## Osteoporosis: risk factors and diagnostic approach

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2010

***document version***
Publisher's PDF, also known as Version of record

## Chapter 5

# Additive value of Vertebral Fracture Assessment in case-finding for osteoporosis in patients with a fracture.

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*(Submitted)*

## ABSTRACT

**Objective** This study presents the results of the implementation of a case-finding strategy for osteoporosis in patients with a recent fracture, according to the Dutch Osteoporosis Guidelines, and investigates the additive value of Vertebral Fracture Assessment (VFA).

**Design** The study was performed in a university hospital and in a large municipal hospital. 1435 patients of 50 years and older with a recent fracture were invited to participate. They received a questionnaire on risk factors for fractures and subsequently underwent a BMD measurement. A sub-sample of 372 patients was additionally invited for VFA. A treatment advice was based on estimated absolute 10-years hip, wrist or vertebral fracture risk and BMD results.

**Results** Assessment was completed by 554 (39%) patients including 121 men (63.7 ± 10.4 years) and 434 women (66.2 ± 9.7 years). From those, 22.3% of men (n=27) and 30.3% of women (n=131) were diagnosed with osteoporosis (T-score ≤ -2.5). The most common risk factors for fracture were low body weight, previous fracture, and use of a walking aid in both sexes. Prevalent vertebral fractures were diagnosed by VFA in 40 from 149 patients (27%). Of those, 23 (58%) had a T-score>-2.5 and would not be diagnosed properly without VFA.

**Conclusions** The case-finding approach was successfully implemented in two hospitals. VFA proved to be an important tool in diagnosing prevalent vertebral fractures and an important step in case-finding.


## INTRODUCTION

Osteoporosis is often diagnosed at the stage where fractures have already occurred. The diagnosis is usually based on risk factors followed by bone densitometry, referred to as a case-finding approach. A fracture in a woman above the age of 50 years is one of the most important risk factors for future fracture which should lead to bone mineral density (BMD) assessment (1).

While North American Guidelines recommend screening by bone densitometry in women aged over 65 years, all European Guidelines, including the Dutch (Osteoporosis Second Guidelines), currently advise a case-finding approach in which individuals are selected for bone densitometry on the basis of clinical risk factors (1,2). Major risk factors such as age and prior fracture figure in many guidelines.

Since the publication of the results of the fracture liaison service in Glasgow (a program for the evaluation and management of patients with osteoporotic

fracture) (3), many fracture and osteoporosis (FO) outpatient clinics emerged in the Netherlands to improve the identification of patients with osteoporosis and to make recommendations for treatment (4-6). Assessment for Osteoporosis in Glasgow proved to be very successful, with up to 31 % of the patients for which the general practitioner received recommendations for treatment with bisphosphonates or raloxifene (3).
The aim of this project was to implement a case-finding strategy for osteoporosis in patients with a recent fracture diagnosed at the Department of Trauma Surgery according to the Dutch Osteoporosis Guidelines, to access the acceptance of this strategy, to determine types of fractures associated with osteoporosis in our population, and to make treatment recommendations for general practitioners (GPs) using BMD measurements and the estimated absolute 10-years fracture risk. As the main objective, we evaluated the additive value of Vertebral Fracture Assessment (VFA) as a tool in diagnosing prevalent vertebral fractures, in this case-finding approach.

## METHODS

*Subjects*
All patients of 50 years and older who came to the Department of Trauma Surgery of the VU University Medical Center (VUmc) or Emergency Department of Slotervaart Hospital (SH) with a fracture were invited to participate. Polytrauma patients, patients with more than two fractures, and patients with skull fractures were excluded. From January 2003 till January 2004, 1063 patients were invited for the main study in both hospitals. In addition, from January 2004 till July 2004, 372 patients from VUmc were invited for the amended protocol, including Vertebral Fracture Assessment (VFA) of the spine. In total, 1435 patients were approached (Figure 1). All of them received a letter with information about osteoporosis, a questionnaire on risk factors, and an invitation for BMD measurement. The detailed analysis was based on those who underwent the complete assessment (questionnaire and BMD measurement). Those who sent back the questionnaire but did not undergo BMD measurement formed the group of incomplete assessment. Those who refused to participate and those who did not react at all, were analyzed as non-participants. In the latter group, limited information was available (age, sex, type of fracture, and sometimes the reason for refusing), and this was analyzed to investigate the acceptance of the assessment by patients in our population. Informed consent was obtained from all participants and the study was approved by the Ethical Review Board of the VUmc.

