10.5005/jp-journals-10032-1118

RESEARCH ARTICLE

Osteoporosis in Black South African Women: Myth or Reality

[1]Lineo Matsela, [2]Olakunle Towobola, [3]Ephraim T Mokgokong

ABSTRACT

Aim: The study was conducted to ascertain the severity of the occurrence of osteopenia and osteoporosis among black South African women during their transition from premenopause to postmenopause.

Materials and methods: Sixty-eight black South African women, aged between 32 and 77 years, residents of three districts of Pretoria, South Africa, constituted the participants in the study. Following informed consent, the women were randomly recruited and assessed for age, medical history, and lifestyle data. Each woman was classified as being premenopause, perimenopause, or postmenopause based on her menstrual history within the preceding 12 months to the study. Bone mineral density (BMD) of the L1-L4 vertebrae and the hip vertebrae was measured using dual-energy X-ray absorptiometry (DEXA) method and the results were expressed as T-scores based on World Health Organization (WHO) classifications for osteopenia and osteoporosis.

Results: Osteopenia was found in 2 of the 8 (25%) premenopausal women aged 37 and 38 years. Similarly, 2 perimenopausal women out of the 28 (7.1%), aged 45 and 49 years, also had evidence of osteopenia. Among 32 postmenopausal women, 11 (34.4%) had osteopenia and 8 (25%) were diagnosed with osteoporosis. There was no statistical significant difference ($p = 0.0832$) for osteopenia between premenopausal and perimenopausal women. However, the incidence of osteopenia became statistically significant between premenopausal and postmenopausal women ($p = 0.0137$), and between perimenopausal and postmenopausal women ($p = 0.0218$).

Conclusion: Even from this small cohort study, it is apparent that osteoporosis does afflict postmenopausal black South African women. The need to institute screening strategies and appropriate guidance to prevent osteoporosis in these women is strongly advocated.

Clinical significance: The study draws special attention to the necessity to investigate black South African women for early detection of osteopenia and osteoporosis.

[1-3]Professor

[1,3]Department of Obstetrics and Gynecology, Sefako Makgatho Health Sciences University, Pretoria, Gauteng, Republic of South Africa

[2]Department of Internal Medicine and Clinical Research, Sefako Makgatho Health Sciences University, Pretoria, Gauteng Republic of South Africa

Corresponding Author: Lineo Matsela, Professor, Department of Obstetrics and Gynecology, Sefako Makgatho Health Sciences University, Pretoria, Gauteng, Republic of South Africa Phone: +27125214461, e-mail: lineomatsela@yahoo.com

Keywords: Cohort study, Menopause, Osteopenia, Osteoporosis, South African black women.

How to cite this article: Matsela L, Towobola O, Mokgokong ET. Osteoporosis in Black South African Women: Myth or Reality. J South Asian Feder Menopause Soc 2017;5(2):111-116.

Source of support: The authors herewith express their gratitude to both MSD (South Africa) and the South African Menopause Society for their financial donations, which enabled the DEXA evaluations of participants in this study.

Conflict of interest: None

Date of received: 05 June 2017

Date of acceptance: 09 August 2017

Date of publication: December 2017

INTRODUCTION

Osteoporosis is a skeletal disorder characterized by compromised bone strength, predisposing to an increased risk of bone fracture.[1] Bone strength is highly correlated with its mass and mineral content.[2] Factors that are associated with bone density and quality are race, gender, age, reproductive history, body build, genetic, and dietary factors. According to Melton and Riggs,[3] there are three fracture sites that are particularly characteristic of osteoporosis, namely the vertebrae, femoral neck, and radius, and they constitute an enormous public health problem in developed countries.

That very little attention is being paid to the problem of osteoporosis among black South African women is partly due to the notion among healthcare practitioners that black South African women are less likely to suffer from osteoporosis than their Caucasian counterparts. It may also be due to the behavior of African women who may treat the physiological and clinical manifestations of the transition to menopause as being natural and due to old age.

