

## Vertebral Fracture Status and the World Health Organization Risk Factors for Predicting Osteoporotic Fracture Risk\*

Peiqi Chen<sup>1</sup>, John H Krege<sup>1</sup>, Jonathan D Adachi<sup>2</sup>, Jerilynn C Prior<sup>3</sup>, Alan Tenenhouse<sup>4</sup>, Jacques P Brown<sup>5</sup>, Emmanuel Papadimitropoulos<sup>1</sup>, Nancy Kreiger<sup>6</sup>, Wojciech P Olszynski<sup>7</sup>, Robert G Josse<sup>6</sup>, David Goltzman<sup>4</sup>, and the CaMOS Research Group

<sup>1</sup>Eli Lilly and Company, Indianapolis, Indiana, USA

<sup>2</sup>McMaster University, Hamilton, Ontario, Canada

<sup>3</sup>University of British Columbia, Vancouver, British Columbia, Canada

<sup>4</sup>McGill University, Montreal, Canada

<sup>5</sup>Laval University, Quebec City, Canada

<sup>6</sup>University of Toronto, Toronto, Ontario, Canada

<sup>7</sup>University of Saskatchewan, Saskatoon, Saskatchewan, Canada

### Abstract

Vertebral fractures are the most common osteoporotic fracture, and patients with prevalent vertebral fractures have a greater risk of future fractures. However, radiographically determined vertebral fractures are not identified as a distinct risk factor in the World Health Organization (WHO) fracture risk assessment tool. The objective of this study was to evaluate and compare potential risk factors including morphometric spine fracture status and the WHO risk factors for predicting 5-yr fracture risk. We hypothesized that spine fracture status provides prognostic information in addition to consideration of the WHO risk factors alone. A randomly selected, population-based community cohort of 2761 noninstitutionalized men and women 50 yr of age living within 50 km of one of nine regional centers was enrolled in the Canadian Multicentre Osteoporosis Study (CaMOS), a prospective and longitudinal cohort study following subjects for 5 yr. Prevalent and incident spine fractures were identified from lateral spine radiographs. Incident nonvertebral fragility fractures were determined by an annual, mailed fracture questionnaire with validation, and nonvertebral fragility fracture was defined by investigators as a fracture with minimal trauma. A model considering the WHO risk factors plus spine fracture status provided greater prognostic information regarding future fracture risk than a model considering the WHO risk factors alone. In univariate analyses, age, BMD, and spine fracture status had the highest gradient of risk. A model considering these three risk factors captured almost all of the predictive information provided by a model considering spine fracture status plus the WHO risk factors and provided greater predictive information than a model considering the WHO risk factors alone. The

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Address reprint requests to: David Goltzman, MD, CaMOS, Royal Victoria Hospital, 687 Pine Avenue West, Room E1-59, Montréal, Québec, Canada H3A 1A1, david.goltzman@mcgill.ca.

use of spine fracture status along with age and BMD predicted future fracture risk with greater simplicity and higher prognostic accuracy than consideration of the risk factors included in the WHO tool.

## Keywords

vertebral fracture; World Health Organization tool; fracture prediction; osteoporosis

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## INTRODUCTION

The prediction of future fracture risk provides clinicians and patients with information on which to make lifestyle and treatment choices. Recently, a fracture risk assessment tool (FRAX) was developed by the World Health Organization (WHO).<sup>(1)</sup> The WHO fracture risk assessment tool considers clinical risk factors for future fracture, including age, prior clinical fracture, current smoking, alcohol use, parental history of hip fracture, glucocorticoid use, rheumatoid arthritis, and BMD, to assign a 10-yr absolute fracture risk.<sup>(2)</sup>

Vertebral fractures are the most common type of fragility fracture occurring in postmenopausal women with osteoporosis.<sup>(3-6)</sup> Many studies have shown that prevalent vertebral fractures increase the risk of new vertebral and nonvertebral fractures in postmenopausal women.<sup>(7-12)</sup> Future vertebral fracture risk is positively associated with the number of prevalent vertebral fractures<sup>(10,13-15)</sup> and the severity of the vertebral deformity.<sup>(10,14,15)</sup> The number and severity of vertebral fractures is captured in the spinal deformity index (SDI), a summary measure of spine fracture burden that is predictive of future fracture risk.<sup>(16,17)</sup> Recently, Cauley et al.<sup>(18)</sup> found that women with a prevalent vertebral fracture at baseline were more than four times more likely to experience an incident vertebral fracture over 15 yr of follow-up compared with women without a prevalent vertebral fracture. Furthermore, Siris et al.<sup>(17)</sup> showed that, at any particular value for BMD, spine fracture status increased future vertebral or nonvertebral fragility fracture risk by up to 7-fold.