*Risk factors*

Questionnaires included risk factors for fractures. Five risk factors (recent fracture, low body weight (< 60 kg), prevalent vertebral fracture, serious immobility, and use of corticosteroids >7.5 mg per day) were used to calculate the total risk score and the estimated absolute 10-years risk for a hip, wrist or vertebral fracture according to the Dutch Guidelines (1). Other risk factors such as other previous fractures after the age of 50 years, hip fracture in mother, type of fracture and some other (Table 2) were also assessed. Type of fracture was dependent on localization: we considered wrist, subcapital humerus, hip, and vertebral fracture as osteoporotic.

*BMD*

The BMD was measured at the Departments of Radiology of both VUmc and Slotervaart Hospital, using a Hologic QDR 4500, Delphi A (Hologic Inc., Waltham, MA, USA). In patients of 50-60 years, BMD of the lumbar spine (L1-L4,grams/cm2) was measured, while in patients who were older than 60 years, both BMD of lumbar spine and of non-dominant hip were measured. From the two measurements (lumbar spine or total hip), the worst outcome was used for diagnosis, according to WHO criteria (T-score≥-1 = normal BMD, -2.5<T-score<-1 = osteopenia, T-score≤-2.5 = osteoporosis).

*VFA*

Single-energy 12 s morphometry scans (VFA) were performed using the Hologic Delphi A densitometer at the VUmc, with the scanner arm in lateral position. The scans were performed and evaluated in one single session after BMD measurement of the spine and hip by a skilled radiological technician. VFA scan images were evaluated on a visual display unit. Software markers (software version 12.3.3.) for quantitative analysis of scan images were displayed for each vertebra from in general T4 to L4 and were adjusted by hand, allowing accurate vertebral height measurements. Each scan was then checked on the presence of vertebral fractures by the investigator (NK) and clinician with expertise in the field of osteoporosis (PL). The two observers identified vertebral deformities independently, and differences in judgment were adjudicated by consensus between the two observers. On indication (in case of doubt or poor image quality of VFA), additional thoracic or lumbar spine radiographs were made. Fracture evaluation on both VFA images and spine radiographs was performed qualitatively and then graded semiquantitatively using the Genant classification as mild (grade 1, 20-25% height loss), moderate (grade 2, 25-40% height loss), or severe (grade 3,

>40% height loss) fracture (7). The presence of a prevalent vertebral fracture was used in the estimation of total risk score along with other risk factors. The three semiquantitative categories were analyzed together owing to small numbers.