One-third of all women over the age of 65 years have one or more vertebral fracture, which may be associated with severe and sometimes prolonged pain, spinal deformity, and loss of height.[2] Hip fracture, which affects one in three who survive to extreme old age, has a mortality rate of 12 to 20% at 6 months and results in increased deficiency and/or hospitalization in the majority of survivors.[3]

In developing countries, including South Africa, osteoporosis among black South African women has failed to attract adequate attention. A number of reasons can be cited for this poor knowledge and, hence, neglect of this condition in a select population group in South Africa. First, healthcare policies are geared toward giving priority to infectious diseases (high on the list is human immunodeficiency virus), as well as noncommunicable diseases such as hypertension, diabetes, and coronary heart disease. Second, limited resources for timely diagnosis and the paucity of information and data on osteoporosis among black South African women have contributed to this neglect.[4] The present gap in the knowledge and the enormity of the problem of osteoporosis among black South African women need to be addressed. Early detection of the BMD being compromised as women transit from premenopause through perimenopause could provide a guide for averting the consequences of osteoporosis after menopause. Information derived from this study highlights the need for this type of surveillance in other developing countries with similar notion of the needs of women as they transit to menopause and beyond.

MATERIALS AND METHODS

The participants in this study were recruited from the group of women who had participated in another study looking at the sociodemographic and psychosomatic characteristics of menopausal black South African women. All participants were, at the time of this study, resident in Ga-Rankuwa, Soshanguve, and Odi districts of northern Pretoria, South Africa. The areas covered by these districts are semiurban and the population consists of people who have migrated from the North West of South Africa and Limpopo Provinces, seeking better opportunities in the Gauteng province.

The study consisted of 68 women aged between 32 and 77 years, who were classified into three distinct groups based on their menstrual history:

1. Premenopausal women—participants who were menstruating regularly and were not on any hormone therapy.
2. Perimenopausal women—participants who were menstruating with episodes of amenorrhoea lasting several months but less than 12 months.
3. Menopausal women—participants who had not menstruated for 12 months or more.

Following ethical approval for the study by the Institutional Review Committee of Sefako Makgatho Health Sciences University, each of the women signed an informed consent form to participate in the study. Participation in the study necessitated each participating woman providing the following accurate information of relevance:

- Previous occurrence of fractures
- Family history of fractures
- Life style of the participant—to establish present or past involvement in smoking or alcohol intake
- History of drug usage, to exclude corticosteroid therapy, usage of highly active antiretroviral drugs or antiepileptic drugs
- Presence of chronic diseases such as diabetes, hypertension, or cardiac disease

MEASUREMENTS

The BMD at the femoral neck and the lumbar spine (L1-L4) expressed as gm/cm^2 was measured using DEXA with Hologic 4500 densitometer (Hologic Inc.; Massachusetts, USA). The radiation dose with this method is negligible at 0.28 μGy. Body weight was measured as a standing weight (without shoes) using a calibrated electronic scale. Body mass index (BMI) was calculated as ratio of weight over height (in meters squared). The DEXA result of BMD was expressed as T-score based on WHO classifications.[5] The statistical tool used to analyze the results was Statistical Package for the Social Sciences, version 22.0.

The WHO definitions of osteopenia and osteoporosis (Table 1) used to interpret spine and hip BMD results from DEXA in white women are as follows (there are no estimates of DEXA BMD values for black South African women):

RESULTS

All the women who participated in the study were found to be healthy with none of the above-listed medical conditions. In Table 2, the average age [± standard deviation (SD)] of the women in this group was 37 years (±2.98). Based on the DEXA results in this cohort, 2 of the 8 premenopausal women (25%) were found with evidence of osteopenia. The two women who were diagnosed with osteopenia had DEXA results as (–1.30) and (–1.16).

