# Bone Mineral Density Measurements of Women in a Black African Population in Lagos, Nigeria Using Accudexa BMD Assessment System: A Preliminary Study

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## ABSTRACT

**Objective:** No normative database for bone mineral density (BMD) exists in Nigeria. The study was done to provide the basis for the creation of a normative reference BMD database for women in Nigeria, while assessing the appropriateness of applying normative data for African-American women to Nigerian females.

**Methods:** The BMD measurements of 70 women aged 50 years and above as well as 58 women aged between 23 and 30 years, were taken using an accuDexa Dual X-ray Absorptiometry (DEXA) machine. Their local T-scores were determined using the BMD measurements of the young healthy normal group as control and the patients were grouped using the World Health Organization definitions (WHO) classification into normal, low bone density and osteoporosis. This was compared with the T-scores obtained using the African-American normative database.

**Results:** Using the local reference to determine T-scores for the older women, 24 were normal, 32 had low bone density and 14 had osteoporosis. When the African-American database was used as reference, 31 were normal, 31 had low bone density and eight had osteoporosis. This gave a diagnostic difference of 10% for the normal group, -1.4% for the low bone density group and -8.6% for the osteoporosis group.

**Conclusion:** The preliminary results suggested that the BMD of the local young healthy normal female Nigerian was higher than the African-American female. Since the diagnostic difference for osteoporosis was greater than 5%, the African-American reference values were considered inappropriate for the diagnosis of osteoporosis in the female Black Nigerian. Therefore, there is a need for a larger multicentre study to evaluate these findings.

**Keywords:** Black African, bone density, osteoporosis, women

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## INTRODUCTION

The quantity of minerals (*eg* calcium) present in the bone is directly correlated to the strength of the bone, and it indicates of its propensity for fracture. As a part of the natural aging process, the rate of new bone regeneration slows even as the existing bone continues to breakdown. This rate reversal results in the net loss of calcium and other minerals of the (delete) bones, resulting in thinner, lighter, less dense and weaker bones.

The bone mineral density (BMD) assessment measures the quantity of minerals in the bone and provides a useful clinical tool to: (1) diagnose osteoporosis, (2) determine an individual's risks for fractures, and (3) provide a quantitative outcome that measures the response to osteoporosis treatment. For utility as a diagnostic tool, the test results are interpreted relative to the normative databases, relevant to the individual or sample being assessed, and typically organized by age, gender or race. In the absence of established normative databases for the test subjects, appropriate alternate reference databases are used.
Other methods of identifying women with low bone mineral density include: the Osteoporosis Risk Assessment Instrument (ORAI). This instrument was developed and validated in a cohort of Canadian women and had a sensitivity of 93.3% and specificity of 41.4% in patients with low bone density, and a specificity of 94.4% in osteoporotic women in that population (1). Osteoporosis Risk Assessment Instrument gives the scores for age, weight and oestrogen use.

Some authors have evaluated different decision rules to complement the diagnostic tests to identify the subjects at higher risk that were more likely to benefit from BMD tests. These included: Simple Calculated Osteoporosis Risk Estimation (SCORE), ORAI, Age, Body, size, no Estrogen (ABONE), body weight less than 70 kg (weight criterion) and the National Osteoporosis Foundation (NOF) guidelines. They found the SCORE and ORAI to

be superior to the (NOF) guidelines. The ABONE and weight criteria were found to miss 13 to 17% of women with osteoporosis and are thus not very useful (2).

Despite the variety of devices available for BMD assessment, the lack of normative databases local to Nigerian denizens and specifically, women residents of Nigeria, limits their clinical utility.

Standard reporting of BMD results:

1. *T-score:*

Considered the most reliable measure for diagnosing osteoporosis, the T-score compares BMD values with the ideal or peak BMD of a healthy 30 year-old adult. The score was reported in units of standard deviations, and were interpreted according to the World Health Organization definitions [WHO] (3).

2. *Z-score:*

The Z-score compares BMD values to average values of age, gender and typically, race matched population groups. It is similarly reported in units of SD, with more negative values indicating lower BMD than the average of the matched population, and positive values indicating higher BMD than the average of the matched population group.

