The discriminatory capacity of BMD measurements by DXA and dual X-ray and laser (DXL) at the calcaneus including clinical risk factors for detecting patients with vertebral fractures

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Abstract

Summary Osteoporotic fracture risk depends on bone mineral density (BMD) and clinical risk factors (CRF). Five hundred and eighty-eight untreated female and male outpatient subjects were evaluated, 160 with vertebral fractures. BMD was measured both by using calcaneal dual X-ray and laser (DXL) and dual-energy X-ray absorptiometry (DXA), and CRF were evaluated. Detection frequencies for different BMD methods with or without CRF are presented.

Introduction Osteoporotic fracture risk depends on bone mineral density and clinical risk factors. DXA of the spine/hip is considered a gold standard for BMD assessment, but due to degenerative conditions, particularly among the older population, assessment of BMD at the lumbar spine has been shown to be of limited significance. Portable calcaneal dual X-ray technology and laser can be an easily obtainable alternative.

Methods Vertebral fractures were evaluated in a baseline analysis of 588 females and males (median age 64.4, range 17.6–93.1 years), comparing BMD measurements by using DXL and DXA and CRF with/without BMD. One hundred and sixty subjects had radiological verified vertebral fractures. Area under receiver-operating characteristic curves (AUROCC) and univariate and multiple logistic regressions were calculated.

Results AUROCC for detection of vertebral fractures was comparable for DXL at calcaneus and DXA at femoral neck (DXL 0.665 and DXA 0.670). Odds ratio for prevalent vertebral fracture was generally weak for DXA femoral neck (0.613) and DXL (0.521). Univariate logistic regression among CRF without BMD revealed age, prevalent fragility fracture, and body mass index significantly associated with prevalent vertebral fracture (AUROCC=0.805). Combining BMD and CRF, a prognostic improvement in case of DXA at femoral neck (AUROCC 0.869, \( p=0.02 \)), DXL at calcaneus (AUROCC 0.869, \( p=0.059 \)), and DXA at total hip (AUROCC 0.861, \( p=0.06 \)) was observed.

Conclusions DXL was similarly sensitive compared with DXA for identification of subjects with vertebral fragility fractures, and combination of CRF with BMD by DXL or DXA further increased the discriminatory capacity for detection of patients susceptible to vertebral fracture.

Keywords Clinical risk factors · DXA spine/hip · DXL calcaneus · Vertebral fractures

Introduction

Osteoporosis is a systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone
Low bone mineral density (BMD) is a strong predictor of fragility fractures [9–11]. Dual-energy X-ray absorptiometry (DXA) of the spine and hip is considered a gold standard for assessment of BMD and diagnosis of osteoporosis according to the WHO criteria [1]. Clinical assessment of fracture risk should depend on the presence of clinical risk factors (CRF) and BMD values [12]. However, with increasing age, DXA measurement of the spine might be distorted by conditions such as scoliosis, osteoarthritis, degenerative conditions, or compression fractures which further decreases the sensitivity of this method. In addition, DXA measurement of the hip and spine requires large and expensive scanners which have to be fixed securely in a specialized room and is therefore limited to specialized centers.

Therefore, alternative methods such as BMD measurement of the calcaneus, which would be less prone to degenerative alterations, would offer an attractive alternative [13]. Calcaneal bone is similar in structure to the vertebrae, and it consists mainly of trabecular bone (up to 90 %) [12]. In general, trabecular bone may be affected earlier by the loss of bone mass since its turnover rate is six to eight times higher compared with that of the cortical bone [14]. It has been shown that calcaneal BMD is a useful method for predicting fracture risk [15, 16].

The technique of calcaneal BMD measurement has been improved by combining DXA with a laser measurement of heel thickness [dual X-ray and laser (DXL)] [17, 18]. In comparison to conventional DXA, the DXL device (Calscan® DXL) is a portable trolley, easy to use, and less expensive. In addition, these measurements are less time consuming (taking about 1 min), effective radiation dose is low (<0.2 μSv), and even immobile patients or patients with problems in positioning the hip can be scanned. Consequently, misclassification of bone and soft tissue can be reduced. Several studies suggest that BMD measurements with Calscan® DXL may well reflect the actual bone status [19–21].