Table 3 illustrates the average age (±SD) of the women who were in their perimenopausal state and this was 45.7 years (±4.0). Based on the DEXA results for this group, 2 of the 28 perimenopausal women (7.1%) were adjudged to have evidence of osteopenia with DEXA results of (–1.42) and (–1.79).

Among the women who were defined as having attained menopause (Table 4), the average age (±SD) of

Table 1: T-score based on WHO classifications

Terminology	*T-score definition*
Normal	$T \geq 1.0$
Osteopenia	$(-2.5) < T < (-1.0)$
Osteoporosis	$T \leq (-2.5)$
Established osteoporosis	$T \leq (-2.5)$ in the presence of one or more fragility fractures

Table 2: Results of BMD evaluation of premenopausal women

Age	*Weight (kg)*	*Height (cm)*	*BMI*	*Average BMD (L1–L4)*	*Average BMD (Hip)*	*T-score*	*Results*
32	83	155.0	34.50	1.108	1.154	+1.72	Normal
34	72	163.0	27.00	0.976	1.043	+1.10	Normal
36	97	167.5	34.89	1.155	1.060	+1.26	Normal
37	79	152.5	34.00	0.916	0.867	–1.30	Osteopenia
38	93	163.0	35.00	0.839	0.992	–1.16	Osteopenia
38	96	155.0	40.00	1.128	1.026	+1.99	Normal
40	89	163.0	33.50	1.304	1.070	+2.69	Normal
41	87	162.0	33.10	1.028	1.247	+1.39	Normal

Table 3: Results of BMD evaluation of perimenopausal women

Age	*Weight (kg)*	*Height (cm)*	*BMI*	*Average BMD (L1–L4)*	*Average BMD (Hip)*	*T-scores*	*Results*
38	97.0	167.0	34.8	1.123	1.060	+2.10	Normal
40	62.0	162.0	23.6	1.039	1.035	+1.11	Normal
40	80.0	164.0	29.8	1.192	1.266	+1.85	Normal
41	72.0	152.0	31.1	1.122	1.021	+1.04	Normal
41	45.0	162.0	17.1	0.979	0.953	+1.01	Normal
43	96.0	157.0	39.0	0.875	1.065	+1.32	Normal
43	123.0	157.0	50.0	1.102	1.046	+1.17	Normal
43	70.0	164.5	26.0	0.976	1.057	+1.34	Normal
44	66.0	167.0	23.7	1.049	1.388	+2.90	Normal
44	82.0	174.5	27.1	1.047	1.090	+1.47	Normal
44	64.0	171.5	21.9	1.051	0.956	+1.17	Normal
45	120.0	157.0	48.0	0.995	1.139	+1.10	Normal
45	125.0	156.0	51.0	0.944	0.938	+1.00	Normal
45	82.5	160.0	32.2	1.097	1.135	+1.01	Normal
45	65.0	161.0	25.0	0.880	0.952	–1.42	Osteopenia
45	82.0	161.0	31.6	1.133	1.066	+1.00	Normal
46	79.0	172.0	26.7	1.181	1.096	+1.51	Normal
46	83.0	156.0	34.1	0.952	1.020	+1.04	Normal
48	90.0	160.5	35.1	1.063	1.270	+1.61	Normal
48	116.0	160.0	45.0	1.067	1.176	+1.63	Normal
49	52.0	158.0	20.0	0.763	0.855	–1.79	Osteopenia
49	74.0	170.0	25.6	1.034	1.113	+1.09	Normal
50	83.0	155.0	34.5	1.136	1.147	+1.49	Normal
50	71.0	165.0	26.0	1.128	1.013	+1.55	Normal
50	110.0	181.5	33.6	1.053	1.057	+1.52	Normal
52	72.0	159.0	28.5	1.140	0.999	+1.15	Normal
52	75.0	167.0	26.9	1.080	1.234	+1.54	Normal
54	103.0	166.0	37.3	1.204	1.320	+1.14	Normal

the women was 53.2 years (± 5.1). From this group, 11 of the 32 women (34.4%) were found with evidence of osteopenia and an additional 8 women (25%) had evidence of osteoporosis. The average age of women who had osteopenia was 55.6 years as compared with an average age of 68.0 years for those who were diagnosed with osteoporosis. The DEXA results for this group ranged between –1.20 and –2.18 for those who had osteopenia and between –2.65 and –3.21 for those with osteoporosis.