In the Western world, hip fractures had been singled out as a major cause of morbidity and mortality in the elderly (4) with considerable costs of treatment and rehabilitation (5, 6). A worldwide increase in the number of hip fractures from 1.7 million in 1990 to 6 million in 2050 had been predicted on account of improved life expectancy (7).

Evidence of osteoporosis according to the WHO, indicates risk of fracture, not certainty. Evidence of normal bone mass according to WHO criteria provides no assurance that a patient will not fracture. However, the National Osteoporosis Foundation

United States of America (USA) suggests initiating drug therapy in post-menopausal women and men aged 50 years and above with the following:

a) Hip or vertebral fractures with low BMD or osteoporosis.

b) T-scores of 2.5 or less at the femoral neck, total hip or lumbar spine.

c) Low bone mass at the femur neck or lumbar spine and a 10-year probability of hip fracture greater than or equal to three per cent or a 10-year probability of a major osteoporosis related fracture equal to or greater than 20 per cent based on the US-adopted WHO algorithm (8). These medications include: antiresorptives such as bisphosphonates, calcitonins, oestrogen agonists/antagonists and oestrogen therapy as well as anabolics such as parathyroid hormone. The available bisphosphonates include: alendronate, ibandronate, risedronate, and zolendronic acid. They increase bone density and reduce the risk of fractures in the spine, hip and other bones.

Inter-ethnic variations in bone mineral density had been observed with one study stating that the young healthy African-Americans had approximately 10% greater mean BMD compared with young healthy Caucasians (9). Another study showed that black women had the highest BMD in a study group where Asians had the lowest. Native Americans and white women had similar BMD but Hispanics had slightly lower levels (10).

Lagos State, Nigeria has a health policy that gives free treatment to the elderly aged 60 years and above. A study carried out in Lagos State University Teaching Hospital between July 2006 and December 2007, revealed that 5.6% of the patients treated for fractures were aged 65 years and above; and that, their fractures were sustained mainly as a result of falls (11). The study did not reveal how many of them were associated with osteoporosis.

The value of adequate dietary intake of calcium and phosphorus as well as physical activity on BMD had been studied (12); but there are no normative values for BMD in the Nigerian man or woman. Therefore the diagnosis of osteoporosis when made would be based

on the normative values in the black-American population. It is therefore desirable to create a normative data base for the black African population with a view to making proper diagnosis to assess fracture risk and commence osteoporosis medication to prevent fractures.

**Primary research objective**

To provide the basis for the creation of a normative reference BMD database for women in Lagos, Nigeria, while assessing the appropriateness of applying the established normative data for African-American women to the population of age-matched women in Lagos.

**Secondary research objective**

To initiate osteoporosis treatment in patients diagnosed with osteoporosis.

## METHODS

The BMD of 58 young healthy normal (YHN) black African women, aged between 23 and 31 years, and a non-biased sample of 70 black African women aged, between 50 and 78 years in Lagos State, was assessed with the Accudexa BMD assessment system. The results were analysed in order to form the basis of a local reference BMD database of women in the state.

The collected data were compared with the published age-matched normative data for African American women. In the course of the study, the individuals diagnosed with osteoporosis were placed on medication for osteoporosis treatment (Alendronate 70 mg weekly).

Approval was given by the research and ethics committee of the hospital and all the patients gave their informed consent.

**Hypothesis**

For an age-bound, but otherwise, non-biased sample of women in Lagos State, the percentage difference of their BMD results interpreted using a normative reference database of gender and race-matched young healthy normal (YHN) adults *versus* a normative reference database of YHN African-American women, will be less than 5%.