It is acknowledged by the authors of the WHO tool<sup>(19)</sup> that a prior clinical vertebral fracture is an especially strong risk factor. It is also acknowledged that a fracture detected as a radiographic observation alone (a morphometric vertebral fracture) should count as a previous fracture.<sup>(19)</sup> However, most of the epidemiology studies from which this tool was developed did not include spine imaging, and therefore spine fracture status information was not available for study or for inclusion in the tool. The objectives of this analysis were to determine whether information regarding morphometric vertebral fracture status at baseline would improve prognosis of future fracture risk when added to the WHO risk factors, and, in addition, whether a more parsimonious model including some of the WHO risk factors plus morphometric vertebral fracture could provide a prognosis of future fracture risk as well as or better than the WHO risk factors.

## MATERIALS AND METHODS

### Study participants and population

The Canadian Multicentre Osteoporosis Study (CaMOS) is a prospective cohort study following a randomly selected, population-based community cohort of 9423 non-institutionalized men and women  $\geq 25$  yr of age living within 50 km of one of nine regional centers. Details of the objectives, purpose, and methodology of the CaMOS study have been reported elsewhere.<sup>(20)</sup> Briefly, recruitment for the cohort began in February 1996 and ended in September 1997. The study was approved by all regional institutional ethics review boards. All participants provided written informed consent in accordance with the Helsinki Declaration. This analysis was limited to those subjects who were  $\geq 50$  yr of age who had completed analyses of spine radiographs at baseline and year 5.

### BMD

Lumbar spine (L<sub>1</sub>–L<sub>4</sub>) and hip BMD was measured in all subjects by DXA. BMD was with Hologic QDR 1000, 2000, or 4500 densitometers at seven centers and Lunar DPX densitometers at two centers. BMD results were converted to a Hologic standard, using the method described by Genant et al.<sup>(21)</sup> Each year, a semianthropomorphic spine phantom (Siemens, Munich, Germany) was measured at each site for cross-calibration purposes.<sup>(22)</sup> BMD results used in this analysis are femoral neck measurements from the baseline assessment. The T-scores for the femoral neck were derived from CaMOS reference data.<sup>(23)</sup>

### Clinical risk factor measurement

Participants completed an extensive interviewer-administered questionnaire to assess for osteoporosis and fracture-related risk factors at baseline. A second intensive interview was conducted 5 yr after enrollment to reassess these risk factors. All clinical risk factors were derived from the baseline interview except for parental history of hip fracture, which was obtained from the year 5 questionnaires. Subject responses were coded to indicate if they were current cigarette smokers, if they had used systemic glucocorticoid therapy for  $>3$  mo without regard to dose, if they had sustained a minimal trauma fracture after 50 yr of age,<sup>(24)</sup> if their parents had hip fracture, or if they consumed  $>2$  units of alcohol/d. A subject was considered to have rheumatoid arthritis if he or she self-reported a physician diagnosis of rheumatoid arthritis.

### Fracture diagnosis

Lateral thoracic and lumbar spine radiographs obtained on all subjects  $\geq 50$  yr of age at baseline and after 5 yr were digitized and assessed at a central site (Department of Radiology, University of Alberta, Edmonton, Alberta, Canada). Fracture severity was determined by quantitative morphometric analysis of T<sub>4</sub>–L<sub>4</sub> vertebrae, with each vertebrae being assigned a severity score.<sup>(6)</sup> Deformities were graded as 0 if the height ratio was  $\geq 3$  SD below the mean of respective uninvolved vertebrae by sex; grade 1 for a mild deformity ( $>3$  but  $\leq 4$  SD); and grade 2 for a moderate deformity ( $>4$  SD). A new vertebral fracture was recorded if a normal vertebra (grade 0) became deformed (grade  $\geq 1$ ). The SDI for a subject

was defined as the sum of the individual vertebral deformity scores for each vertebra from T<sub>4</sub> to L<sub>4</sub>.