Low BMD is an important component of fracture risk, but there are other risk factors which contribute to skeletal fragility. Therefore, a distinction should be made between the diagnosis of osteoporosis solely based on BMD and the assessment of future fracture risk. In addition, some risk factors provide extra information to BMD and could, therefore, be used to enhance risk prediction with BMD. Clinical studies and meta-analyses have identified CRF for future fractures such as age, parental history of hip fracture, previous fragility fracture, etc. [10, 12, 22]. CRF are an integral part of a calculation tool which has been developed to assess an individual 10-year fracture risk (FRAX®) for categorizing individuals into risk groups according to their individual fracture risk and setting intervention thresholds [23, 24].

The hypothesis of this study was to test if BMD measurements of different skeletal sites and through different techniques have different abilities to discriminate between subjects with osteoporosis and/or prevalent osteoporotic vertebral fractures. The aim was to investigate the impact of CRF alone or in combination with DXA and DXL measurements on the capacity of detecting these patients.

The primary objectives of this study were to compare the ability of two different techniques of BMD measurements (DXA and DXL) by receiver-operating characteristic (ROC) curves and kappa scores at different skeletal sites with regard to sensitivity and to identify patients with vertebral fractures. Secondary objectives were the calculation of ROC curves of clinical risk factors with or without BMD measurements at different skeletal sites and the identification of significant CRF in our study population.

**Methods**

**Patients**

Between July 2009 and June 2010, 2,789 Caucasian outpatient female (n=2,287) and male (n=502) subjects were referred for evaluation of osteoporosis to a specialized tertiary referral bone center in Vienna, Austria. In this manuscript, baseline characteristics of the study population of a preplanned 5-year follow-up study are presented. Patients with high-trauma fractures, premenopausal women, patients with malignancies, or immobile individuals were excluded from the analysis as well as subjects who had previously received any specific osteoporosis treatment except calcium and/or vitamin D. All subjects had a complete clinical work-up, including medical history, spinal X-ray (anterior-posterior+lateral), and laboratory testing. Furthermore, circulating serum levels of calcium, phosphorus, 25-hydroxyvitamin D, and intact parathyroid hormone were measured. The participant disposition is shown in Fig. 1.

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Clinical risk factors

At baseline, CRF according to the FRAX® algorithm were collected for each individual [24, 29].

Fractures

All patient self-reported fractures were verified by medical history and former doctor’s letters. Fragility fractures were defined as any fall from standing or lower height.

X-ray

Digital spine X-ray scans with a special bone software application for enhanced delineation of osseous structures of each subject were assessed, and vertebral fractures were evaluated by two experienced and certified radiologists using a semiquantitative technique [25]. A height reduction of ≥20 % was considered as a vertebral fracture. We did not categorize vertebral fractures into different grades. In case of differences in deciding, whether a vertebral fracture was present or not, another independent radiologist, who was blinded as well, was involved in the diagnostic process.

Assessment of BMD

BMD of the total hip, femoral neck, and lumbar spine were measured using a DXA scanner (iDXA®, GE Healthcare Lunar, Madison, WI, USA). BMD assessments of the calcaneus were performed by DXL (Calscan®, Demetech AB, Taby, Sweden). Both measurements were performed consecutively by the same well-trained and International Osteoporosis Foundation–International Society for Clinical Densitometry-certified technician.

Daily cross-calibrations with standardized control phantoms (iDXA®, aluminum spine phantom serial number 32619–2; Calscan®, aluminum heel phantom serial number 031410–04) were conducted for validation of both devices. The in vivo precision error of iDXA, expressed as coefficient of variation (CV) is 0.41 % for the lumbar spine and 0.53 % for total hip [26], but recently, published data report a CV of iDXA at the femoral neck of even 0.94 % up to 1.36 % [27]. The CV for DXL at the heel is 1.19 % [20].

Both devices were equipped with the latest available software for analysis (iDXA®, Encore 13; DXL Calscan® Version 1.3.1), and all measurements in one individual were performed on the same day. BMD was expressed as absolute BMD values (in gram per square centimeter) and T-scores. The manufacturers’ reference databases on female and male Caucasian subjects were used for both devices [28].