Inclusion criteria: Female black Nigerian residents of Lagos State

*Exclusion criteria:*

1. Relevant medical issues: deformity that prevents the patients' non-dominant hand from being properly positioned, orthopaedic hardware in the middle finger of the non-dominant hand, and previous fracture of the middle finger of the non-dominant hand.
2. Concurrent treatments with antiresorptives (bisphosphonates, calcitonins, oestrogen agonists/antagonists, oestrogen therapy and hormone replacement therapy), or anabolics (parathyroid hormone).
3. Pregnancy (although exposure from an accuDEXA BMD test is 1/150 000 of a chest X-ray, any radiation exposure during pregnancy must be deemed medically necessary by a physician).

*Equipment*

The accuDEXA device from Lone Oak Medical Technologies is a bone densitometer that estimates bone mineral density (BMD) of the non-dominant hand. It is a self-contained, table-top unit, employing dual energy X-ray absorptiometry (DEXA) technology. After the finger is scanned, results are generated in less than one minute. This BMD value is a relative indicator of bone density elsewhere in the body and the accuDEXA's BMD estimates can be used as an aid to the physician in determining fracture risk.

*Study procedure/ protocol*

1. Record the subject demographic information

2. Baseline calibration of system

3. Setup the assessment

Scan location: Non-dominant hand, middle finger.

4. Record first T-score reading (Reading 1)

5. Reset the system to the baseline

6. Record second T-score reading (Reading 2)

The main risk posed to the subjects was the exposure to low doses of X-ray radiation. In accordance with international standard IEC-601-3: General Requirements for radiation protection in Diagnostic X-ray equipment, the use of the accuDEXA was limited to no more than 20 patients' scans per hour.

All the results were analysed using the Microsoft Excel software.

## RESULTS

Fifty-eight young healthy normal (YHN) women aged between 23 and 31 years, were recruited for the study after giving their informed consent. Only one of them was aged 31 years, 20 were aged 30 years, the average age was 27.5 years, and the median was 28 years (Fig. 1). Their bone mineral density ranged from 0.454 g/cm$^2$ to 0.712 g/cm$^2$ (Table 1).

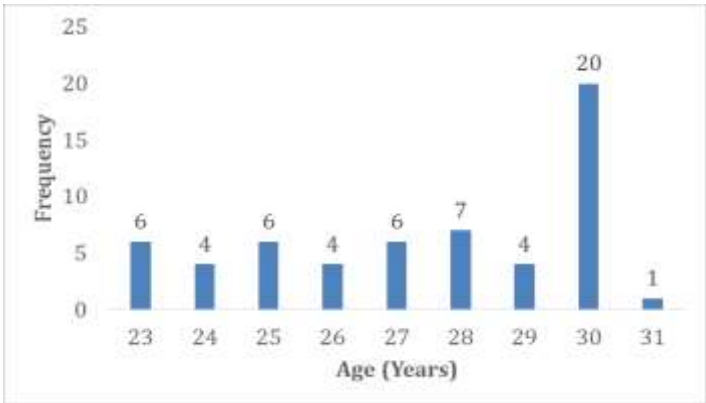


Fig. 1: Age distribution of the 58 Young Healthy Normal women used for the reference range.

Table 1: BMD range (high, low, median) for healthy young normal ($g/cm^2$)

| **Age (years)** | **23** | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** |
|---|---|---|---|---|---|---|---|---|---|
| High BMD | 0.660 | 0.644 | 0.634 | 0.700 | 0.625 | 0.712 | 0.695 | 0.462 | 0.551 |
| Low BMD | 0.454 | 0.487 | 0.565 | 0.490 | 0.511 | 0.475 | 0.695 | 0.702 | 0.551 |
| Median BMD | 0.562 | 0.541 | 0.598 | 0.614 | 0.610 | 0.607 | 0.600 | 0.604 | 0.551 |

Seventy women aged between 50 and 78 years were also recruited for the study after giving their informed consent. Their average age was 58.79 years and the mean was 59.5 years. Their BMD ranged from 0.33 $g/cm^2$ to 0.72 $g/cm^2$, and was lower with advancing age (Fig. 2).