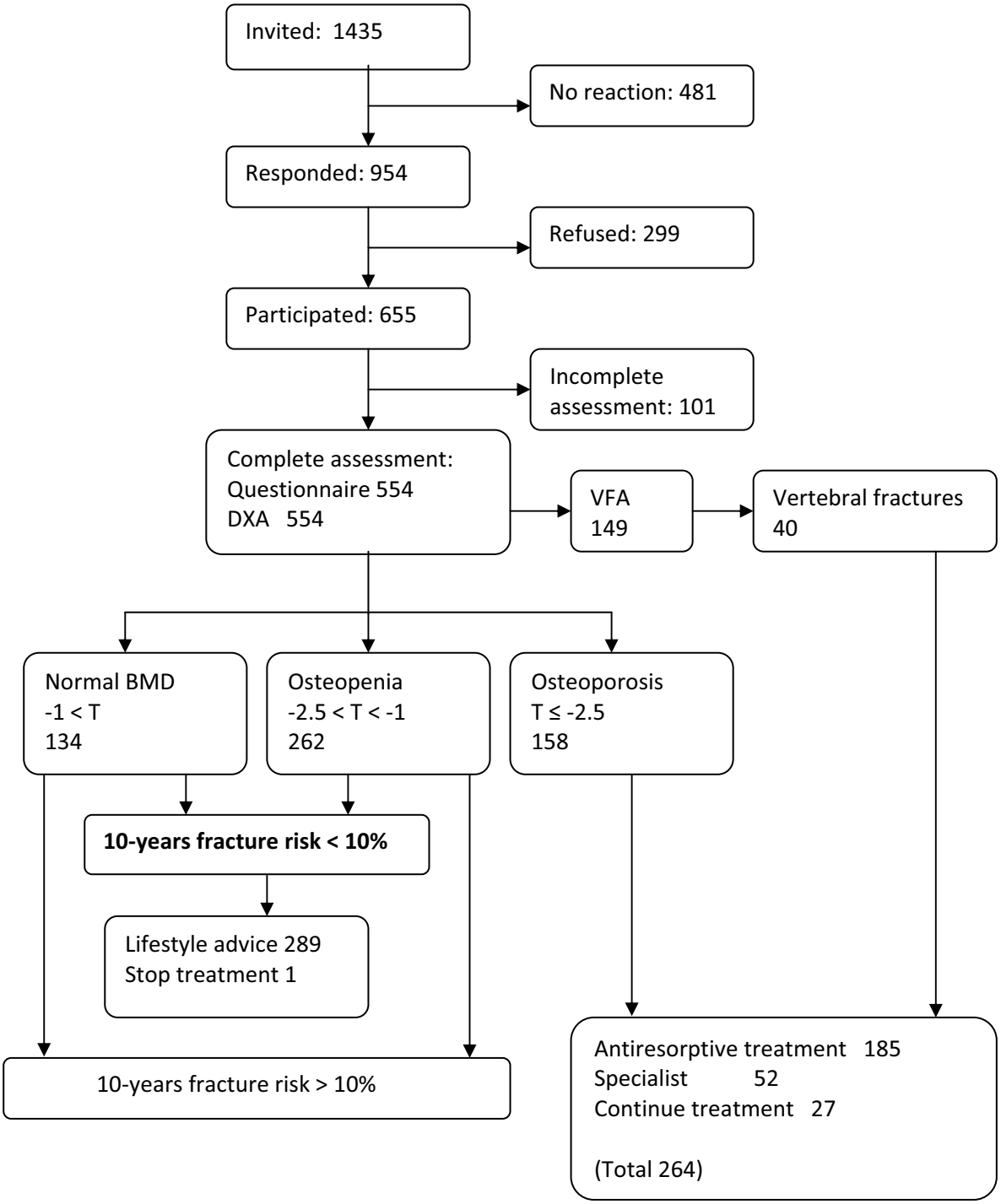
*Recommendation*

The results of the case-finding (estimated absolute 10-years fracture risk and BMD) were used to make the treatment recommendations for the patients and their GPs. The five possible advices included lifestyle advice (with sufficient dietary calcium intake and vitamin D when sunlight exposure was insufficient), antiresorptive treatment (bisphosphonates or raloxifene), referral to a specialist, continuation of treatment in patients already on antiresorptive medication, or stop treatment.

*Statistical analyses*

The data were analyzed using SPSS 14.0 Software. All analyses were performed in men and women separately due to differences in age and fracture type between both sexes. For the analysis of non-response, one-way ANOVA with Bonferroni post-hoc analysis was used to compare response groups. Differences between groups with and without vertebral fracture were tested using Chi-Square analysis.

**Figure 1.** Flow-diagram for the case-finding for osteoporosis and treatment advice.



## RESULTS

In total, 1435 patients (336 men and 1099 women) with 1498 fractures were invited to participate in the study. Figure 1 shows a flow-diagram of all data. Slightly more than a half of these (n=765, 53.3%) had one or two fractures considered osteoporotic fractures (such as wrist fracture, subcapital humerus fracture, hip fracture, or vertebral fracture), wrist fracture being the most common (n=401, 26.8%). Other patients (n=670, 46.7%) had fractures which are not traditionally associated with osteoporosis (hand, finger, foot, toe, ankle, other).

There was a difference in the percentage of osteoporotic fractures according to sex: 36.4% of men (n=122) and 61.5% of women (n=677) had fractures which are considered osteoporotic, and 2.7% of men (n=9) and 4.8% of women (n=53) had a second fracture on admission.

In men, fractures of the wrist were most common (n=46; 13.4%), followed by hand or fingers (n=40; 11.6%), ankle (n=37; 10.8%), hip (n=36; 10.5%), and foot or toes (n=33; 9.6%). In women, the most common fractures were those of the wrist (n=355; 30.8%), followed by subcapital humerus (n=176; 15.3%), hip (n=137; 11.9%), foot or toes (n=88; 7.6%), and hand or fingers (n=87; 7.5%).

