historical back pain was correlated with fractures but current back pain was not. There are two possible explanations. One is that people with historical back pain recalled more severe pain than those with current pain. Potentially, that severe pain might be more likely to be related to fracture. Another is that historical pain might be less inclusive of arthritic pain or pain due to other comorbidities while current pain might be more inclusive of arthritic pain, which does not correlate with fractures.

The relative risk of fragility fracture for those with historical back pain was estimated to be around 1.7. This might be greater than the actual value because of the definition or classification of pain status. Specifically, intensity, duration, site, or quality of pain should be further investigated for determining what kind of pain is an appropriate exposure variable. Ettinger, referring to the sites of back pain, stated that back pain other than low back pain may be more strongly associated with fracture because most osteoporotic fractures occur in the thoracic or upper lumbar spine.⁹ Furthermore, back pain is attributable to many diseases. For instance, osteoarthritis could have clinical symptoms similar to those of osteoporotic fracture. Therefore, future investigations should differentiate diseases, including prolapsed intervertebral discs, lumbar disc degeneration, osteoarthritis, trauma, osteoporosis, and spondylolisthesis in relation to low-back pain.¹⁰ The first three conditions are sufficiently prevalent that they are most likely to contribute to misclassification. Ettinger indicated that the association between pain and osteoporotic vertebral deformity was likely to be weak, but vertebral deformities cause substantial pain, especially, in case of extremely large deformity.⁹

Sample size to detect differences is also an issue. If the 7-

year incidence of fractures is 0.2 in a population having baseline back pain, and 0.1 in a population not having baseline pain, then the statistical power of this study is calculated¹¹ to be around 0.83. While adequate, this does not have the capacity to withstand the possible influence of underlying assumptions about incidence.

We must be very careful about generalizations. Pain is difficult to quantify and there are elements of pain that are more acceptable according to one's cultural orientation. Additionally, many of the participants in this rural setting actively engaged in supporting family-related farming in their youth and young adulthood. Thus, some elements of pain might have resulted from increased wear and tear on joints, which is more osteoarthritic than osteoporotic in nature.

Our data showed that historical back pain might possibly be a more important factor to anticipate future fractures. Fractures in youth are rare but Boden suggested that the significance of hip fractures in young patients may currently be underestimated.¹² He also stated that young women in the lower normal range of BMD could be at risk. Hence, back pain in youth should be further examined.

In summary, this study indicates the following: (1) Women who reported baseline or historical back pain did not have significantly lower physical activity or a lower Quetelet index at follow-up 7 years later than those who did not report pain. (2) Changes of radial bone mineral density over a 5-year period were not proved to be different between women with and without historical back pain. (3) There was a positive relationship between 7-year fracture incidence and historical back pain. This association was statistically significant (OR=2.126, [95%CI 1.409, 2.844]) when age, baseline BMD, constitution, physical activity levels, and baseline back pain were taken into account. Therefore, a history of back pain could be a good predictor of future fragility fractures.

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