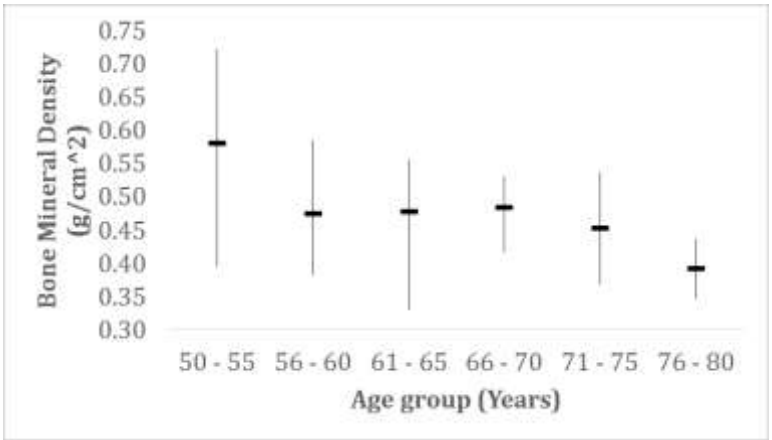


Fig. 2: Raw bone mineral density values (high, low and median values) as a function of age group for study (older) participants.

Using the data obtained from the young healthy normal group as the local reference, and the African-American database provided by the accuDEXA as non-local reference, the T-scores were compared. Using the non-local reference, 31 women were normal according to the WHO criteria (above 1 standard deviation (SD) of the mean), 31 women had low bone

density (between -1 and -2.5 SD) and eight were osteoporotic [below 2.5 SD], (Table 2, Fig. 3).

Table 2: Comparison of non-locally referenced and locally referenced T-Score values. World Health Organization definitions categories are used to interpret readings to normal, osteopaenia and osteoporosis conditions.

| **WHO criteria** | **T-Scores** | | | | |
|---|---|---|---|---|---|
| | **Non-local reference** | | **Local reference** | | **Diagnostic difference** |
| Normal (> -1.0) | 31 | 44.3% | 24 | 34.3% | +10% |
| Osteopaenia (-1.0 to -2.5) | 31 | 44.3% | 32 | 45.7% | -1.4% |
| Osteoporosis (< -2.5) | 8 | 11.4% | 14 | 20.0% | -8.6% |

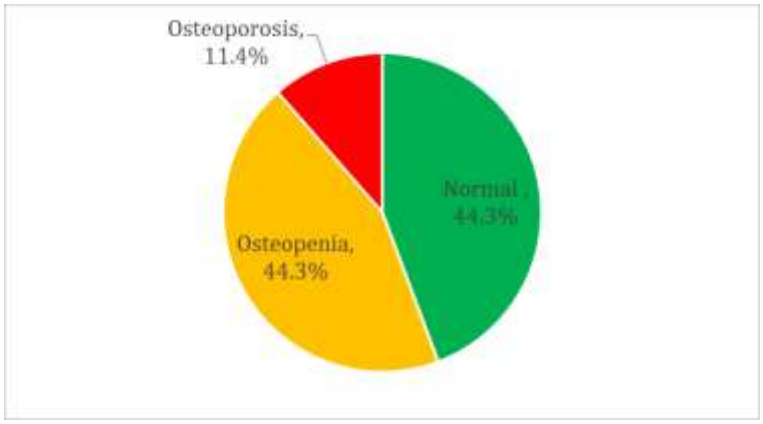


Fig 3: World Health Organization definitions classification of non-locally referenced T-Scores. Referenced to African American women.

However, when the local reference was used, only 24 women were normal, 32 had low bone density and 14 had osteoporosis. This gave a diagnostic difference of +10% for the normal group, -1.4% for the osteopaenia group, and -8.6% for the osteoporosis group (Table 2, Fig. 4).

