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# Association between bone mineral density and lumbar disc degeneration

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ABSTRACT

*Objectives:* Higher vertebral bone mineral density (BMD) has been found to be related with lumbar disc degeneration (LDD), while relationship between femoral neck BMD and LDD remains controversial. The aim of our research was to study the relationship between LDD and BMD of the lumbar spine and femoral neck.
*Study design:* The study population consisted of 168 postmenopausal women (aged 63.3–75.0 years, mean 68.6 years) from the prospective OSTPRE and OSTPRE-FPS study cohorts. The severity of LDD was graded from T2-weighted MRI images using the five-grade Pfirrmann classification. Four vertebral levels (L1-L4) were studied (total 672 discs). The association between lumbar BMD and *Z*-score and the severity of LDD was studied separately for each vertebral level with AN(C)OVA analysis, using potential confounders as covariates.
*Results:* Higher lumbar BMD and *Z*-score were associated with more severe LDD at all studied levels (L1-L4): between L4-L5 disc and L4 BMD ($p = 0.044$) and L4 *Z*-score ($p = 0.052$), between L2-L3 disc and L3 BMD ($p = 0.001$) and at all other levels ($p < 0.001$). The mean degeneration grade of the studied discs was associated with the mean L1-L4 BMD and *Z*-score ($p < 0.001$). Statistical significance of any result did not alter after controlling for confounding factors. There was no significant association between femoral neck BMD and LDD.
*Conclusions:* Higher lumbar BMD/*Z*-score were associated with more severe LDD. There was no significant association between femoral neck BMD and disc degeneration. Femoral neck BMD may be a more reliable measurement for diagnosing osteoporosis in postmenopausal women with degenerative changes in the lumbar spine.



## 1. Introduction

Osteoporosis and lumbar disc degeneration (LDD) are very common conditions in the aging population [1,2]. Both significantly decrease the quality of life and impose a major cost on society. LDD can cause disc herniations, spinal stenosis and degenerative spondylolisthesis, which can result in low back pain and, at the worst, to total incapacity and disability. A decrease in bone mineral density (BMD) increases the risk of fractures.

The relationship between BMD and disc degeneration is not totally clear. Several studies have reported that there is a positive correlation between LDD and BMD, i.e. higher vertebral bone density is related to lumbar disc degeneration [3–10]. One explanation for this association could be that osteophytes and lumbar spine fractures can overestimate bone density interpretation [11].

The association between hip BMD and disc degeneration remains controversial. A few studies have reported that there is no significant correlation between higher hip BMD and disc degeneration [4,6,7,12], while some have reported that higher BMD in the hip and disc degeneration are related [5,10]. On the other hand, it has

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been reported that patients with osteoporosis have more severe disc degeneration [13]. An inverse relationship between osteoporosis and spondylosis has also been suggested [8,9,14,15]. The literature also contains studies documenting inadequate support for a correlation between osteoporosis and spondylosis [16,17]. In addition, a positive correlation between BMD in the radius and disc degeneration has also been reported [7].

Lumbar disc degeneration is characterized radiologically by the presence of disc space narrowing, osteophytes and end plate sclerosis [5]. The disc degeneration grade can be evaluated more specifically using T2-weighted MRI images with the five-grade Pfirrmann classification system, based on disc space narrowing and nucleus pulposus signal intensity [18]. An association has been found between disc height, disc signal intensity, anterior osteophytes, disc bulge and higher hip BMD [10]. It has also been suggested that osteophytes and end plate sclerosis, but not disc space narrowing, are related to higher hip BMD [5]. No significant association was detected between disc degeneration and endplate BMD, but more severe disc degeneration tends to be associated with greater thickness of the endplate [19].

The aim of the present study was to investigate the relationship between lumbar and hip bone mineral density and lumbar disc degeneration using the five-grade Pfirrmann classification system [18].

## 2. Methods

### 2.1. Study population

The present study population was based on the Kuopio Osteoporosis Risk Factor and Prevention (OSTPRE) and OSTPRE Fracture Prevention Study (OSTPRE-FPS) study cohorts. Detailed protocols of both studies have been previously described [20,21].

The OSTPRE cohort was established in 1989 by selecting all women born in 1932–1941 and residing in the region of Kuopio, Finland ($n$ = 14,220). The baseline postal inquiry included questions about health-related factors, co-morbidity, medications, fractures and anthropometric information and was sent to the women in 1989. The follow-up questionnaires were sent at five-year intervals in 1994, 1999 and 2004 to the 13,100 women who responded at baseline and responses were received from 11,954, 11,537, and 10,926 women, respectively. The study was approved by the Ethics Committee of the University Hospital of Kuopio. Informed written consent from the participants was collected with the postal enquiries.