Statistical analyses

Comparison of age, weight, and BMI between groups of patients was performed by using a two-sample t test. Osteoporosis was defined as T-score ≤−2.5 SD, osteopenia as T-score ≤−1.0 SD, and of >−2.5 SD. T-scores >−1.0 SD were considered as normal values for DXA and DXL. Using this classification, the weighted kappa coefficient was calculated to describe the agreement between different BMD measurements.
The McNemar test was used to test for statistically significant differences in the detection of osteoporosis.

Sensitivities, specificities, and receiver-operating characteristic curves were calculated to describe the accuracy of the BMD measurements with regard to the probability of vertebral fractures. The area under ROC curves (AUROC) of different DXL and DXA measurements was compared.

Univariate and multiple logistic regression models were used to evaluate the impact of CRF for vertebral fractures. In addition, global AUROC for these risk factors was calculated. Then, BMD measurements and T-scores were included in this model in case of statistical significance. The impact of the factors considered in the logistic regression models are described by odds ratios (OR) and 95% confidence intervals (CI). All p values are results of two-sided tests, and p values of <0.05 were taken to indicate statistical significance.

Results

Patient characteristics

Five hundred and eighty-eight subjects were included in the analysis, 494 postmenopausal women and 94 men. Median age of the participants was different, 62.8 years (range 25.5–90.2) and 68.9 years (17.6–93.1) for males and females, respectively. At least one prevalent vertebral fracture identified by X-ray was detected in 160 (27%) subjects; 40% were clinical vertebral fractures, and 60% were morphometric vertebral fractures. Among these 160 patients, there were 87 (54%) patients with 1 vertebral fracture, 52 (33%) patients with 2 vertebral fractures, and 21 (13%) patients with ≥3 vertebral fractures (Tables 1 and 2). In general, these patients were older, [74.4 years (range 37.5–93.1) vs. 65.7 years (17.6–92.9); p<0.0001] and had a higher body mass index (BMI; 26.5±5.2 vs. 25.0±4.9 g/cm²; p=0.002) compared with subjects without vertebral fractures (Table 3).

Table 1 Baseline characteristics of all patients of the analysis (n=588) including age, BMI, gender, vertebral fracture status, and BMD measurements expressed as T-scores

<table>
<thead>
<tr>
<th></th>
<th>Women (n=494)</th>
<th>Men (n=94)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median age [years (range)]</td>
<td>68.9 (17.6–93.1)</td>
<td>62.8 (25.5–90.2)</td>
</tr>
<tr>
<td>Mean BMI (g/cm²), ±SD</td>
<td>25.4±5.1</td>
<td>25.5±4.2</td>
</tr>
<tr>
<td>Without vertebral fracture, n (%)</td>
<td>364 (74)</td>
<td>64 (68)</td>
</tr>
<tr>
<td>With vertebral fracture, n (%)</td>
<td>130 (26)</td>
<td>30 (32)</td>
</tr>
<tr>
<td>1 vertebral fracture</td>
<td>72 (83)</td>
<td>15 (17)</td>
</tr>
<tr>
<td>2 vertebral fractures</td>
<td>43 (83)</td>
<td>9 (17)</td>
</tr>
<tr>
<td>≥3 vertebral fractures</td>
<td>15 (71)</td>
<td>6 (29)</td>
</tr>
</tbody>
</table>

Among our patients with vertebral fractures, there were 130 females (81%) and 30 males (19%). These percentages are in line with the gender distribution of the female and male study population (84% females vs. 16% males). More than 60% (97/160 patients) of all fractures were fragility fractures and not related to any adequate trauma. Clinical signs in these patients were sudden or chronically persistent back pain. Fragility fracture and alcohol intake of more than 3 units per day were the most discriminating risk factors in patients with prevalent fractures.

BMD measurements and detection frequency

Subjects with normal BMD, osteopenia, and osteoporosis were identified by BMD measurements (in gram per square centimeter) and by calculation of T-scores at different locations according to each manufacturer’s database.

Detection frequency of subjects with a T-score of less than –2.5 was higher with DXL compared with DXA. These differences were statistically significant for all comparisons of DXL and DXA (p<0.0001). The detection frequency of osteopenic subjects was comparable for all measurements. Agreement of the different T-score measurements was evaluated by the kappa coefficient. Agreement is highest if values are close to +1 and random for a value close to or less than 0. Different DXA measurements only slightly conformed with DXL, with kappa coefficients ranging from 0.319 to 0.341.