In this study, a nonvertebral fragility fracture (hip, forearm/wrist, ribs, pelvis, and other) was defined as a fracture with minimal trauma that was confirmed by either radiographic or medical report and a vertebral fracture was a fracture detected by spine radiography. The WHO fracture risk assessment tool defines a prevalent fracture as a previous fracture in adult life occurring spontaneously, or a fracture arising from trauma which, in a healthy individual, would not have resulted in a fracture. The WHO risk fracture assessment tool predicts the risk for hip fractures and of a major osteoporotic fracture (clinical spine, forearm, hip, or shoulder fracture). In our study, the risk of any fragility fracture refers to the risk of a participant experiencing either an incident vertebral fracture detected by spine radiography and/or a nonvertebral fragility fracture by annual questionnaire and confirmed by either radiographic or medical report.

### Statistical analysis

A series of logistic regression analyses were performed to determine the importance of spine fracture status and the WHO risk factors for predicting the 5-yr risk of any future vertebral or nonvertebral fragility fracture. Although the WHO fracture risk assessment tool provides a 10-yr fracture risk, it is stated that, in individuals with a low mortality, the 1-yr probability is ~10% of the 10-yr probability. To test the hypothesis that inclusion of spine fracture status along with the WHO risk factors would improve the prediction of future fracture risk, a logistic regression model that included the WHO risk factors only was compared with models including the WHO risk factors plus the following: vertebral fracture (yes/no), vertebral fracture severity (grade 0, 1, or 2), prevalent vertebral fracture number (0, 1, or 2), and SDI score (0, 1, 2, or 3). To pool the data from the sexes, the models included the interaction effects of risk factors with sex at the 10% level of significance. Because there were no statistically significant interactions, the relationship between all the risk factors and incident fracture risk was statistically consistent between the two sexes. The performance of each model was assessed as the gradient of risk (GR; i.e., the increase in fracture risk per SD [GR/SD]); this assessment was used in the development of the WHO fracture risk tool.<sup>(25)</sup> GR was also transformed as area under the receiver operating characteristic (ROC) curve (AUC) as detailed elsewhere.<sup>(26)</sup>

After these models showed that consideration of spine fracture status plus the WHO risk factors improved the prediction of future fracture risk beyond consideration of the WHO risk factors alone, further analyses were conducted to determine the predictive ability of sequential addition of the most important WHO risk factors and spine fracture status. To do this, univariate analysis was used to investigate the association between individual risk factors (age, BMD, prior fragility fractures, spine fracture status, current smoking, alcohol use, parental history of hip fracture, glucocorticoid use, rheumatoid arthritis) and future fracture risk. Spine fracture status was considered in the four different ways described above. The gradient of fracture risk was examined in different models by sequential addition of the most important risk factors determined from the univariate analyses. Five-year absolute fracture risk was estimated using the logistic regression model including the risk

factors age, femoral neck T-score, and spine fracture (yes/no). All analyses are reported for pooled data using SAS version 8.2 (SAS Institute, Cary, NC, USA).

## RESULTS

### Subject characteristics

Of 7753 subjects 50 yr of age in the original CaMOS cohort, 4744 had spine radiographs both at baseline and 5 yr, and analyses of vertebral deformities were complete in 2761 (58%). The mean age of the sample population was 64.3 yr for men ( $n = 776$ ) and 64.4 yr for women ( $n = 1985$ ). Compared with men, women had significantly lower BMD T-scores, a higher proportion had prior clinical fracture, and fewer used alcohol (Table 1). Whereas a greater proportion of women than men experienced incident non-vertebral fractures, similar proportions experienced new vertebral fractures and total fragility fractures at 5 yr (Table 1).

### Comparison of models considering WHO risk factors alone versus WHO risk factors plus spine fracture status

The performance characteristics of the models were expressed as GR/SD change in the risk indicator. The GR for the original WHO risk factors was 1.88 with an AUC of 0.67. Including spine fracture status as determined by four different methods improved the GR and AUC (Table 2). Inclusion of the vertebral fracture (yes/no), vertebral fracture severity (grade 0, 1, or 2), prevalent vertebral fracture number (0, 1, or 2), and SDI score (0, 1, 2, or 3) in the WHO model increased the GR to 2.08, 2.11, 2.10, and 2.11, respectively.