Complete assessment was underwent by 35.8% of men (n=121) and 39.5 % of women (n=433), including both the questionnaire and BMD measurement (Table 1). Reasons for non-participation were given by 299 patients of the total number of 780. The main reasons for refusing were similar in men and women: “not interested” (39.7%), followed by “physical or mental illness” (26.7%), “circumstances” (11.3%), “death” (10.0%), “already treated” (6.3%) and “unknown address” (6.0%). In the second part of the study (VFA protocol), we approached those who did not react to the first letter within 6 weeks, with a reminder in order to increase participation. This increased the response to 80.4%, participation to 50.0%, and complete assessment to 42.2% (data not shown). Men in the complete assessment group (63.7±10.4 years) had similar age to men with incomplete assessment or men who did not respond at all; whereas men who refused to participate, were older (71.6±13.0 years). In women, the complete assessment group (66.2±9.7 years) was significantly younger than all other response groups. The distribution of fracture types in men was similar in the “complete assessment” and “no reaction” group. Women in the “complete assessment” group had less osteoporotic fractures in comparison to other response groups (data not shown). Further results concern only the complete assessment group.

**Table 1.** Age of patients at inclusion in different response groups.

| Response group | Age at inclusion | | | | | |
|---|---|---|---|---|---|---|
| | Men | | Women | | Total | |
| | N (%) | Mean±SD | N (%) | Mean±SD | N (%) | Mean±SD |
| Participation: Complete assessment | 121 (35.8) | 63.7±10.4 [b] | 433 (39.5) | 66.2±9.7 | 554 (38.6) | 65.6±9.9 |
| Participation: Incomplete assessment [a] | 28 (8.4) | 63.1±10.2 [b] | 73 (6.6) | 74.4±11.4 [c] | 101 (7.0) | 71.3±12.2 [d] |
| Participation: *Total* | *149 (44.2)* | *63.6±10.4* | *506 (46.1)* | *67.3±10.4* | *655 (45.6)* | *66.5±10.5* |
| Non-participation: Refused assessment | 67 (20.0) | 71.6±13.0 | 232 (21.1) | 79.5±9.9 | 299 (20.8) | 77.8±11.2 |
| Non-participation: No reaction | 120 (35.8) | 63.4±11.8 [b] | 361 (32.8) | 74.5±11.3 [c] | 481 (33.5) | 71.7±12.4 [d] |
| Non-participation: *Total* | *187 (55.8)* | *66.3±12.8* | *593 (53.9)* | *76.5±11.0* | *780 (54.4)* | *74.0±12.3* |
| **Total** | ***336 (100)*** | ***65.1±11.8*** | ***1099 (100)*** | ***72.3±11.7*** | ***1435 (100)*** | ***70.6±12.1*** |

[a] incomplete assessment included only DXA without questionnaire in three patients, and only questionnaire without DXA in the rest.
[b] no difference between the groups in men, tested by one way ANOVA with Bonferroni post-hoc analysis.
[c] no difference between the groups in women, tested by one way ANOVA with Bonferroni post-hoc analysis.
[d] no difference between the groups in men and women together, tested by one way ANOVA with Bonferroni post-hoc analysis.

**Table 2.** Prevalence of fracture risk factors in different BMD diagnosis groups for men and women with a recent fracture.

