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A CROSS SECTIONAL ANALYSIS ON THE ASSOCIATION BETWEEN PHYSICAL PERFORMANCE AND BONE MINERAL DENSITY OF INDIAN OSTEOPENIC AND OSTEOPOROTIC WOMEN

Amitava Ghosal [*1], Dr. Nita Bandyopadhyay [2]

[*1] Corresponding Author, Department of Physical Education, University of Kalyani, India.
[2] Department of Physical Education, University of Kalyani, India.

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ABSTRACT

The present study were to observed the difference in Bone Mineral Density (BMD), physical functioning, and body composition parameters between Osteopenic and Osteoporotic women and the association between BMD and physical functioning, body composition parameters. Total 51 Indian women were divided into Osteoporotic (N = 21, 56.809 yrs. ± 1.794) and Osteopenic (N = 30, 39.933 yrs. ± 0.911) groups. Distal radius BMD measured through Quantity Ultrasound. Physical functioning test included grip strength, gait velocity; Body composition parameter included Fat Body Mass, Lean Body Mass. For statistical analysis, Independent sample t-test, linear regression, Receiver Operating Characteristics were computed. Osteoporotic group BMD, grip strength, gait velocity and lean mass were significantly lower than Osteopenic group. Only the fat mass didn't shown the significant difference between the groups. The results of regression shown that grip strength, velocity of gait, lean mass, fat mass significantly predict the BMD. This study concluded that BMD, physical functioning and body composition parameters of Osteoporotic women were lower than Osteopenic women. Physical functioning and body composition parameters significantly predict the BMD of both groups. Specifically, velocity of gait was a good predictor of BMD of Osteoporotic women.

KEYWORDS: Bone Mineral Density, Osteoporotic, Osteopenic, Physical functioning, Body composition.

I. INTRODUCTION

Gender is a most important factor one of many social determinants of health, which include social, economic and political factors, which play vital role for health outcome of Indian women. Currently the highest amount of malnourished women is presence in India compare to other developing countries and malnutrition increase for married women compare to non-married women [1]. Another reason for poor health of Indian women is preferential treatment for girls compare to men [2]. Osteopenia and osteoporosis or low Bone Mineral Density (BMD) is a major risk for Indian women. Approximately 35 – 40% of Indian women aged 40 – 65 years suffer from osteopenia. It is reported that 42.5% women and 24.6% men above the age of 50 years suffer from osteoporosis in India. In India, peak bone mineral density (BMD) at hip, forearm and spine is significantly lower than corresponding western counterparts. Lack of sufficient calcium intake and inadequate exercise are the cause of low bone density of Indian women. Bone density reaches its peak at the age of 20 to 35 years, after that the processes are declining. At the age 40 the bone loss less than 0.5 percent of their mass per year. Post-menopausal women loss 2 – 3% or more bone mass per year. If that is not preventing, then from year of 70 – 80 a woman can loss 50% of her peak bone mass [3] [4] [5] [6] [7] [8] [9]. Women face more than double the risk of getting fractures compared with men, largely due to osteoporosis, or major loss of bone mass. It is one of the reason; they spend 10.7% of their lives in poor health, compared with 9.4% for men [3]. Women start to lose bone mass from age 35, against 45 for men. Between 2007 and 2009, 1,477 women and 634 men per thousand fractured their hips each year. These fractures often result in long periods of immobility, loss of muscle strength and bedsores. The bone loss of women does at a faster rate 0.75 % to 1 % a year compared with 0.5 % a year for men [3] [4] [5]. Ghosal & Bandyopadhyay, (2017) reported that adequate calcium intake, vitamin D synthesis, and exercise are the crucial elements in determining peak bone mass and greater protection against fractures in later life. There is thus an urgent need for greater public awareness, and appropriate govt. policy should be adopted India immediately for elder population especially for postmenopausal women. Inclusion of osteoporosis as a National

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Health Priority programmes in the context of elder population of India [4]. The purpose of this present study to observed the difference in BMD, physical functioning, and body composition parameters between Osteopenic and Osteoporotic women. And to observed the association between BMD and physical functioning, body composition parameters.

II. MATERIALS AND METHODS

Subjects

Total 51 Indian women were recruited from the city of Kalyani from state of West Bengal through the help of some local renounce person and instructors of the Department of Physical Education, University of Kalyani. The subjects were divided into two groups Osteoporotic (N = 21, 56.809 yrs. ± 1.794) and Osteopenic (N = 30, 39.933 yrs. ± 0.911). The oral informed consent obtained from the subjects and the Institutional research committee approved the study. The remaining subjects were excluded due to below age category, injury due to household work, weak health status like high blood pressure, uric acid problem, thyroid problem, some metabolic problem, osteoarthritis, arm dislocation etc. Selected subjects belong to lower socioeconomical status, which was predicted through their approximate monthly family income.

Personal data

Age was evaluated through the date of birth, weight and height were measured with minimal cloth and without shoes.

Physical performance test

Handgrip strength (DFLXGS) and 10 m gait speed (MS6) were measured. All physical performance test was measured twice and mean value was use for analysis. Dominant handgrip strength with 90^0 flexion with standing position was measured with grip dynamometer. Walk without assistance for 10 meters with time measured for the intermediate 6 meters, with the command 'Ready Set Go' subject started to walk normal comfortable speed with wearing regular footwear. Time taken by stopwatch when the toes of the leading foot crosses the 2 meter mark and stop timing when the toes of the leading foot crosses the 8 meter mark. Investigator measured the Isometric grip strength and velocity of gait, to assess the strength level and gait movement with BMD of the subjects [10] [11] [12] [13] [14] [15].