### Univariate analyses for 5-yr risk of new fractures

In univariate analyses, age provided the highest GR, followed by femoral neck BMD T-score and spine fracture status. Prior clinical fracture had the next highest GR, and other risk factors provided relatively lower GR (data not shown). Because the results were similar in men and women, multivariable analyses were performed on the combined set of men and women.

### Multivariable analyses for 5-yr risk of new fractures

The performance characteristics of models with sequential addition of the most important risk factors are shown in Table 3, expressed as GR/SD change in the risk indicator. For fracture prediction, a model that included age, BMD T-score, and presence or absence of spine fracture had a GR of 1.99. After these three risk factors were included in the model, the increment in the GR/SD by adding the six additional risk factors described in the WHO risk assessment tool was 0.09.

### Absolute risk of fracture based on age, femoral neck T-score, and spine fracture status

The 5-yr absolute risk of incident fragility fracture in the CaMOS population based on age, femoral neck T-score, and presence or absence of spine fracture is shown for women (Table 4) and men (Table 5). Results for total hip and lumbar spine BMD were similar to results for femoral neck BMD (data not shown). The fracture risk increased in both men and women with increasing age, more negative T-score, and presence of spine fracture.

## DISCUSSION

We found that consideration of spine fracture status along with the WHO risk factors provided additional information compared with considering the WHO risk factors alone. In univariate analysis, we found that spine fracture status was one of the most significant predictors of 5-yr fracture risk. In addition, we assessed models for predicting future fracture risk by sequentially adding the most important risk factors and found that a model including age, BMD T-score, and presence or absence of spine fracture provided almost as much information as consideration of all WHO fracture risk tool risk factors plus presence or absence of spine fracture. Moreover, we found that this model provided more prognostic information than consideration of the WHO risk factors alone.

In the absence of knowledge about prevalent spine fracture status, assessments based on the WHO risk factors may under- or overestimate the true risk of an individual experiencing an incident fracture. This is similar to the experience of Siris et al.,<sup>(17)</sup> who observed that, in the absence of knowledge about spine fracture status, assessments based on BMD alone may under- or overestimate the true fracture risk.

This is the first analysis to compare the importance of the WHO fracture risk factors and spine fracture status for predicting future fracture risk. We assessed spine fracture burden as a predictor of future fractures in four different ways, comparing the impact of dichotomization of the presence or absence of vertebral fractures; the number of vertebral fractures; the severity of vertebral fractures; and the SDI. Although SDI provided the best discrimination of future fracture risk in the univariate analyses, the four different methods of assessing spine fracture status provided roughly similar information in multivariate analyses, and for simplicity, we used only the presence or absence of spine fracture in the final model. Like several of the WHO risk factors that are dichotomized, clearly patients with greater spine fracture burdens have greater risk than those patients with lesser spine fracture burdens.

We previously found that a simplified risk factor system comprising age, BMD, a history of prior clinical fracture, and systemic glucocorticoid use performed approximately as well as the eight clinical risk factors comprising the WHO tool in predicting absolute fracture risk.<sup>(27)</sup> This analysis showed that age, BMD, and presence or absence of spine fracture were the most important risk factors for predicting future fracture in this population-based cohort. Consideration of these three risk factors alone provided greater predictive capacity than the risk factors included in the WHO tool. Furthermore, consideration of age, BMD, and presence or absence of spine fracture was sufficient, and little more useful risk prediction was obtained by consideration of the other risk factors in the WHO model.

An advantage of including only three variables in the assessment of future fracture risk is that predicted absolute fracture risk can be reported in simple tables such as Table 4 for women and Table 5 for men. These tables highlight the prognostic significance of spine fracture status. For example, in a 55-yr-old woman having a femoral neck T-score of  $-1$ , fracture risk was 9.4% for subjects with no spine fractures and was 21.4% for subjects with spine fractures. For those patients with age or BMD between the intervals provided in the



tables, the risk is intermediate. Practitioners assessing patients similar to those in our study for osteoporosis can therefore use age, BMD, and presence or absence of spine fracture to predict 5-yr fracture risk using these tables.

Several differences between these analyses and those performed to develop the WHO fracture risk assessment tool bear mentioning. CaMOS included serial assessments of spine radiographs, allowing us to consider spine fracture status as a determinant of future fracture risk. Additionally, inclusion of serial spine imaging in CaMOS provided the opportunity to define an endpoint of vertebral fracture and/or nonvertebral fragility fracture. It is important to note that the WHO tool provides information regarding the probability of different endpoints, including hip fracture or of a major osteoporotic fracture, defined as any hip, clinical spine, humerus, or forearm fracture.<sup>(26)</sup> Our analyses included only one cohort of patients, whereas nine cohorts were used to develop the WHO fracture risk assessment tool. As such, our results may not be as generalizable.