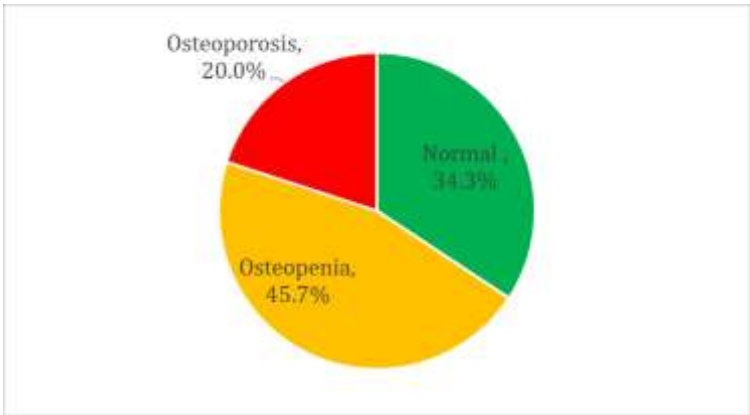


Fig: 4. World Health Organization classification of T-Scores referenced to Young Healthy Normal individuals of the same gender and ethnic background.

## DISCUSSION

This study was based on the premise that the BMD data for African-American women could be used as a reference to diagnose osteoporosis in black African women in Lagos. This study showed that there was a diagnostic difference of 10% in the normal group and -8.6% in the osteoporotic group. Using the non-local reference, only eight women were diagnosed as being osteoporotic, whereas, using local data, 14 were osteoporotic. This implies that six women who required treatment would have been excluded. This also implies that the BMD of the young healthy African woman is higher than that of the African American.

Limitations of the study:

The main limitation of this study is the very small sample size. Larger numbers are required to confirm these observations in future studies.

## CONCLUSION

The results of this preliminary study suggested that there might be significant differences between the bone mineral density of African-American women and black African Nigerians

in Lagos. Larger, multicentre studies need to be conducted to build a database in Lagos in order to objectively diagnose osteoporosis amongst the women.

## REFERENCES


1. Cadarette SM, Jaglal SB, Kreiger N, McIssac WJ, Darlington GA, Tu JV. Development and validation of the osteoporosis risk assessment instrument to facilitate selection of women for bone densitometry. CMAJ 2000; **102:** 1289–94.
2. Cadarette SM, Jaglal SB, Murray TM, McIssac WJ, Joseph L, Brown JP. Evaluation of decision rules for referring women for bone densitometry by dual x-ray absorptiometry. JAMA 2001; **286:** 57–63.
3. Cummings SR, Black DM, Nevitt MD, Browner W, Cauley J, Ensurd K et al. Bone density at various sites for prediction of hip fractures. The Study of Osteoporotic Fractures Research Group. Lancet 1993; **34:** 72–5.
4. Kanis JA. Assessment of fracture risk and its application to screening for menopausal osteoporosis: synopsis of a WHO report. Osteoporos Int 1994; **4:** 368–81.
5. Melton LJ. Hip fracture: a worldwide problem today and tomorrow. Bone 1993; **14:** S1–S8.
6. Lindsay S. The burden of osteoporosis: cost. Am J Med 1995; **98:** 9S–115.
7. De Laet CEDH, Van Hout BA, Hofman A, Pols HA. Costs due to osteoporosis-induced fractures in The Netherlands; possibilities for cost control. [Dutch] Ned Tijdschr Geneeskd 1996; **140:** 1684-8.
8. Clinicians guide to prevention and treatment of osteoporosis. 2014, version 1. National Osteoporosis Foundation.
9. Looker C, Wahner HW, Dunn WL, Calvo MS, Harris TB, Heyse SP et al. Updated data on proximal femur bone mineral levels of US adults. Osteoporosis 1998; **8:** 468–89.

10. Barrett-Connor E, Siris ES, Wehren LE, Miller PD, Abbott TA, Berger ML, Berger ML et al. Osteoporosis and fracture risk in women of different ethnic groups. J Bone Miner Res 2005; **20:** 185–94.

11. Adewole OA, Kayode MO, Shoga MO, Balogun RA. Fractures in the elderly in a West African Teaching Hospital. Niger J Orthop Trauma 2009; **8:** 18–19.

12. Marwaha RK, Puri S, Tandon N, Dhir S, Agarwal N, Bhadra K et al. Effects of sports training and nutrition on bone mineral density in young Indian healthy females. Indian J Med Res 2011; **134:** 307–13.