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Population Studies

US White and Black Women Do Not Represent the Bone Mineral Density of Sub-Saharan Black Women

Cynthia Mukwasi,[*,1] *Lynda Stranix Chibanda,*[1] *Josephat Banhwa,*[1] *and John A. Shepherd*[2]

[1]*Department of Radiology, College of Health Sciences, University of Zimbabwe, Harare, Zimbabwe; and* [2]*Department of Radiology and Biomedical Imaging, University of California San Francisco, San Francisco, CA, USA*

Abstract

Reference populations from the United States (US) are often used around the world for representative measures of bone mineral density (BMD) by sex, age, and race. We examined BMD in adult black Zimbabwean women and compared it to that of US women (white and black). In a cross-sectional study, we recruited healthy black Zimbabwean women working at Parirenyatwa Hospital regardless of designation, who were not pregnant and had no diseases or medications known to affect BMD. Dual-energy X-ray absorptiometry scans of the left hip and lumbar spine (L1−L4) were performed for each participant by 1 operator, on 1 dual-energy X-ray absorptiometry machine. Results are presented for 289 participants aged 20−69 years, with a mean weight, height, and body mass index (BMI) of 71.7 ± 15.1 cm, 164.9 ± 6.3 kg, and 26.3 ± 5.3 kg/m^2, respectively. At 5% level of significance, age and BMD were weakly associated for the total lumbar spine ($p \leq 0.001$) but not for the total hip ($p = 0.890$) and femur neck ($p = 0.062$). BMI and weight were positively correlated with BMD for all 3 sites ($p \leq 0.001$). Compared to US white women, mean BMD for black Zimbabwean women in this study was 4.5%−7.4% lower for the lumbar spine but 2.0%−4.8% higher for the total hip and 0.2%−10.2% higher for the femur neck for 20−59 years. Compared to US black women, mean BMD for black Zimbabwean women was 9.1%−11.5% lower for the lumbar spine and 1.4%−8.1% lower for the total hip for 20−59 years. Black Zimbabwean women also had lower mean weight and BMI per decade age group as compared to US women. Differences in weight and BMI offer a possible explanation for the differences in BMD between black Zimbabwean women and US white and black women. Including adjustments for body frame when calculating Z-scores may accurately reflect BMD.

Key Words: Bone mineral density; dual-energy X-ray absorptiometry; osteoporosis; BMI; weight.

Introduction

The worldwide rate of osteoporotic fractures is 1 every 3 seconds. A 65-year-old woman has a risk ratio of 2.94 for fracturing the hip and 1.38 of any other low trauma fracture for every standard deviation (SD) decrease in bone mineral density (BMD) as measured by dual-energy X-ray absorptiometry (DXA) *(1)*. BMD is clinically important because of its use to diagnose osteoporosis, estimate fracture risk in individuals, and determine who would best benefit from chemoprevention. Low BMD in young adults leads to osteoporosis in later years, the major consequence of which is low trauma fractures. Women, however, are at an increased risk because in addition to the fact that they, on average, have lower bone mass than men at all ages, the rate of bone loss in women greatly increases in the first 1−10 years after menopause, with an average 40% bone loss as compared to approximately 25% in men *(2,3)*.

Africa is not an exception to the complications and occurrence of osteoporotic fractures *(4)*. Osteoporosis is projected to be on the increase in developing countries because of such factors as westernization of diets and it being a metabolic complication of human immunodeficiency virus or AIDS, which is prevalent in most African countries *(4−6)*. The current

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*Address correspondence to: Cynthia Mukwasi, BSc (Hons), College of Health Sciences, University of Zimbabwe, PO Box A178, Avondale, Harare, Zimbabwe. E-mail: cmukwasi@medsch.uz.ac.zw

internationally-accepted BMD reference values for diagnosis of osteoporosis are based on a young adult mean reference value from US white (non-Hispanic white) women from the third National Health and Nutrition Examination Survey (NHANES III) study. The NHANES III study was based on DXA data for the femur site from 1988 to 1994 (7,8). NHANES 2005−2008 updated data for the femur and added the lumbar spine sites (9). The femur neck BMD normalized to the young reference BMD, and SD values from NHANES are commonly used to classify women into osteoporosis risk groups using the World Health Organization criteria: normal (BMD difference within −1 SD or greater), low bone density (osteopenia, BMD difference between −1 and −2.5 SD), and osteoporosis (BMD difference of −2.5 SD or lower.) (10). Furthermore, Z-scores can be calculated from the NHANES age, sex, and ethnicity-specific BMD values.