Identification of patients with prevalent vertebral fractures

The value of BMD measurements and T-scores to identify patients with prevalent vertebral fractures was evaluated by univariate logistic regression models (Table 4). Odds ratios for a change in BMD by 0.1 g/cm² and T-score by 1.0 were estimated for each method comparing patients with and without vertebral fractures. Odds ratio was lowest for calcaneal DXL (OR 0.521), higher for DXA at the femoral neck, total hip, and lumbar spine (OR 0.613, 0.680, and 0.810, respectively; p<0.001 for all comparisons). Evaluated T-scores gave almost identical findings compared with BMD.

ROC analysis

For the estimation of sensitivity and specificity of calcaneal DXL and DXA at different sites, ROC curves were calculated. ROC analysis of BMD showed the best performance for DXA at the femoral neck (AUROC 0.670), followed by DXL at the calcaneus (AUROC 0.665) and DXA at the total hip (AUROC 0.661). Compared with these tests, DXA of the lumbar spine had the lowest sensitivity according to ROC (AUROC 0.598). The difference between DXA of
the lumbar spine and DXL at the calcaneus was statistically significant ($p=0.04$) (Figs. 2 and 3a).

ROC analysis of T-scores revealed similar results: calcaneal DXL showed the best performance (AUROCC 0.687), followed by DXA at the femoral neck (AUROCC 0.667) and DXA at the total hip (AUROCC 0.667); DXA at the lumbar spine had the lowest discriminatory value (AUROCC 0.607; $p=0.02$ for comparison of DXA at the lumbar spine and DXL at calcaneus.

Univariate and multiple logistic regression analyses

Potentially associated risk factors for fractures were analyzed by univariate logistic regression. Using this model, age (OR 1.038), fragility fracture (OR 24.516), and body mass index (1.05) were statistically significantly associated with fracture probability, with an AUROCC of 0.805 (Table 5, Fig. 3b). Global AUROCC was 0.853, resulting from the multiple logistic regression model when considering all CRF simultaneously.

Taking into account the BMD measurements at different sites in addition to the CRF in the multiple regression model, the DXA at the femoral neck was an independent statistically significant factor ($p=0.02$). DXL at the calcaneus and DXA at total hip or lumbar spine were not statistically significant (Table 6).

When T-scores at different sites were considered in addition to the clinical risk factors, this showed a statistically significant effect for DXL ($p=0.022$), DXA at the femoral neck ($p=0.01$), and DXA at the total hip ($p=0.03$). Again, change in DXA at the lumbar spine was not statistically significant ($p=0.2$).

Multiple logistic regression analyses, which included BMD measurements or T-scores, revealed that fragility fracture, alcohol intake of >3 units/day, and BMD measurement were statistically significant risk factors in combination with DXA at the femoral neck. AUROCC improved to 0.869 (Table 6; Fig. 3c).

For BMD measurements using calcaneal DXL, the only statistically significant factors were age and fragility fracture, increased alcohol intake, but not BMD. AUROCC was 0.861. Using T-scores of calcaneal DXL, the only statistically significant factors were age and fragility fracture; AUROCC was 0.863.

Discussion

In the current study, DXA, the gold standard for BMD measurement, was most sensitive when measured at the femoral neck, whereas measurement at the lumbar spine had a very low ability to detect patients with vertebral fragility fractures [30, 31]. In contrast to clinical studies with highly selected patients, a mixed and untreated population was recruited into this study, thus reflecting a situation of daily practice.

Morphometric vertebral fractures are frequently diagnosed during screening for osteoporosis [32]. Accordingly,
in this study, fragility fractures were diagnosed in 60% of patients with fractures and about one fifth of all patients tested. Patients with prevalent fragility fractures had a significantly higher BMI and advanced median age compared with subjects without fractures. The mean BMI of 26.6 in the vertebral fracture population is significantly higher than the BMI observed in the population without vertebral fractures. This is in line with previous findings suggesting that these patients are out of the protective BMI window of 18–25 and that an increased BMI is not associated with a lower number of fractures [29, 31]. Using diagnostic categories as suggested by the WHO (normal BMD, osteopenia, and osteoporosis), we discovered that the number of patients classified as osteoporotic was comparable among the different methods of BMD measurements. These findings are supported by previously published clinical studies on heel DXL [19, 21, 33]. Therefore, calcaneal DXL might be an effective alternative to conventional DXA measurements, especially in geographical regions where DXA is not available or in situations in which DXA scans might not be feasible, e.g., for immobile patients or patients with severe osteoarthroses.