Table 5 reflects the composite evidence of osteopenia or osteoporosis among the three classified groups of women. Out of the 68 women, there were 22.0% cases of osteopenia cut across all three stages of menopause and an additional 25% of the cases of osteoporosis only in the postmenopausal group.

DISCUSSION

The study shows that there was 22% incidence rate of osteopenia in the whole study group, while 11.76% of the participants were osteoporotic (uncorrected for age). Osteopenia was detected even among premenopausal women—an indication that the process leading to bone

Table 4: Results of BMD evaluation of postmenopausal women

Age	Weight (kg)	Height (cm)	BMI	Average BMD (L1–L4)	BMD (Hip)	T-score	Results
43	71.0	153.0	30.3	0.914	0.925	–1.20	Osteopenia
45	70.0	165.0	25.7	0.839	0.928	–1.24	Osteopenia
46	100.0	161.0	2.4	1.089	0.956	+1.21	Normal
48	50.0	160.0	19.5	0.967	0.900	–2.18	Osteopenia
49	68.0	165.0	25.0	0.857	0.941	–2.08	Osteopenia
50	93.0	161.0	35.9	0.878	1.010	+1.12	Normal
51	70.0	163.0	26.4	0.906	0.925	+1.11	Normal
51	87.0	156.0	35.8	0.891	1.097	+1.14	Normal
52	72.0	157.0	29.2	1.064	1.113	+1.36	Normal
54	56.0	160.0	21.8	0.774	0.790	+1.00	Normal
54	83.0	154.0	35.0	1.032	1.031	+1.45	Normal
55	49.0	164.0	18.2	0.747	0.803	–2.94	Osteoporosis
55	82.0	153.0	35.0	1.398	1.411	+1.47	Normal
56	55.5	150.0	24.7	0.781	0.788	–1.89	Osteopenia
56	87.0	151.5	38.0	0.914	1.172	–1.45	Osteopenia
56	92.9	155.5	24.5	0.954	1.013	–1.60	Osteopenia
57	55.0	135.0	30.2	0.759	0.869	–2.19	Osteopenia
58	98.0	158.0	39.3	0.972	1.196	+2.00	Normal
60	82.0	155.5	33.7	1.091	1.023	+1.30	Normal
61	81.0	175.0	26.0	0.844	0.956	–2.09	Osteopenia
61	122.0	165.0	44.8	1.028	0.990	0.82	Normal
63	87.0	155.0	36.2	0.671	0.927	–2.65	Osteoporosis
64	95.0	155.5	39.0	1.010	1.175	–3.21	Osteoporosis
67	80.0	153.0	34.1	0.862	0.908	+1.10	Normal
68	80.0	164.0	29.8	0.751	1.026	–2.72	Osteoporosis
69	72.0	160.0	28.1	0.807	0.626	–2.81	Osteoporosis
69	99.0	174.0	32.7	0.851	0.872	–1.67	Osteopenia
70	92.5	155.0	38.7	1.079	1.263	+1.55	Normal
71	66.0	161.0	25.4	0.796	0.839	–2.78	Osteoporosis
72	67.0	152.0	29.0	0.868	0.890	–1.45	Osteopenia
77	56.0	140.0	28.6	0.760	0.926	–2.73	Osteoporosis
77	87.0	170.0	30.1	0.651	0.651	–3.00	Osteoporosis

Table 5: The overall evidence of osteopenia and osteoporosis among the three groups of women

Menopausal status of women (n = 68)	No. of women	Percent of total sample	No. of women with osteopenia	Percent	Percentage of women with osteoporosis
Premenopausal	8	12	2		0
Perimenopausal	28	41	2	22	0
Menopausal	32	47	11		8 (25%)

mineral resorption could have started long before the women became menopausal. This finding is partly supported by the work of Finkelstein et al,[6] which emphasizes that bone loss is accelerated from late perimenopause to menopause.