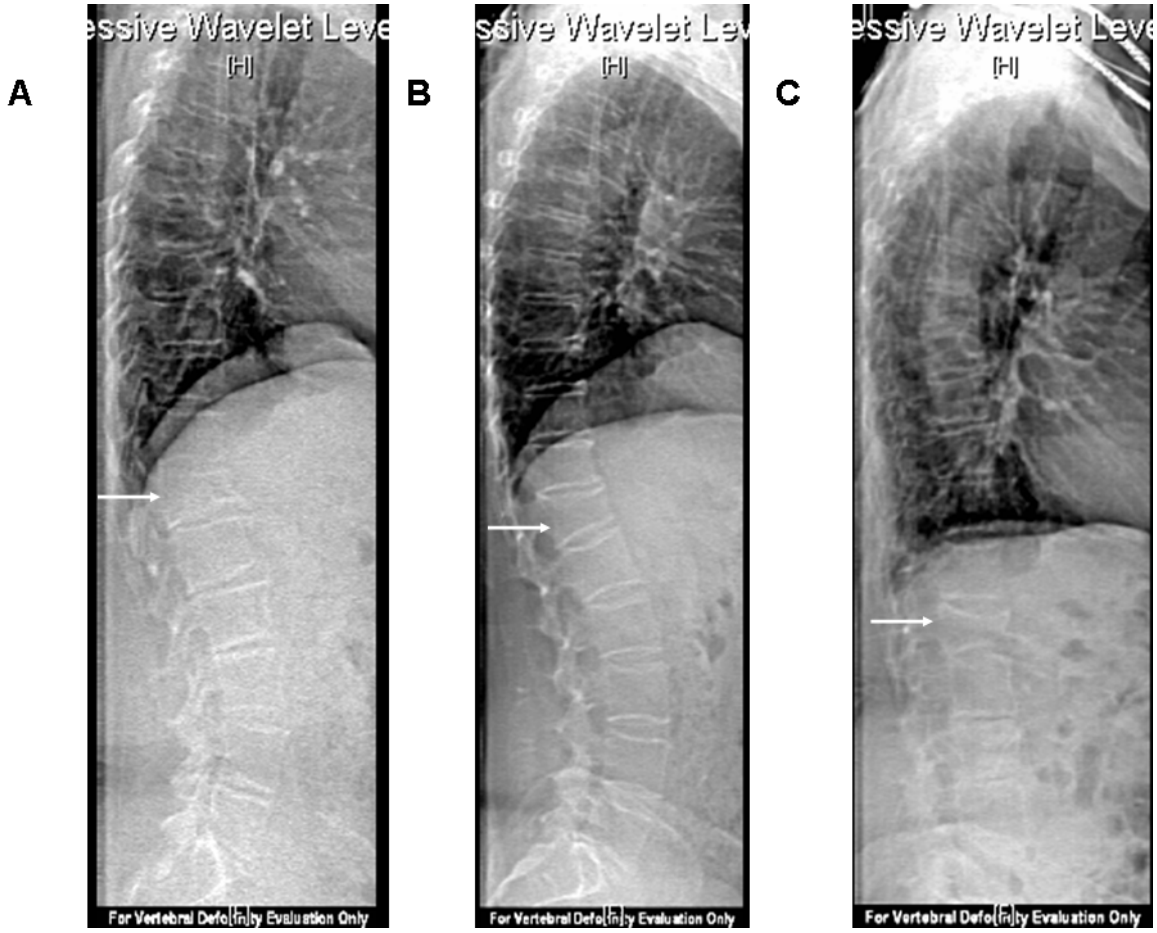
| *Risk factors* | *Men* | | | *Women* | | |
|---|---|---|---|---|---|---|
| | Normal | Osteopenia | Osteoporosis | Normal | Osteopenia | Osteoporosis |
| | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) |
| Recent fracture (inclusion, n=554) | 37 (100) | 57 (100) | 27 (100) | 97 (100) | 205 (100) | 131 (100) |
| Osteoporotic fracture [a] | 9 (24.3) | 25 (43.9) | 11 (40.7) | 40 (41.2) | 112 (54.6) | 89 (67.9)*** |
| Ankle fracture | 6 (16.2) | 7 (12.3) | 0 (0) | 18 (18.6) | 14 (6.8) | 8 (6.1)** |
| Hand, finger, foot, toe | 13 (35.1) | 8 (14.0) | 5 (18.5) | 18 (18.6) | 39 (19.0) | 18 (13.7) |
| Other fracture | 9 (24.3) | 17 (29.8) | 11 (40.7) | 21 (21.6) | 40 (19.5) | 16 (12.2) |
| One or more previous fractures [b] | 3 (8.1) | 13 (22.8) | 9 (33.3)* | 15 (15.5) | 48 (23.4) | 33 (25.2)*** |
| >3 cm shorter | 2 (5.4) | 6 (10.5) | 7 (25.9) | 11 (11.3) | 46 (22.4) | 48 (36.6) |
| Hip fracture in mother | 3 (8.1) | 9 (15.8) | 3 (11.1) | 9 (9.3) | 26 (12.7) | 17 (13.0) |
| Use of walking aid | 3 (8.1) | 5 (8.8) | 8 (29.6)* | 9 (9.3) | 29 (14.1) | 30 (22.9)* |
| Low body weight (< 60 kg) | 0 (0) | 2 (3.5) | 6 (22.2)*** | 4 (4.1) | 37 (18.0) | 47 (35.9)*** |
| Self-reported vertebral fracture | 1 (2.7) | 4 (7.0) | 3 (11.1) | 3 (3.1) | 7 (3.4) | 6 (4.6) |
| Severe immobility | 0 (0) | 3 (5.3) | 1 (3.7) | 0 (0) | 9 (4.4) | 5 (3.8) |
| Corticosteroids >7.5 mg/day | 0 (0) | 3 (5.3) | 0 (0) | 2 (2.1) | 3 (1.5) | 1 (0.8) |
| Additional VFA assessment (subgroup, n=149) | 6 (100) | 13 (100) | 4 (100) | 34 (100) | 58 (100) | 34 (100) |
| Diagnosed vertebral fracture | 2 (33.3) | 6 (46.2) | 1 (25.0) | 6 (17.6) | 9 (15.5) | 16 (47.1)* |

[a] hip, wrist, humerus, or vertebral fracture.