Regarding the identification of subjects with prevalent vertebral fracture, low BMD determined by DXA at the femoral neck and by DXL at the calcaneus generally is superior compared to measurements at the lumbar spine. However, when BMD measurements were solely considered, their sensitivity and specificity were only moderate.
Therefore, only BMD measurement, regardless of the method applied, is a not very reliable means in identifying subjects with increased vertebral fractures.

In contrast to this, presence or absence of CRF had a much higher discriminative ability compared with BMD measurements [34]. Analysis of CRF showed that a prevalent fragility fracture was the most important risk factor for vertebral fractures. The odds ratio of 24.5 is unexpectedly high compared with previously published analyses, which showed an approximately eight times increased risk [35]. However, mean age of subjects included in this study was lower than those in previous studies, i.e., there were no community dwelling or immobile patients in this study. Combination of BMD measurement with CRF analysis revealed similar results: previous fragility fracture was, by far, the strongest indicator for identification of patients with prevalent vertebral fractures. In contrast, other significant risk factors according to CRF analysis—e.g., increased age or body mass index—lost statistical CRF with BMD measurements at the hip and calcaneus further increased discriminatory capacity for detection of patients with vertebral fractures [24]. AUROCC improved by 30 % to 0.869 for DXA at the femoral neck and DXL at the calcaneus.

**Table 5** Univariate logistic regression analyses of CRF without BMD measurements in patients with vertebral fractures

<table>
<thead>
<tr>
<th>CRF</th>
<th>OR (95 % CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>1.038 (1.02; 1.056)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>1.010 (0.996; 1.024)</td>
<td>0.1762</td>
</tr>
<tr>
<td>Hip fracture of a parent (yes vs. no)</td>
<td>0.780 (0.344; 1.768)</td>
<td>0.5521</td>
</tr>
<tr>
<td>Fragility fracture (yes vs. no)</td>
<td>24.516 (13.461; 44.649)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Current smoking (yes vs. no)</td>
<td>0.713 (0.288; 1.311)</td>
<td>0.2765</td>
</tr>
<tr>
<td>BMI (g/cm²)</td>
<td>1.050 (1.008; 1.094)</td>
<td>0.0206</td>
</tr>
<tr>
<td>Rheumatoid arthritis (yes vs. no)</td>
<td>0.638 (0.201; 2.023)</td>
<td>0.4456</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>0.974 (0.356; 2.662)</td>
<td>0.9591</td>
</tr>
<tr>
<td>Alcohol intake (&gt;3 units/day)</td>
<td>1.644 (0.62; 4.082)</td>
<td>0.2843</td>
</tr>
<tr>
<td>Secondary osteoporosis (yes vs. no)</td>
<td>0.805 (0.413; 1.569)</td>
<td>0.5239</td>
</tr>
</tbody>
</table>

Therefore, only BMD measurement, regardless of the method applied, is a not very reliable means in identifying subjects with increased vertebral fractures.

In contrast to this, presence or absence of CRF had a much higher discriminative ability compared with BMD measurements [34]. Analysis of CRF showed that a prevalent fragility fracture was the most important risk factor for vertebral fractures. The odds ratio of 24.5 is unexpectedly high compared with previously published analyses, which showed an approximately eight times increased risk [35]. However, mean age of subjects included in this study was lower than those in previous studies, i.e., there were no community dwelling or immobile patients in this study. Combination of BMD measurement with CRF analysis revealed similar results: previous fragility fracture was, by far, the strongest indicator for identification of patients with prevalent vertebral fractures. In contrast, other significant risk factors according to CRF analysis—e.g., increased age or body mass index—lost statistical CRF with BMD measurements at the hip and calcaneus further increased discriminatory capacity for detection of patients with vertebral fractures [24]. AUROCC improved by 30 % to 0.869 for DXA at the femoral neck and DXL at the calcaneus.
respectively. There was no difference whether BMD was determined at the hip or calcaneus. In the combined model, again, age, prevalent fragility fracture, increased alcohol intake, and BMI were the most specific parameters [31, 36]. T-scores at the hip and calcaneus were comparable to absolute BMD values in identifying patients, and AUROC was similar.

