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Original Article

Dual-Energy X-ray Absorptiometry Diagnostic Discordance Between Z-Scores and T-Scores in Young Adults

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Abstract

Diagnostic criteria for postmenopausal osteoporosis using central dual-energy X-ray absorptiometry (DXA) T-scores have been widely accepted. The validity of these criteria for other populations, including premenopausal women and young men, has not been established. The International Society for Clinical Densitometry (ISCD) recommends using DXA Z-scores, not T-scores, for diagnosis in premenopausal women and men aged 20−49 yr, though studies supporting this position have not been published. We examined diagnostic agreement between DXA-generated T-scores and Z-scores in a cohort of men and women aged 20−49 yr, using 1994 World Health Organization and 2005 ISCD DXA criteria. Four thousand two hundred and seventy-five unique subjects were available for analysis. The agreement between DXA T-scores and Z-scores was moderate (Cohen's kappa: 0.53−0.75). The use of Z-scores resulted in significantly fewer (McNemar's $p < 0.001$) subjects diagnosed with ''osteopenia,'' ''low bone mass for age,'' or ''osteoporosis.'' Thirty-nine percent of Hologic (Hologic, Inc., Bedford, MA) subjects and 30% of Lunar (GE Lunar, GE Madison, WI) subjects diagnosed with ''osteoporosis'' by T-score were reclassified as either ''normal'' or ''osteopenia'' when their Z-score was used. Substitution of DXA Z-scores for T-scores results in significant diagnostic disagreement and significantly fewer persons being diagnosed with low bone mineral density.

Key Words: Diagnosis; DXA; T-score; young adults; Z-score.

Introduction

Bone mineral density (BMD) can be measured easily and noninvasively using dual-energy X-ray absorptiometry (DXA) *(1−5)*. Using the BMD measurement and subject demographics, DXA software programs generate a T-score and/or Z-score *(1−4,6−8)*. In 1994, the World Health Organization (WHO) recommended central DXA as the gold standard for noninvasive measurement of BMD and also to use central DXA T-scores for the diagnosis of postmenopausal osteoporosis *(5)*. These diagnostic criteria were widely accepted and hailed as a major advancement in the assessment of this disorder, and resulted in widespread use of central DXA

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(4,6,9–12). However, these criteria were developed primarily from studies of postmenopausal white women, and their application to other populations has not been well validated (5,9,13). Thousands of central DXA devices are in use worldwide, which are sometimes used for skeletal assessments in children, premenopausal women, and men (8,13).

The prevalence of low bone mass and osteoporosis in premenopausal women and men aged 20–49 yr remains unknown for several reasons. Attempts to establish universally accepted diagnostic criteria for premenopausal women or men are hampered by a lack of published scientific studies. Existing studies evaluating the prevalence of this disorder and incident fractures tend to focus on older individuals (5,14–22). Published data from NHANES III (The Third National Health and Nutritional Examination Survey, 1988–1991) suggest that the number of young adults with these disorders is quite low, ranging somewhere between 0.1% and 10% depending on the T-score criteria used (23). This implies that much larger samples would be needed to provide accurate, precise, and reliable assessments of the true prevalence. Additionally, our ability to accurately diagnose low bone mass or osteoporosis in these populations is complicated by the lack of validated DXA diagnostic criteria. Recent International Society for Clinical Densitometry (ISCD) guidelines to use Z-scores instead of T-scores in premenopausal women and men aged 20–49 yr have not been universally accepted (10,13,24,25). Finally, because the incidence of fracture in this population is much lower than that in adolescents and the elderly (4,5), studies evaluating the use of DXA for assessing fracture risk will be more difficult.

Although one expects little difference in young-adult DXA T-scores and Z-scores, in clinical practice, this is not always true. It has recently been shown that these measures occasionally differ substantially in men and women aged 20–49 yr (8). In clinical practice, these differences can result in diagnostic discordance in these persons if their Z-scores are used instead of their T-scores, leading to ambiguity about their diagnosis, and sometimes, inappropriate evaluations and treatments. There are 3 main clinical scenarios where such problems are encountered:

1. When a premenopausal woman or man aged 20–49 yr (young adult) sees a practitioner who applies the WHO criteria and diagnoses ''osteopenia'' or ''osteoporosis,'' but the young adult has ''normal bone mass for age'' as per ISCD criteria;
2. When a young adult is scanned on 2 different devices and there are marked differences between the Z-score and/or T-score obtained from each device; and finally
3. When a man reaches 50 yr or a woman is deemed postmenopausal and is diagnosed with ''osteopenia'' or ''osteoporosis'' applying their T-score and WHO criteria, but their actual BMD has not changed, and their prior Z-score diagnosis by ISCD criteria was ''normal bone mass for age.''

We undertook this study to gain a better appreciation of how often the use of young-adult DXA Z-scores would change the T-score ''diagnosis,'' hypothesizing that:

1. Use of Z-scores instead of T-scores for DXA diagnosis would result in significant diagnostic discordance in these populations.
2. The predictive value of a DXA diagnosis using a subject's Z-score in this population would be poor because of the differences between DXA Z-scores and T-scores in these populations.

The results of these additional analyses are presented in this article.

Materials and Methods

The study subjects were a sample of previously described adults aged 20–49 yr drawn from a convenience cohort of individuals undergoing a DXA scan as part of their clinical evaluation for either ''osteoporosis'' or other disorders of bone and mineral metabolism (8). The subjects had a DXA scan for a variety of clinical conditions, including the presence of a fragility fracture, diseases, such as premature menopause, organ transplant evaluation, osteogenesis imperfecta, osteomalacia, cystic fibrosis, anorexia nervosa, use of medications known to cause bone loss, including glucocorticoids and chemotherapy, and finally in peri- and postmenopausal women with additional risk factors for osteoporosis where the presence of significant bone loss or low BMD may have impacted their ongoing health maintenance programs. Data from 11 of the 12 DXA scanners within the Cleveland Clinic Healthcare network have been incorporated into a large research database, containing almost 200,000 individuals, approx 3% of whom are aged between 20 and 49 yr at the time of their first DXA scan. Each subject was scanned on either a Lunar or Hologic DXA machine in this cross-sectional study. Each subject's first scan (included both the proximal femur and spine, or either of them if only the hip or spine were scanned) was included in this analysis. We used the software supplied with the DXA scanner to calculate both T-score and Z-score values (8). Hologic T-scores matched for ethnicity and gender, Z-scores matched for age, ethnicity, and gender; Lunar T-scores matched for gender, Z-scores matched for age, ethnicity, gender, and weight. The collection of data and performing of the analyses was approved by the local Institutional Review Board before study commencement.

We chose to compare diagnostic agreement between T-scores and Z-scores using both 1994 WHO criteria (5) and 2005 ISCD criteria (10) as follows: WHO T-score cutpoints of less than −1.0 and more than −2.5 as ''osteopenia'' and −2.5 or lower as ''osteoporosis,'' and Z-score cutpoint of less than −2.0 as ''low bone mass for age'' (BMD below the expected range for age), respectively. These criteria were used to compare overall diagnosis picking the lowest DXA T-score and Z-score measurements from 1 of 4 sites—lumbar spine (L1–4), total hip, femoral neck, and trochanter—and also to compare diagnosis for each individual skeletal site. However, ISCD overall diagnosis did not include the trochanter. Because very few subjects had a forearm scan, results of the distal radius are not presented here.