[b] after the age of 50 .

* p<0.05, ** p<0.01, *** p<0.001 difference between osteoporosis and normal BMD group, tested by Bonferroni post-hoc analysis.

**Figure 2.** VFA in diagnostics of the vertebral fractures in three patients with a wrist fracture.




**A**, 67-year old woman, BMD at lumbar spine is T= -1.3; Th12 has a height loss of 33% (moderate fracture). **B**, 70-year old woman, BMD: T= -2.0 at lumbar spine and T= -1.6 at total hip; Th12 has a height loss of 40% (severe fracture). **C**, 77-year-old woman, L1 has a height loss of 50% (severe crush fracture).

**Table 3.** Prevalence of fracture risk factors and BMD diagnosis in patients without or with prevalent vertebral fracture in a subgroup of 149 patients with VFA.

| | *Diagnosed vertebral fracture* | |
|---|---|---|
| | No | Yes |
| *Risk factors* | N (%) | N (%) |
| Recent fracture (inclusion) | 109 (100) | 40 (100) |
| Osteoporotic fracture [a] | 52 (47.7) | 26 (65.0) |
| Ankle fracture | 13 (11.9) | 4 (10.0) |
| Hand, finger, foot, toe | 16 (14.7) | 1 (2.5)* |
| Other fracture | 28 (25.7) | 9 (22.5) |
| One or more previous fractures [b] | 26 (23.9) | 16 (40.0)* |
| >3 cm shorter | 17 (15.6) | 12 (30.0)* |
| Hip fracture in mother | 10 (9.2) | 2 (5.0) |
| Use of walking aid | 14 (12.8) | 13 (32.5)** |
| Low body weight (< 60 kg) | 15 (13.8) | 12 (30.0)* |
| Self-reported vertebral fracture | 6 (5.5) | 9 (22.5)** |
| Severe immobility | 2 (1.8) | 1 (2.5) |
| Corticosteroids >7.5 mg/day | 1 (0.9) | 1 (2.5) |
| Normal BMD | 32 (29.4) | 8 (20.0) |
| Osteopenia | 56 (51.4) | 15 (37.5) |
| Osteoporosis | 21 (19.3) | 17 (42.5)** |

[a] Hip, wrist, humerus, or vertebral fracture.
[b] After the age of 50.
* p<0.05, ** p<0.01, difference between groups without and with vertebral fracture, tested with Chi-Square.

Overall, 22.3% of men (n=27) and 30.3% of women (n=131) were diagnosed with osteoporosis according to WHO definition with a T-score ≤ -2.5 (Table 2). VFA was performed in 149 patients (23 men and 126 women). Vertebral fractures were diagnosed in 9 men and 31 women. In women with osteoporosis, prevalent vertebral fracture was, together with osteoporotic type of fracture, the most common of all risk factors: it was diagnosed in 47% of women with osteoporosis. The prevalence of low body weight, previous fractures, and use of walking aid (immobility) was common in patients with osteoporosis of both sexes, while the prevalence of severe immobility, use of corticosteroids of > 7.5 mg/day and a self-reported vertebral fracture, was low. Table 3 shows that the prevalence of risk factors such as previous fractures, low body weight, use of walking aid, loss of

height > 3 cm, self-reported vertebral fracture, and a T-score ≤ -2.5 were more common in patients with a diagnosed vertebral fracture than in patients without. Table 4 shows the frequencies and percentages of men and women in different risk groups for developing a hip, wrist, or vertebral fracture in the coming 10 years. These 10-years absolute risks were estimated for each individual patient based on self-reported risk factors and patient's age. (1) As can be seen in Table 4, almost 95% of men and 80% of women had a 10-years risk of less than 10% for developing a hip, wrist, or vertebral fracture, based on self-reported risk factors. This percentage drops to 82% for men and 70% for women with addition of the information on diagnosed vertebral fracture by VFA. In these estimations, only clinical risk factors, and not BMD, were taken into account. Treatment recommendations were prepared, based both on the absolute 10-years risk of hip, wrist or vertebral fracture, and on BMD (Figure 1).