One of the limitations of this study is its retrospective design. Another limitation is the relatively small number of 588 female and male subjects included in this study. Therefore, the discriminatory ability with regard to hip fractures could not be analyzed in this study, due to the low number of cases. On the other hand, our population represents a homogenous collective of patients. However, a prospective study of more than 4,000 Swedish women demonstrated that prediction of hip fractures is feasible by calcaneal DXL [37].

Results from this study underline that BMD measurement is a necessary and useful tool in determining patients with fractures. Both DXA and DXL scans proved to provide feasible data although the detection rates for osteoporotic BMD measurements expressed as a T-score of $< -2.5$ were significantly higher for calcaneal DXL compared with DXA of the spine or hip. However, risk stratification for individual vertebral fracture risk as well as decisions on antiresorptive treatment should not be based solely on BMD. In the absence of CRF, none of the different BMD measuring methods alone proved to be sensitive or specific enough to identify fracture patients. In addition to BMD measurements, a thorough history of CRF including any prior low-trauma fracture, regardless of the age of occurrence and spinal X-ray, is essential [7, 38].

In conclusion, none of the BMD measurements alone are comparable to the discriminative power of the CRF alone. Our data demonstrate that BMD measurements by DXA at the femoral neck or DXL at the calcaneus are comparable in regard to identifying patients with prevalent vertebral fractures. Therefore, DXL measurements might be a feasible, cheaper, and an easy transportable alternative in regions where DXA is not available.

### Acknowledgments
Vinforce receives academic funding grants.

### Conflicts of interest
None.

### References

### Table 6 Multiple logistic regression analysis of CRF including BMD measurements at femoral neck and calcaneus in patients with vertebral fractures

<table>
<thead>
<tr>
<th>CRF</th>
<th>DXA femoral neck</th>
<th></th>
<th>DXL calcaneus</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95 % CI)</td>
<td>p value</td>
<td>OR (95 % CI)</td>
<td>p value</td>
</tr>
<tr>
<td>Age</td>
<td>1.019 (0.992; 1.046)</td>
<td>0.1653</td>
<td>1.028 (1.002; 1.054)</td>
<td>0.0369</td>
</tr>
<tr>
<td>Hip fracture of a parent (yes vs no)</td>
<td>1.023 (0.964; 1.051)</td>
<td>0.1456</td>
<td>1.121 (0.844; 1.157)</td>
<td>0.3451</td>
</tr>
<tr>
<td>Fragility fracture</td>
<td>20.944 (10.540; 41.618)</td>
<td>&lt;0.0001</td>
<td>23.938 (12.532; 45.724)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Current smoking</td>
<td>1.002 (0.387; 2.593)</td>
<td>0.9967</td>
<td>0.949 (0.397; 2.272)</td>
<td>0.9071</td>
</tr>
<tr>
<td>BMI (g/cm²)</td>
<td>1.065 (0.985; 1.151)</td>
<td>0.1123</td>
<td>1.027 (0.968; 1.090)</td>
<td>0.3755</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>0.254 (0.035; 1.873)</td>
<td>0.1789</td>
<td>0.329 (0.055; 1.979)</td>
<td>0.2246</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>2.979 (0.478; 18.56)</td>
<td>0.2422</td>
<td>1.939 (0.360; 10.452)</td>
<td>0.4411</td>
</tr>
<tr>
<td>Alcohol intake (&gt;3 units/day)</td>
<td>3.896 (1.051; 14.446)</td>
<td>0.042</td>
<td>2.935 (0.860; 10.016)</td>
<td>0.0856</td>
</tr>
<tr>
<td>Secondary osteoporosis</td>
<td>1.087 (0.349; 3.387)</td>
<td>0.8857</td>
<td>1.214 (0.439; 3.358)</td>
<td>0.7087</td>
</tr>
<tr>
<td>BMD (g/cm²)</td>
<td>0.676 (0.481; 0.949)</td>
<td>0.0237</td>
<td>0.754 (0.498; 1.143)</td>
<td>0.1831</td>
</tr>
</tbody>
</table>