Available data from developed countries highlight the importance of assessing BMD in different settings because it differs according to factors such as population, race, ethnicity, gender, and geographical location (1,10,11). For example, in Turkish women, a 50.3% (lumbar spine) and 60.8% (femur neck) prevalence of low BMD was reported when using a US-based reference for calculating T-scores as compared to 14.0% (lumbar spine) and 14.6% (femur neck) when using a local reference, underscoring the need for population-specific BMD references (12). Although there have been other studies done in sub-Saharan countries like South Africa, how the BMD of the US white population vs age compares to women in other developing countries, such as Zimbabwe, is for the most part unexplored.

In this cross-sectional study, we investigate the BMD of the left hip and lumbar spine in a sample of healthy Zimbabwean women over a broad age range. We report here how their BMD values differ by age to the US white and black (non-Hispanic black) populations.

Materials and Methods

A descriptive cross-sectional study was conducted at Parirenyatwa Hospital, Harare, Zimbabwe. The participants and methods are described in detail in the following.

Participants

Our target population was healthy adult sub-Saharan black women. The accessible population was healthy adult Zimbabwean black women working at Parirenyatwa Hospital, regardless of designation. The targeted sample size was 321. This number was first estimated to provide a 95% confidence of being within <2% of the anticipated mean neck BMD of 0.86 ± 0.12 g/cm^2 (US white) (10), resulting in a sample size of 193 women. For robust analysis, we anticipated that 60% of the women would be eligible, therefore, the sample size was adjusted to 193/0.6 = 321. Potential participants were randomly identified from a list of employees and approached by the researchers. Black Zimbabwean was defined as having both parents and both grandparents being of black Zimbabwean heritage. Adult age was defined as 20 years and above. Exclusion criteria were a history of major disease or condition known to affect BMD, pregnancy, current medication that could affect bone metabolism, and a history of trauma or surgery at the measurement site. A questionnaire was administered to determine eligibility and to collect personal information such as date of birth, weight, height, menopausal status, family history of osteoporosis or breast cancer, physical activity levels, dietary intake, smoking status, and alcohol intake. Menopause was self-reported and defined as no menstruation for 6 months unrelated to pregnancy or postpartum amenorrhea. Current smoking and alcohol intake were considered as actively smoking and taking alcohol at the time of data collection. Past smoking and past alcohol intake were defined as no longer smoking and drinking alcohol, respectively, regardless of when they stopped. Each participant gave written informed consent. This study was approved by the Parirenyatwa Hospital and University of Zimbabwe−College of Health Sciences Joint Research Ethics Committee (approval number−JREC/247/11) and Medical Research Council of Zimbabwe (approval number−MRCZ/B/284).

DXA Acquisition and Analysis

DXA scans were acquired at the University of Zimbabwe−University of California San Francisco Collaborative Research Programme's DXA facility situated in the X-ray department at Parirenyatwa Hospital. For each participant, a posteroanterior DXA scan of the L1−L4 lumbar spine and proximal hip (femur) was performed. A Hologic Discovery Wi (QDR series) Model machine (software version 3.0, Hologic Inc., Bedford, MA, USA) was used to acquire and analyze all scans. As recommended by Hologic, daily quality control scanning of the Hologic spine phantom was performed to verify system stability and calibration. The Coefficient of Variation (CV) for the spine phantom throughout the study was 0.014 for a period of 15 months. All DXA scans were performed and analyzed by 1 DXA operator to avoid differences due to operator variability. Measurements of bone mineral content (BMC; g), bone area (cm), and BMD (g/cm^2) were recorded for the lumbar spine, total hip, and femur neck.

Statistical Methods

Data were entered and analyzed using Microsoft Excel 2010 (Microsoft Corp., Redmond, Washington, USA), SPSS version 16 (SPSS Inc., Chicago, Illinois, USA), and STATA version 13 (StataCorp, College Station, Texas, USA). Descriptive statistics for BMD were calculated for each decade age group. Pearson's correlations were used to test if there was a linear relationship between BMD and continuous variables such as age, weight, height, and BMI. A multiple regression analysis was done to assess if BMD could be predicted from weight and BMI. For the total hip, femur neck, and lumbar spine, mean BMD for each decade age group was compared with those reported for US white and US black women from the NHANES 2005−2008(9) study by use of an independent sample's *t* test. Mean weight and mean BMI per decade age group in this sample was also compared to