Our study included 5 yr of follow-up, whereas the WHO fracture risk assessment tool provides 10-yr fracture risk. In this regard, it is notable that some of the most elderly individuals in this cohort did not survive to complete spine radiographs at 5 yr, highlighting a possible limitation of using a 10-yr interval in providing osteoporotic fracture risk assessment in elderly patients.

Prevalent vertebral fracture status was assessed in our study by conventional lateral spine radiography, a technique considered the standard for identifying vertebral fractures. Nevertheless, patient inconvenience and radiation exposure could limit the performance of this test in all patients with low bone mass or osteoporosis. Furthermore, access to spine imaging may be hard to find in some jurisdictions because of limitations of equipment or expertise, and the lack of inclusion of radiographic data may have been an attempt by the WHO to keep some degree of standardization across borders, a laudable goal. Nevertheless, these issues are less likely to be impediments in regions where BMD measurements are routinely available, and BMD has been incorporated as an important component of the WHO fracture risk prediction tool in many countries in North America, Europe, and Asia. To maximize the diagnostic yield of radiographic assessment, some screening of those most in need of spine imaging might include an assessment of height loss.<sup>(28,29)</sup> Serial measurements of height showing 2 cm of height loss or history showing 4 cm of height loss should prompt spine imaging. Also, whereas morphometric vertebral fractures are sometimes described as “silent,” there is considerable innervation of the periosteum, and rather than being asymptomatic, the pain from spine fractures may resolve spontaneously and not reach medical attention. Consequently, questioning of patients about back pain, especially positional back pain, may occasionally show a history consistent with a vertebral fracture. Nevertheless, whereas symptoms of vertebral fracture may resolve or indeed be silent, and it has been estimated that only about one quarter of incident radiographic vertebral deformities are diagnosed as new clinical vertebral fractures,<sup>(30)</sup> their occurrence remains permanently detectable by lateral spine imaging, which therefore represents an important mechanism for maximizing the detection of an important risk factor. A possible alternative to lateral spine radiography, vertebral fracture assessment (VFA)—lateral spine imaging performed by DXA—at the time of BMD testing, involves less radiation exposure

and cost and is less subject to parallax distortion; however, it historically has generated images of lower resolution.<sup>(31,32)</sup>

Our study therefore showed that the use of prevalent vertebral fracture status along with age and BMD has the capacity to predict future fracture risk at least as well as or better than the risk factors included in the WHO tool but with greater simplicity. For patients for whom spine imaging is practical, our findings emphasize the degree to which spine fracture burden offers future fracture risk prediction, shows the importance of having such information as part of the routine evaluation for osteoporosis, and provides a practical approach for using this information.

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## APPENDIX: CaMOS RESEARCH GROUP

CaMOS Coordinating Center, McGill University, Montreal, Quebec: Suzette Poliquin (national coordinator), Suzanne Godmaire (research assistant), Claudie Berger (study statistician), Lawrence Joseph (consultant statistician).

Memorial University, St John's Newfoundland: Carol Joyce (director), Christopher Kovacs (co-director), Emma Sheppard (coordinator).

Dalhousie University, Halifax, Nova Scotia: Susan Kirkland, Stephanie Kaiser (co-directors), Barbara Stanfield (coordinator).

Laval University, Quebec City, Quebec: Louis Bessette (co-director), Marc Gendreau (coordinator).

Queen's University, Kingston, Ontario: Tassos Anastassiades (director), Tanveer Towheed (co-director), Barbara Matthews (coordinator).

University of Toronto, Toronto, Ontario: Sophie Jamal (co-director), Tim Murray (past director), Barbara Gardner-Bray (coordinator)

McMaster University, Hamilton, Ontario: Alexandra Papaioannou (co-director), Laura Pickard (coordinator).

University of Saskatchewan, Saskatoon, Saskatchewan: K. Shawn Davison (co-director), Jola Thingvold (coordinator).

University of Calgary, Calgary, Alberta: David A. Hanley (director), Jane Allan (coordinator).

