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Original Article

Does the Precision of Dual-Energy X-ray Absorptiometry for Bone Mineral Density Differ by Sex?

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Abstract

Given larger bone size in men, bone mineral density (BMD) precision might differ between sexes. This study compared dual-energy X-ray absorptiometry BMD precision of 3 International Society for Clinical Densitometry-certified technologists in older men and women. Each technologist scanned a cohort of 30 men and 30 women (total n = 180) by using a Lunar iDXA densitometer (GE Healthcare, Madison, WI). Each volunteer had 2 lumbar spine and bilateral hip scans with repositioning between examinations. BMD least significant change was calculated. Age and body mass index did not differ between men and women. Mean height and weight were greater in men, 174.6 cm ± 6.9 and 81.6 kg ± 11.1 respectively, ($p < 0.0001$) than in women, 161.5 cm ± 5.9/ 69.1 kg ± 14.2, respectively. Bone area was greater in men ($p < 0.0001$) at all sites. BMD least significant change was statistically better ($p < 0.05$) in women at the mean total femur (0.014 vs 0.018 g/cm^2) and left femoral neck (0.025 vs 0.038 g/cm^2), but not different at either total femur, the right femoral neck, or lumbar spine (all $p > 0.05$). In conclusion, statistically significant male/female differences in BMD precision were observed at the mean total femur and left femoral neck. Given the small magnitude of difference in g/cm^2 and inconsistent pattern, that is, no right femoral neck difference, there is virtually no clinical difference in BMD precision between sexes. These data do not support a need for sex-specific precision analyses.

Key Words: Bone density; DXA; precision; sex.

Introduction

All quantitative clinical measurements, including dual-energy X-ray absorptiometry (DXA)-measured bone mineral density (BMD), are subject to variability as the result of inherent mechanical and technologist inconsistency. Thus, there is always some imprecision in BMD values obtained when scanning an individual *(1−3)*. Because one goal of DXA performance is to allow the assessment of BMD change over time, it is essential that what constitutes a ‘‘real’’ skeletal change (not simply reflecting instrument and/or technologist variability) be defined *(4)*. To this end, the DXA field developed an approach to determine when BMD differs between 2 scans with 95% confidence; a value widely referred to as the least significant change (LSC) *(1,5−7)*. The International Society for Clinical Densitometry (ISCD) recommends that each DXA technologist conduct their own precision assessment and determine their LSC *(7)*. Importantly, this recommendation specifies that such precision assessments be performed ‘‘using patients representative of the clinic's patient population’’ *(7)*. As such, facilities that scan primarily women should perform precision assessment with women and vice versa.

In this regard, it is plausible that sex affects the precision of DXA. Specifically, because larger bone area improves precision *(8)*, one could hypothesize that the larger bone areas generally observed in men might be measured more reproducibly than the smaller bone areas of women. Conversely, as

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potential confounders to reproducible BMD measurement, for instance, spinal degenerative changes and aortic calcification (8–10), might be more prevalent in men, it is plausible that BMD precision is poorer in men. However, to our knowledge, the possibility that BMD measurement reproducibility differs between men and women has not been investigated. If a difference in BMD LSC exists between men and women, clinical practice should be altered and sex-specific precision assessments conducted with corresponding LSC values applied. Thus, the goal of this study was to evaluate BMD LSC in older men and women.

Methods

Study Design

Three technologists each performed 2 precision assessments, one using men, the other women, per ISCD guidelines of replicate scanning using 30 volunteers. This allowed assessment of technologist variation in addition to potential differences by sex. Three technologists were chosen, as that was the number of experienced technologists available at the center. Consequently, data of hip and spine BMD precision on180 volunteers were collected.

Participants

All study participants were community-dwelling older adults age ≥64 yr. One hundred eighty volunteers were recruited from the surrounding region; demographic data are presented in Table 1. In summary, the male and female groups did not differ in age or body mass index, but women were shorter and lighter ($p = 0.0001$) than the men. This study was reviewed and approved by the University of Wisconsin Health Sciences Institutional Review Board. All participants provided written informed consent before any study procedure was conducted.

DXA Acquisition and Analysis

Three ISCD-certified DXA technologists, each with more than 2 years of densitometry experience, scanned 30 men and 30 women twice with repositioning between scans; the repeat scan set was acquired within minutes of completing the initial. Each technologist used a different cohort of 30 men and 30 women for this study such that only one pair of lumbar spine and bilateral proximal femurs was obtained on any volunteer. All scans were performed in routine clinical manner following research facility standard operating procedures using a GE Healthcare (Madison, WI) Lunar iDXA densitometer. Software version 13.31 used for all acquisition and analyses. Autoanalysis was used for all initial scan analyses with manual correction of region of interest markers and/or bone edges when necessary. The copy feature was used to analyze the second scan in each pair.

Statistical Analyses

Student's *t*-test was used to compare group demographics and bone area. Mixed effects linear regression models were used to estimate the precision error and least significant change both overall and for subgroups based on technician

Table 1
Demographic Data of the Subjects

	Entire group male, n = 90	Entire group female, n = 90	Tech 1 male, n = 30	Tech 1 female, n = 30	Tech 2 male, n = 30	Tech 2 female, n = 30	Tech 3 male, n = 30	Tech 3 female, n = 30
Age, yr	75.8 (7.3)	73.9 (6.2)	76.4 (8.1)	74.6 (6.4)	75.9 (7.4)	74.4 (6.4)	75.1 (6.5)	72.5 (6.0)
BMI, kg/m^2	26.8 (3.4)	26.6 (5.3)	27.9 (3.5)	26.5 (5.7)	26.4 (3.5)	26.4 (5.6)	25.9 (2.9)	27.1 (4.6)
L1-4 BMD, g/cm^2	1.137 (0.257)	1.131[a] (0.189)	1.308 (0.194)	1.139 (0.202)	1.344 (0.291)	1.145 (0.206)	1.306 (0.280)	1.115 (0.161)
Mean TF BMD, g/cm^2	1.012 (0.146)	0.898[a] (0.129)	1.03 (0.138)	0.907 (0.135)	1.013 (0.148)	0.883 (0.110)	0.997 (0.153)	0.908 (0.142)
L1-4 area, cm^2	65.4 (6.5)	53.9[a] (4.9)	65.9 (5.7)	54.5 (4.7)	64.9 (6.8)	53.8 (5.1)	65.8 (7.5)	53.3 (5.1)
Mean TF area, cm^2	38.5 (2.4)	32.3[a] (2.2)	38.5 (2.2)	32.7 (2.2)	37.4 (2.2)	32.1 (2.0)	39.5 (2.6)	32.2 (2.3)

Note: Data are mean (SD).
Abbr: BMD, bone mineral density; BMI, body mass index; TF, total proximal femur.
[a]Different than men; $p < 0.05$.