

# Defining the clinical usefulness of vertebral fracture assessment

## Akademisk avhandling

Som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien, Göteborgs universitet kommer att offentlig försvaras i R-aulan, R-huset,  
Mölnalds sjukhus, Länsmansgatan 28, Mölndal  
Fredag den 17 juni klockan 09.00

av Lisa Johansson, leg.läkare

Fakultetsopponent:

Adjungerad Professor Paul Gerdhem  
Karolinska Institutet, Sverige

## Avhandlingen baseras på följande delarbeten

- I. **Johansson L**, Sundh D, Zoulakis M, Rudang R, Darelid A, Brisby H, Nilsson AG, Mellström D, Lorentzon M. The Prevalence of Vertebral Fractures Is Associated With Reduced Hip Bone Density and Inferior Peripheral Appendicular Volumetric Bone Density and Structure in Older Women. *J Bone Miner Res.* Feb 2018;33(2):250-60. Epub 2017/09/20.
- II. **Johansson L**, Sundh D, Nilsson M, Mellstrom D, Lorentzon M. Vertebral fractures and their association with health-related quality of life, back pain and physical function in older women. *Osteoporos Int.* Jan 2018;29(1):89-99. Epub 2017/11/17.
- III. **Johansson L**, Sundh D, Magnusson P, Rukmangatharajan K, Mellstrom D, Nilsson AG, Lorentzon M. Grade 1 Vertebral Fractures Identified by Densitometric Lateral Spine Imaging Predict Incident Major Osteoporotic Fracture Independently of Clinical Risk Factors and Bone Mineral Density in Older Women. *J Bone Miner Res.* Oct 2020;35(10):1942-51. Epub 2020/06/17.
- IV. **Johansson L**, Johansson H, Axelsson KF, Litsne H, Harvey N C, Liu E, Leslie W D, Vandenput L, McCloskey E, Kanis J A, Lorentzon M. Improved fracture risk prediction by adding VFA-identified vertebral fracture data to BMD by DXA and clinical risk factors used in FRAX. *Osteoporos Int.* 2022 Published online 22 April DOI: 10.1007/s00198-022-06387-x

# Defining the clinical usefulness of vertebral fracture assessment

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## **Abstract**

**Objective:** Vertebral fractures (VFs) are the most common osteoporotic fracture and among the strongest predictors for future fracture. VFs can be identified by vertebral fracture assessment (VFA) from lateral spine imaging (LSI) by dual-energy X-ray absorptiometry (DXA).

**Aims:** The overall aim of this thesis was to evaluate the clinical usefulness of VFA. More specifically, the different aims were to investigate associations between prevalent VFA-identified VFs with bone microstructure and bone strength, and also health-related quality of life (HRQL) and physical function. Further aims were to investigate whether or not VFA-identified VFs, according to their number and severity, predict incident fractures, and more specifically whether or not mild VFs (grade 1; 20% to 25% compression) increase fracture risk. The final aim was to determine whether VFA-identified VFs can improve fracture risk prediction beyond the clinical risk factors (CRFs) and femoral neck (FN) bone mineral density (BMD) used in the Fracture Risk Assessment Tool (FRAX).

**Methods:** The studies are based on the Sahlgrenska University Hospital Prospective Evaluation of Risk of Bone Fractures (SUPERB), a population-based study of 3,028 older women aged 75-80 from Gothenburg. At baseline, BMD was measured by DXA, bone microstructure by high-resolution peripheral quantitative computed tomography (HRpQCT), cortical bone strength by microindentation, HRQL by self-administered questionnaires (SF-12), physical function by One Leg Standing (OLS), Timed Up and Go (TUG), walking speed, 30-second chair stand test and maximum grip strength. VFs were identified by VFA using DXA. Incident fractures were x-ray-verified or captured by diagnosis codes from the National Patient Register (NPR).

**Results:** Trabecular bone microstructure and bone geometry were impaired in women with VFs, but not independently of total hip (TH) BMD. Cortical porosity and cortical bone material strength were not associated with VFs. Physical health and physical function were worse in women with VFs compared with women without. In Paper III, 213 women out of 2,095 women included, sustained a major osteoporotic fracture (MOF) during a median follow-up of 3.6 years. Women with only mild VF had increased risk for MOF independently of CRFs and FN BMD, compared with women without VF. In Paper IV, 422 women out of 2,852 women included, sustained a MOF during a median follow-up of 5.15 years. Independently of CRFs and FN BMD, VFA-identified VFs were associated with an increased risk of MOF, also according to number and severity of baseline VFs. VFA-identified VFs had a substantial impact on the 10-year probability of MOF (uplifting the 10-year probabilities by 1.19 to 1.40, depending on BMD) independently of self-reported prior fracture and other CRFs and FN BMD in FRAX.

**Conclusions:** VFA-identified VFs were associated with inferior trabecular bone volume fraction, TH BMD, worse physical health and physical function in older women. Mild VFs were independently associated with incident MOF, and VFA-identified VFs increase the 10-year probability of MOF substantially. Thus VFA is a clinically useful method for diagnosing relevant VFs and improves fracture prediction in older women.

**Keywords:** Vertebral fracture, vertebral fracture assessment, osteoporosis, DXA, HRpQCT, bone microindentation, mild vertebral fracture, physical function, fracture risk, incident fracture, older women.

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