University British Columbia, Vancouver, British Columbia: Yvette Vigna (coordinator); Brian C. Lentle (radiologist).

**Table 1**

Demographics of CaMOS Participants 50 yr of Age Who Had Assessments at Baseline and 5 yr\*

	Women (N = 1985)	Men (N = 776)	Total (N = 2761)
Age (yr) at baseline	64.4 ± 0.19	64.3 ± 0.30	64.3 ± 0.16
Prevalent morphometric vertebral fracture(s) at baseline (% yes)	20.9	19.8	20.6
Number of prevalent morphometric vertebral fractures at baseline (%)			
0	79.1	80.2	79.4
1	14.5	14.3	14.5
2	6.4	5.5	6.2
Severity of prevalent morphometric vertebral fracture(s) at baseline (%)			
0	79.1	80.2	79.4
Grade 1	12.8	13.1	12.9
Grade 2	8.2	6.7	7.8
Spinal deformity index at baseline (%) <sup>†</sup>			
0	79.1	80.2	79.4
1	10.5	10.8	10.6
2	5.9	5.3	5.8
3	4.5	3.7	4.3
Femoral neck BMD T-score at baseline <sup>‡</sup>	-1.24 ± 0.02	-0.91 ± 0.03	-1.15 ± 0.02
Prior clinical fracture at baseline (% yes) <sup>‡</sup>	15.5	6.7	13.0
Prior glucocorticoid use at baseline (% yes)	1.2	1.6	1.3
Parental history of hip fracture at baseline (% yes)	11.7	9.7	11.2
Current smoking at baseline (% yes)	12.5	13.9	12.9
Consume >2 units of alcohol/d <sup>‡</sup>	1.4	7.1	3.0
Rheumatoid arthritis at baseline (% yes)	6.3	4.7	5.9
Incident fragility fracture(s) at 5 yr			
Morphometric vertebral fracture(s) [n (%)]	238 (12.0)	105 (13.5)	343 (12.4)
Nonvertebral fragility fracture(s) [n (%)] <sup>‡</sup>	170 (8.6)	30 (3.9)	200 (7.24)
Total fractures [n (%)] <sup>§</sup>	381 (19.2)	127 (16.4)	508 (18.4)

\* Values are mean ± SE unless otherwise stated.

<sup>†</sup> Sum of maximal morphometric vertebral deformity severity scores in T4–L4 vertebrae.<sup>‡</sup>  $p < 0.01$  between women and men.<sup>§</sup> Subjects who had either vertebral or nonvertebral fragility fractures.

**Table 2**

Comparison of Predictive Ability of the WHO Risk Factors vs. the WHO Risk Factors Plus Spine Fracture Status

Model	GR/SD (95% CI) <sup>*</sup>
WHO clinical risk factors alone	1.88 (1.69–2.10) [0.67]
WHO clinical risk factors + spine fracture (yes/no)	2.08 (1.87–2.33) [0.70]
WHO clinical risk factors + number of vertebral fractures	2.11 (1.89–2.36) [0.70]
WHO clinical risk factors + severity of vertebral fractures	2.10 (1.89–2.35) [0.70]
WHO clinical risk factors + SDI <sup>†</sup>	2.11 (1.90–2.37) [0.70]

<sup>\*</sup>To determine which model offers the greatest ability for predicting the fracture risk, we also conducted a receiver operator characteristic (ROC) analysis, with the overall discriminatory ability assessed by the areas under the ROC curves (AUC) shown in square brackets.

<sup>†</sup>SDI, spinal deformity index; sum of morphometric vertebral deformity severity scores for vertebrae T4–L4.