Subjects for the present OSTPRE Fracture Prevention Study (OSTPRE-FPS) were selected from the original OSTPRE cohort in November 2002. The inclusion criteria were age 65 years or older, still living in the region, willing to participate, not participating in any other trials or providing bone densitometry readings for the OSTPRE study. The new baseline postal questionnaire of the OSTPRE-FPS study with questions related to health and fracture risk was sent to 5407 women. A total of 4706 enquiries were returned, 3744 of which were adequate. Out of these, 3432 women were willing to participate in the study. A subsample of 750 women was randomly selected from the 3432 women for DXA measurements. Out of these, a valid femoral neck and lumbar spine measurement was obtained from 614 (81.9%) women. The subjects were recruited between August and December 2002.

The selection of the present study population and follow-up drop-outs are outlined in Fig. 1. Of the 13,100 respondents in 1989, 11,055 (84.4%) were willing to undergo DXA bone densitometry. A stratified random sample from this cohort ($n$ = 3686, 33.3%) was selected and invited to attend bone density measurements. Of these women, 3222 (87.4%) underwent DXA in 1989. Valid femoral neck and lumbar spine DXA measurements were performed for 3222 women in 1989, 2954 women in 1994, 2832 women in 1999 and 2497 women in 2004. From these 2497 women, 135 also had a history of lumbar MRI scan at KUH due to low back pain or sciatica. From 614 OSTPRE-FPS women with valid DXA measurements, 33 had a history of lumbar MRI scan at KUH. Thus, the final study population consisted of 168 postmenopausal women who had valid lumbar (L1-L4) DXA measurements and a history of lumbar MRI scan in KUH; 11 of these 168 women had a history of spinal surgical operation (decompression, lumbar disc extirpation and/or spinal fusion) prior to DXA measurement. The mean age of the final study population was 68.6 years (SD 3.0 years).

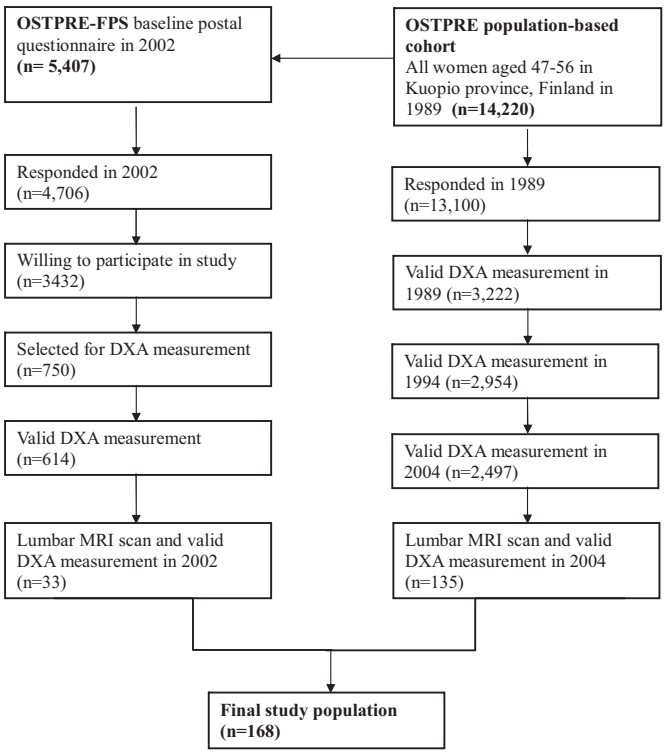


**Fig. 1.** Selection of the study population.

The study was carried out in the Bone and Cartilage Research Unit (BCRU) of the Clinical Research Center of the University of Eastern Finland, Kuopio, Finland.

### 2.2. Magnetic resonance imaging

The MRI scans of the lumbar spine were performed with a 1.5 T MRI imaging unit. The scans were performed between 03/2003 and 12/2010. The images were obtained from the KUH image database PACS (Picture Archiving and Communication System), which has been available since 2002. All available MRI data were included in the present study. Image analysis were performed from T2 weighted MRI images. The sequences for image analysis are represented in Appendix 1. The imaging protocol for all scans conformed to the requirements of the American College of Radiology for the performance of MRI of the adult spine [22]. All MRI scans were performed due to clinical indications (back pain, neurological symptoms of the lower legs and spinal claudication) of MRI imaging from the lumbar spine. Vertebral fractures in the L1-L4 area were identified from MRI images by radiologist.