Bone Mineral Density Using Hounsfield Units: Establishing a Hounsfield Unit Scale

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INTRODUCTION:

T-Scores utilized to define osteopenia and osteoporosis are derived from the National Health and Nutrition III study dataset (Nhanes). This study utilized the mean bone mineral density from Dual Energy X ray Absorptiometry (DEXA) of 409 non hispanic white women aged 20-29 to define cutoffs for this disease. The current gold standard in screening and diagnosis of low bone mineral density is (DEXA). However, nearly 25% of osteoporotic fractures occur before a screening DEXA scan is performed. In contrast, patients with undiagnosed low bone mineral density (BMD) frequently have computed tomography (CT) scans for diagnosis of common medical conditions such as appendicitis or cholecystitis. Prior studies demonstrate the potential of using Hounsfield units (HU) measured on opportunistic CT as an alternative to DEXA T-scores of the femoral neck. This study aims to establish HU values associated with normal/peak BMD in the proximal femur and lumbar spine in physiologically young patients in a similar yet more rigorous fashion to the original Nhanes III definition.

METHODS:

Using the Military Health System Data Repository (MDR), we identified white and black females 20-29 years of age that had obtained a CT of the abdomen/pelvis or pelvis (with or without contrast) from 2017-2024. Exclusion criteria involved any medical history that would impact systemic or focal bone health at the proximal femur or lumbar spine. However, patients on contraceptives were not excluded. Two raters manually measured HU of the proximal femur and L1 vertebral body. All measurements were performed in IMPAX v6.7 (Agfa Healthcare). Slice thicknesses, use of contrast, and scanner brand were recorded when available.

RESULTS:

2398 white and 1130 black females were identified after applying exclusion criteria. A randomized cohort of 500 patients was selected from each racial group and reviewed. Mean age was 25.7 ± 2.6 years. There were 959 (480 black, 479 white) L1 vertebral bodies and 948 (484 black, 464 white) proximal femora available for measurement.

At the L1 vertebral body, mean HU was 274.0 ± 50.7 (black, 292.4 ± 49.7; white, 255.6 ± 44.6; p<.001). At the proximal femur, mean HU was 189.3 ± 60.0 (black, 197.9 ± 62.4; white 180.7 ± 56.3; p<.001).

DISCUSSION AND CONCLUSION:

This normative data can be used to determine HU T-scores similar to those available following DEXA scans and may be useful for opportunistic identification of patients with or at risk for osteoporosis. Therefore, every individual who gets a CT scan of the pelvis for other indications can be risk stratified for osteoporosis.

In this cohort of black and white females with CT imaging of the pelvis and lumbar spine without comorbid bone health-related diagnoses, black females had higher HU at both L1 and proximal femora.
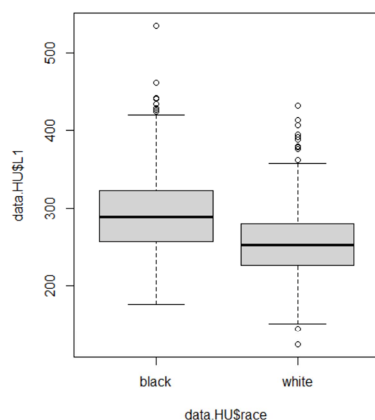

Figure 1. Box-and-whisker plots of L1 vertebral body Hounsfield unit distribution in black and white females.
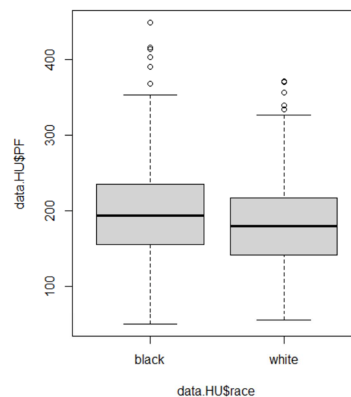

Figure 2. Box-and-whisker plots of proximal femur Hounsfield Unit distribution in black and white females.