**Table 3**

GR/SD Change in Risk Score (95% CIs) and AUC for Different Models

Model	Variable	GR/SD*
1	Age	1.62 (1.46–1.81) [0.63]
2	Age + FN BMD T-score	1.75 (1.58–1.96) [0.65]
3	Age + FN BMD T-score + spine fracture (yes/no)	1.99 (1.78–2.22) [0.69]
4	Age + FN BMD T-score + spine fracture (yes/no) + prior clinical fracture	2.01 (1.81–2.25) [0.69]
5	Age + FN BMD T-score + spine fracture (yes/no) + prior clinical fracture + parental history of hip fracture	2.06 (1.85–2.31) [0.70]
6	Age + FN BMD T-score + spine fracture (yes/no) + prior clinical fracture + parental history of hip fracture + current smoking	2.06 (1.85–2.31) [0.70]
7	Age + FN BMD T-score + spine fracture (yes/no) + prior clinical fracture + parental history of hip fracture + current smoking + prior glucocorticoid use	2.07 (1.85–2.31) [0.70]
8	Age + FN BMD T-score + spine fracture (yes/no) + prior clinical fracture + parental history of hip fracture + current smoking + prior glucocorticoid use + rheumatoid arthritis	2.08 (1.87–2.33) [0.70]
9	Age + FN BMD T-score + spine fracture (yes/no) + prior clinical fracture + parental history of hip fracture + current smoking + prior glucocorticoid use + rheumatoid arthritis + consume >2 units of alcohol per day	2.08 (1.87–2.33) [0.70]

\* To determine which model offers the greatest ability for predicting the fracture risk, we also conducted a receiver operator characteristic (ROC) analysis, with the overall discriminatory ability assessed by the areas under the ROC curves (AUC) shown in square brackets.

FN BMD, femoral neck BMD.

**Table 4**

Five-Year Risk of Incident Fragility Fracture in the CaMOS Population of Women Based on Age, Femoral Neck T-Score, and Spine Fracture (No/Yes)

Femoral neck T-score	Spine fracture	Age (yr)									
		50	55	60	65	70	75	80	85		
-1	No	7.6	9.4	11.4	13.9	16.8	20.1	23.9	28.2		
	Yes	17.9	21.4	25.4	29.8	34.7	39.9	45.3	50.9		
-1.5	No	8.6	10.6	12.9	15.6	18.7	22.4	26.4	31.0		
	Yes	20.0	23.8	28.0	32.7	37.8	43.2	48.7	54.3		
-2	No	9.8	11.9	14.5	17.4	20.9	24.8	29.2	34.0		
	Yes	22.2	26.3	30.9	35.8	41.1	46.5	52.1	57.6		
-2.5	No	11.0	13.4	16.2	19.5	23.2	27.4	32.0	37.1		
	Yes	24.7	29.0	33.8	39.0	44.4	49.9	55.5	60.9		
-3	No	12.4	15.1	18.1	21.7	25.7	30.2	35.1	40.3		
	Yes	27.3	31.9	36.9	42.2	47.7	53.3	58.8	64.0		
-3.5	No	14.0	16.9	20.2	24.1	28.4	33.1	38.2	43.6		
	Yes	30.0	34.9	40.1	45.6	51.1	56.6	62.0	67.1		
-4	No	15.7	18.9	22.5	26.6	31.2	36.2	41.4	46.9		
	Yes	33.0	38.0	43.4	48.9	54.5	59.9	65.1	70.0		



**Table 5**

Five-Year Risk of Incident Fragility Fracture in the CaMOS Population of Men Based on Age, Femoral Neck T-Score, and Spine Fracture (No/Yes)

Femoral neck T-score	Spine fracture	Age (yr)									
		50	55	60	65	70	75	80	85		
-1	No	10.5	11.5	12.6	13.8	15.0	16.4	17.9	19.5		
	Yes	21.2	23.0	24.9	26.8	28.9	31.1	33.4	35.7		
-1.5	No	11.6	12.7	13.9	15.2	16.6	18.1	19.7	21.3		
	Yes	23.2	25.1	27.1	29.2	31.4	33.6	36.0	38.4		
-2	No	12.8	14.0	15.3	16.7	18.2	19.8	21.5	23.3		
	Yes	25.3	27.3	29.4	31.6	33.9	36.3	38.7	41.2		
-2.5	No	14.2	15.5	16.9	18.4	20.0	21.7	23.6	25.5		
	Yes	27.5	29.7	31.9	34.2	36.5	39.0	41.5	44.0		
-3	No	15.6	17.1	18.6	20.2	21.9	23.8	25.7	27.7		
	Yes	29.9	32.1	34.4	36.8	39.3	41.8	44.3	46.9		
-3.5	No	17.2	18.8	20.4	22.1	24.0	25.9	28.0	30.1		
	Yes	32.4	34.7	37.1	39.5	42.0	44.6	47.2	49.8		
-4	No	18.9	20.6	22.3	24.2	26.2	28.2	30.4	32.6		
	Yes	35.0	37.4	39.8	42.3	44.9	47.5	50.1	52.7		