Obesity was recorded in all three groups of women Table 6 and more especially among the premenopausal women. This is contrary to the theory that obesity promotes increased bone mass as a result of peripheral conversion of androstenedione to estrone. Furthermore, previous reports[6-9] did indicate that African black women possess greater muscle mass and would, therefore, be expected to experience less of the characteristics of the consequences of menopause. According to two independent studies, one conducted in South Africa and the other in the United States, which appeared jointly in one publication,[10] the cortical bone histomorphometry[11] of the iliac crest in normal black African adults and Afro-Americans is thicker than their white South African counterparts and the Caucasians in the United States. The study by Solomon,[12] although was conducted many years ago, also elaborated on the fact that black South African women have stronger bone structure than their white counterparts. This may have contributed to less focus being placed on the problems of bone mineral loss during the menopause years among black South African women.

Table 6: Evidence of obesity among women in this study

	Number of women with BMI > 30.0	*Percent*
Premenopausal women (n = 8)	7	87.5
Perimenopausal women (n = 28)	14	50.0
Postmenopausal women (n = 32)	16	50.0

In the current study, there were 16 women who were obese among the postmenopausal women (50%). This may be attributable to a change of lifestyle of African women who lead a more sedentary lifestyle after menopause, with a diet rich in animal protein as a result of urbanization and an increase in a negative calcium imbalance. There is an increase in phosphate, which then leads to an increase in parathyroid hormone—an increase of which promotes urinary calcium excretion.

Large numbers of black population migrate from rural areas to cities to seek better work opportunities. This movement is accompanied by the change in lifestyle and dietary habits, which lead to major health consequences. The article by Seftel[13] has clearly highlighted the effect of urbanization and Westernization in the black South African women with development of noncommunicable diseases such as hypertensive disorders, atheroma with myocardial infarction, as well as diabetes type II. The two studies by Kruger et al[14-16] also support the hypothesis of Seftel that migration has a deleterious effect on the population because of the dietary and lifestyle changes, which may contribute to low bone mass.

A study done in Thailand comparing the effect of urbanization on two groups, namely, the urban and rural populations, clearly indicated that BMD in the rural population was higher in comparison with the urban population. This study has raised concerns that traditional ideas of nutrition are gradually being eroded and replaced by the Western world lifestyle, which is likely to lead to an increase in the prevalence of osteoporosis. This finding has been reinforced by the work of Yang et al[17] and that of Ponjgchaiyakul et al,[18] both of whom have also reported that rural population has a lower incidence of osteoporosis than their counterparts in the urban settings.

The study conducted in Morocco[18] has added the information about the effect of parity and dietary habits of women, with calcium deficiency and an overall consequence of bone demineralization. These factors seem to interact with one another in the reduction of BMD. Vitamin D deficiency and veiled clothing with less exposure to sunlight were cited as factors in this study, and the same findings had been corroborated by a similar study conducted in Saudi Arabia.[19]

The BMD was found to be higher among postmenopausal women of Trinidad and Tobago. This finding is attributed to strong genetic makeup, healthy lifestyle, and probably due to low European admixture as well as the use of thiazide diuretic.[20]

The overemphasis of the protection from osteoporosis among African-American women is mainly due to disparity of osteoporosis screening between them and their white counterparts. The fact that African-Americans have higher BMDs than Caucasians throughout life does not mean that postmenopausal bone loss that occurs in Caucasians will not manifest among the African-Americans.[21-23] The present study also attests to the fact that black African women are not immune to the effects of bone mineral loss during the menopause years.