**Table 4.** Absolute 10 years risk for hip, vertebral or wrist fracture in patients with a recent fracture.

| *Risk group* | Absolute 10 years risk for hip, vertebral or wrist fracture * | | | | | |
|---|---|---|---|---|---|---|
| | Men | | | Women | | |
| | Hip N (%) | Vertebra N (%) | Wrist N (%) | Hip N (%) | Vertebra N (%) | Wrist N (%) |
| Risk assessment without VFA, n=405 | | | | | | |
| <10% | 93 (94.9) | 94 (95.9) | 98 (100) | 252 (82.1) | 243 (79.2) | 251 (81.8) |
| 10-20% | 3 (3.1) | 4 (4.1) | 0 | 49 (16.0) | 55 (17.6) | 56 (18.2) |
| 20-30% | 2 (2.0) | 0 | 0 | 5 (1.6) | 9 (2.9) | 0 |
| >30% | 0 | 0 | 0 | 1 (0.3) | 0 | 0 |
| Risk assessment with VFA, n=149 | | | | | | |
| <10% | 19 (82.6) | 19 (82.6) | 23 (100) | 93 (73.8) | 85 (67.5) | 84 (66.7) |
| 10-20% | 2 (8.7) | 4 (17.4) | 0 | 19 (15.1) | 17 (13.5) | 37 (29.4) |
| 20-30% | 2 (8.7) | 0 | 0 | 10 (7.9) | 23 (18.3) | 5 (4.0) |
| >30% | 0 | 0 | 0 | 4 (3.2) | 1 (0.8) | 0 |

* Calculated from the tables of Dutch Osteoporosis Guidelines(1), based on the total risk score of 5 fracture risk factors (fracture after the age of 50 years, body weight<60 kg, prevalent vertebral fracture, severe immobility, use of corticosteroids >7.5 mg/day), adjusted for age. Note: the two groups presented here include different patients.

## DISCUSSION

In this study, we implemented the case-finding approach for osteoporosis in patients with a recent fracture, recommended by the Dutch Osteoporosis Guidelines (1). We combined the clinical risk score assessment with BMD measurement and later also with the assessment of prevalent vertebral fracture by VFA to optimize the diagnostic process. Although the acceptance of this approach by the patients was less than 50 % (39% of approached patients underwent complete assessment), it is comparable to 30% achieved in a study with a similar design (6). The strength of our study is mainly in its realistic approach. First, we asked the patients once by letter whether they wanted to participate and to be tested for osteoporosis. In the amended protocol, we tried to increase response by sending reminding letters to the patients when they did not respond within 6 weeks. This action slightly increased the percentage of complete responders. The percentage of responders may grow in the future when awareness of osteoporotic fractures increases in the general population. Case-finding may further improve with establishing a fracture and osteoporosis outpatient clinics with a specialized nurse, whose main task is to offer BMD and VFA-measurements to the patients of 50 years and older with a fracture (3-6).

From the assessed clinical risk factors, well-established risk factors such as one or more previous fractures after the age of 50 years, low body weight, and osteoporotic type of fracture, were common risk factors in patients of both sexes with osteoporosis, in accordance to other studies (8-10). However, the definition of osteoporotic fracture varies in literature. As fractures of spine, wrist, humerus and hip are common osteoporotic fractures (11-13), we used this definition in our study, but other fractures also are associated with low BMD (14). Furthermore, in a recent study, almost all types of fractures had an increased incidence in women with low BMD (15).

A diagnosed vertebral fracture appeared to be the most common risk factor in women, with a prevalence reaching 47% in the osteoporosis group. In the literature, very strong associations were observed between prior and subsequent vertebral fractures (16). Women who develop a vertebral fracture, are at substantial risk for an additional fracture within the next years, ranging between 20-25% in different studies (17,18). In the MORE trial, baseline vertebral fracture severity was the best independent predictor for a new vertebral and nonvertebral fracture (19). In our study, if no VFA were performed, 8 men (34.8%) and 15 women (11.9%) with vertebral fractures would not have been diagnosed and treated, as BMD T-score was higher than -2.5. This percentage is not as high as

was found in another study, where the authors concluded that between 26-60% of osteoporotic individuals would have potentially been missed if no VFA would have been used (20), but is similar to another Dutch study on VFA (21). However, our data show that although the prevalence of vertebral fractures is highest in women with T-score < -2.5, VFA still has important additive value for staging of osteoporosis (Figure 2).