Large studies aimed at identifying the prevalence of osteoporosis have failed to include a large population of Afro-American women. However, three articles have indicated that osteoporosis is a reality among African-Americans with an incidence rate ranging from 15 to 28%. Although the articles reported on studies conducted with small sample sizes, however, their common finding points to the existence of the reality of osteoporosis existing among women of African descents living in the United States.[24-27]

A study by Solomon[28] in South Africa, which was conducted more than 30 years ago, did not find any osteoporosis among black South African women. This study assessed BMD by using anteroposterior radiographs of the second metacarpal bone. This method cannot be extrapolated to the hip as well as to the vertebrae in determining the BMD. In contrast, more recent studies by Kruger et al[29] and the work of Conradie et al[30] have confirmed that there is osteoporosis among black South African women. The current study, although from a small sample population of black South African women, further provides additional evidence that corroborates previous reports of the studies alluded to in the present study.

CONCLUSION

Osteoporosis exists among black South African women. The inclusion of urbanization among the risk factors for this population is necessary and relevant to the fact that the occurrence of osteopenia and osteoporosis is not confined to Caucasians. The need for an osteoporosis clinic, with a multidisciplinary approach and reinforcement of screening strategies, is a recommendation, especially in academic hospitals in South Africa where adequate logistics are likely to be available.

REFERENCES

1. NIH Consensus Development Panel on Osteoporosis Prevention, Diagnosis, and Therapy. Osteoporosis prevention, diagnosis, and therapy. JAMA 2001 Feb 14;285(6):785-795.
2. The Johns Hopkins University of Hygiene and Public Health. Epidemiol Rev 1985;7:178-208.

3. Melton LJ, Riggs BL. Clinical spectrum. In:Riggs BL, Melton LJ, editors. Osteoporosis: aetiology, diagnosis, and management. New York (NY): Raven Press; 1988. p. 155-179.
4. Handa R, Kalla AA, Maalouf G. Osteoporosis in developing countries. J Best Pract Res Clin Rheumatol 2008;22(4)693-708.
5. World Health Organization. Report of a WHO Scientific Group – Prevention and management of osteoporosis. World Technical Report Series 921; 2003.
6. Finkelstein JS, Brockwell SE, Mehta V, Greendale GA, Sowers MR, Ettinger B, Lo JC, Johnson JM, Cauley JA, Danilson ME, et al. Bone mineral density changes during the menopause transition in a multiethnic cohort of women. J Clin Endocrinol Metab 2000 Mar;93(3):861-868.
7. Aloia JF, Vaswani A, Ma R, Flaster E. Comparison of body composition in black and white premenopausal women. J Lab Clin Med 1997 Mar;129(3):294-299.
8. Cohn SH, Abesamis C, Zanzi I, Aloia JF, Yasumura S, Ellis KJ. Body elemental composition: comparison between black and white adults. Am J Physiol 1977 Apr;232(4):E419-E422.
9. Wang MC, Bachrach LK, Van Loan M, Hudes M, Flegal KM, Crawford PB. The relative contributions of lean tissue mass and fat mass to bone density in young women. Bone 2005 Oct;37(4):474-481.
10. Aloia JF, Vaswani A, Ma R, Flaster E. Body composition in normal black women: the four-compartment model. J Clin Endocrinol Metab 1996 Jun;81(6):2363-2369.
11. Schnitzler CM, Mesquita JM. Cortical bone histomorphometry of iliac crest in normal black and white South Africans. Calcif Tissue Int 2006 Dec;79(6):373-382.
12. Solomon L. Osteoporosis and fracture of the femoral neck in the South Africa Bantu. J Bone Joint Surg Br 1968 Feb;50(1):B2-B12.
13. Seftel HC. Diseases in urban and rural Black populations. S Afr Med J 1977 Jan 29;51(5):121-123.
14. Kruger MC, de Winter RM, Becker PJ, Vorster HH. Changes in markers of bone turnover following urbanisation of Black South African women. SAJCN 2003;16:104-108.
15. Kruger MC, Kruger IM, Wentzel-Viljoen E, Kruger A. Urbanization of black South African women may increase risk of low bone mass due to low vitamin D status, low calcium intake, and high bone turnover. Nutr Res 2011 Oct;31(10):748-758.
16. Kruger SH, Venter CS, Vorster HH, THUSA Study. Physical inactivity as a risk factor for cardiovascular disease in communities undergoing rural to urban transition: the THUSA study. Cardiovasc J S Afr 2003 Jan-Feb;14(1):16-23.
17. Yang TS, Chen YR, Chen YJ, Chang CY, Ng HT. Osteoporosis: prevalence in Taiwanese women. Osteoporos Int 2004 Apr;15(4):345-347.
18. Ponjgchaiyakul C, Nguyen TV, Kosulwat V, Rojroongwasinkul N, Charoenkiatkul S, Rajatanavin R. Effect of urbanization on bone mineral density: a Thai epidemiological study. BMC Musculoskelet Disord 2005 Feb 4;6:5.
19. Allali F, Maaroufi H, Aichaoui SE, Khanzani H, Saoud B, Benyahya B, Abouqal R, Hajjaj-Hassouni N. Influence of parity on bone mineral density and peripheral fracture risk in Moroccan postmenopausal women. Maturitas 2007 Aug 20; 57(4):392-398.
20. Sadat-Ali M, Al-Habdan IM, Al-Mullhim FA, El-Hassan AY. Bone mineral density among postmenopausal Saudi women. Saudi Med J 2004 Nov;25(11):1623-1625.
21. Hill DD, Cauley JA, Bunker CH, Baker CE, Patrick AL, Beckles GL, Wheeler VW, Zmuda JM. Correlates of bone mineral density among postmenopausal women of African Caribbean ancestry: Tobago women's health study. Bone 2008 Jul;43(1):156-161.
22. Gourlay ML, Callahan LF, Preisser JS, Sloane PD. Osteoporosis preventive care in white and black women in community family medicine settings. South Med J 2007 Jul;100(7): 677-682.
23. Miller RG, Ashar BH, Cohen J, Camp M, Coombs C, Johnson E, Schneyer CR. Disparities in osteoporosis screening between at-risk African-American and white women. J Gen Intern Med 2005 Sep;20(9):847-851.
24. Sadler C, Huff M. African-American women: health beliefs, lifestyle, and osteoporosis. Orthop Nurs 2007 Mar-Apr;26(2):96-101.
25. Wallace LS, Ballard JE, Holiday D, Turner LW, Keenum AJ, Pearman CM. Evaluation of decision rules for identifying low bone density in postmenopausal African-American women. J Natl Med Assoc 2004;96(3):290-296.
26. Woodson GC. Risk factors for osteoporosis in postmenopausal African-American women. Curr Med Res Opin 2004 Oct;20(10):1681-1687.
27. Wilkins CH, Goldfeder JS. Osteoporosis screening is unjustifiably low in older African-American women. J Natl Med Assoc 2004 Apr;96(4):461-467.
28. Solomon L. Bone density in an ageing Caucasian and African populations. Lancet 1979 Dec 22-29;2(8156-8157):1326-1330.
29. Kruger IM, Kruger MC, Doak CM, Kruger A. Cut-off values of distal forearm bone density for the diagnosis of central osteoporosis in black postmenopausal South African women. J Endocrinol Metabol Diabet S Afr 2012;17(2)65-112.
30. Conradie M, du Plessis M, Hough FS. Ethnic differences and bone density and vertebral fracture prevalence between black and white South African females. JEMDSA 2005;10(1):40-45.