In clinical practice, the diagnosis of osteoporosis is made either by BMD measurement of lumbar spine or hip, or by the presence of a vertebral fracture. Therefore, for men in our study, in whom prevalent vertebral fractures were more observed in patients with normal BMD or osteopenia, the additive value of VFA was high. For these patients, antiresorptive treatment is recommended independently of BMD results (1).

So, in attempt to predict 10-years fracture risk, it is vital to introduce this risk factor into the model. Although fast diagnosis of a vertebral fracture using VFA together with BMD measurement is not always available, plain radiographs of the thoraco-lumbar spine, which are still the gold standard for diagnosis, are available everywhere. Therefore, the assessment of fracture risk can not be complete without vertebral fracture assessment. In our study, only 22.5% of patients with prevalent vertebral fractures reported these in the questionnaire before the assessment (Table 3). Recently, a special model (FRAXTM) for prediction of osteoporotic fractures with the use of clinical risk factors with or without BMD was developed in the UK (22) and was proposed as a tool for risk fracture assessment in the new European Guidance (23). The addition of vertebral fracture status to BMD may improve the predictive value of BMD alone (24). Therefore, we believe that the best tool for the case-finding of osteoporosis will be a combination of the clinical risk factors, vertebral fracture status and BMD.

Following the diagnosis, letters with treatment recommendations for the GPs were sent. We advised an antiresorptive treatment in all patients with a T-score ≤-2.5 SD. This was in accordance to the study from the UK showing that in women at the threshold of osteoporosis with a T-score of -2.5 SD, it was cost-effective to intervene if there was a history of a prior fracture, irrespective of age (25). The same study found that in women with a T-score of < -2.5 SD, it was also cost-effective to intervene, irrespective also of the presence or absence of a prior fragility fracture. In patients with a T-score being normal or representing osteopenia, we have chosen an intervention threshold (IT) at absolute 10-years hip, wrist or vertebral fracture risk of 10%. A recent study of the international thresholds for the treatment of osteoporosis revealed that in different countries, the IT varied from a hip fracture probability of 5.6% in Japan to 14.7% in Spain,

and was used along with fracture risk prediction algorithms to improve the selection of patients for treatment (26). In the UK, the 10-year probability of a major osteoporotic fracture at which intervention becomes cost-effective is approximately 7.5%, which is comparable to the Netherlands, according to the population risk of a hip fracture (23). We believe that the approach with the use of the results of BMD and vertebral assessment on the one side, and clinical risk factors with absolute 10-years fracture risk on the other side, can easily be used in general practice. Some years ago, the Dutch Osteoporosis Guidelines were evaluated by 5 external osteoporosis experts who found that the guidelines scored high for development, clarity and presentation, but low for piloting among target users and implementation (27), but several implementation studies have been conducted since then, both in outpatient clinics (4-6) and in GP practices (28). We conclude that the case-finding approach recommended in these guidelines, was successfully implemented in two hospitals in our study. VFA proved to be an important tool in diagnosing a prevalent vertebral fracture as a major step forward in case-finding.

At the VU University Medical Center, a fracture and osteoporosis (FO) outpatient clinic was started based on experience of our study, with the use of the fracture risk factors, and both BMD measurement and VFA. In order to improve the acceptance by patients, all of them receive an appointment with a specialized nurse practitioner who is supervised by a physician. The investigation of the additive value of these improvements and their influence on patient's acceptance and compliance will be the subject of further study. In conclusion, the addition of VFA to the case-finding approach led to an important increase of diagnosis of vertebral fracture.

***Acknowledgments and affiliations***

We are grateful to Prof. dr. H.J.Th.M. Haarman, Prof. dr. P. Patka and Prof. dr. R.A. Manoliu for the organisatory support; N.C. Pliester, A.M. Nicolaas-Merkus, G. Asma, T. Smeenk, W. de Ruiter, A. Dijkhuis, and M. Tamarit-de Reus for the data collection and practical assistance.

***Competing interests***

None.

***Funding***

This study was supported by the Health Care Insurance Board (CVZ) of the Netherlands.

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