Body composition parameters

Fat Body Mass (FBM) and Lean Body Mass (LBM) were measured. Durnin, and Womersley four-site skin fold caliper method (Sum of biceps, triceps, subscapular and suprailiac skinfold thickness in mm.) was used to assess the percentage of body fat and convert into mass (kg) with the help of total body weight with online linear software.com [16] [17].

Bone Mineral Density (BMD) test

Measured the distal radius site through Quantity Ultrasound Technology (Sunlight Miniomni Maclure software). And obtained SD of T score was used for analysis and group selection according to WHO scientific group on the assessment of osteoporosis report [18].

Statistical analysis

All the statistical analyses were performed by using SPSS, version 21.0 on windows 10.0 and significant level considered 0.05. At first the descriptive statistics was (mean and SD) computed for simpler interpretation of the data. Shapiro-Wilk test and Kolmogorov – Smirnov test were computed to determine the sample data has been drawn from normally distributed population or not and Levine's Test was computed for homogeneity test to determine the equal distribution of single categorical variables of the groups and found satisfactory results. Independent sample t-test was computed to find difference between the groups. OLS Multiple regression analysis (Ordinary Least Square) used to examine the independent effects of parameters on BMD with assumption of multicollinearity and autocorrelation. Receiver operating characteristics (ROC) curves used to determine the sensitivity and specificity of selected tests of two groups [10] [11] [19].

Figure 1. Summary of the recruitment strategy and allocation.

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III. RESULTS

Table 1. Characteristics of all selected parameters

	Osteoporotic	Osteopenic
Subjects	21	30
Age (years)	56.809 ± 1.794	39.933 ± 0.911
Height (cm)	150.931 ± 1.294	152.450 ± 0.761
Weight (kg)	58.476 ± 1.923	62.133 ± 1.466
BMD (Distal radius T Score)	-2.819 ± 0.244	-1.797 ± 0.312
DFLXGS (kg)	21.739 ± 8.001	29.058 ± 6.923
MS6 (m/s)	0.966 ± 0.082	0.820 ± 0.106
FBM (kg)	24.338 ± 4.891	23.679 ± 4.499
LBM (kg)	34.764 ± 5.126	38.442 ± 4.297

Table 2. Multiple Regression Analysis between dependent and independent variables of present data.

Model	**Unstandardized coefficients**		***t***	***P***	**Collinearity statistics**
	B	***Std. Er.***			***VIF***
(Constant)	-1.948	0.692	-2.816	0.01	
MS6	-2.052	0.483	-4.251	0.01	1.177
DFLXGS	0.021	0.007	2.959	0.01	1.203
LBM	0.047	0.013	3.555	0.01	1.474
FBM	-0.031	0.013	-2.311	0.05	1.340
R = 0.781	***R Square*** = 0.610		***Adjusted R Sq.*** = 0.576		***S.E. of the estimate*** = 0.379
Durbin-Watson = 1.900			***F-stat*** = 17.988 (*P* = 0.01)		

Linear regression was calculated to predict the BMD based on all the variables. From Table 2 significant regression equation was found (df = 4, 46 F = 17.988, P < 0.01). F statistics was smaller than 0.01, then the IV (Independent Variables) did a good to explaining the variation in the DV (Dependent Variables). R, R^2, adjusted R^2, Durbin Watson test, VIF (Variance Inflation Factor) finds how well the model fits the data. R was the correlation between observed and predicted values of DV. R of this factor regression was 0.781, which was close to positive 1, and values indicated stronger relationship. R^2 was the proportion of variation in the DV explained by the regression model. The values of R^2 of the factors was 0.610, which indicated that the model was good fit in this study. Also said that, the model contained factors can explain 61% variation of BMD. Adjusted R^2 of factors was 0.576, which was more closely to reflect the goodness of fit of the model in the study. Also said that more precisely 57.6% of variables of BMD closely related to the factors. Durbin Watson tested the present data; the value was 1.900, which was close to 2 that the assumption had almost certainly been met. All VIF value of variables were ranges of 1.177 to 1.474 well below the cutoff value of 5. Which indicated that they moderately correlated, multicollinearity was not threat to the substantive conclusion of this study and data was reliable. It was mentioned that higher the VIF value less reliable the regression result. After the confirmation for the model fit, want to know the relative importance of each predictor (IV) in predicting BMD (DV). The Beta coefficients value was necessary for predicting the dependent variables from the independent variables. The unstandardized beta coefficients was considered for the analysis. The first variables 'Constant' referred to as the Y intercept, the height of the regression line when crosses the Y-axis. In other words, this was the predicted value of performance improvement when all other variables was zero. The predicted value of this study was -1.948 which was significant at 0.01 level. The regression equation written as, the participant predicted BMD = {-1.948 - 2.052 (MS6) ** + 0.021 (DFLXGS) ** + 0.047 (LBM) ** – 0.031 (FBM)*}. The coefficient for MS6 was -2.052 which shows negative relationship and so for every m/s decrease in MS6 or velocity of gait, 2.052 unit increase in BMD was predicted, holding all other variables constant and t value shows significant result (P < 0.01). The coefficient for DFLXGS was 0.021, so for every kg increase in DFLXGS, 0.021 unit increase in BMD was predicted, holding all other variables constant, though the t value shows significant result (P < 0.01). The coefficient for LBM was 0.047, so for every kg increase in LBM, 0.047 unit increase in BMD was predicted, holding all other variables constant, though the t value shows significant result (P < 0.01). The coefficient for FBM was -0.031, which shows

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negative relationship and so for every kg decrease in FBM, 0.031 unit increase in BMD was predicted, holding all other variables constant and t value shows significant result (P < 0.05).

Table 3. Comparison of characterstics of physical function and anthropometric parameters between osteoporotic and osteopenic group.

Variable	Gr.	*df*	*SED*	*t value*	*P*
BMD	Osteoporotic	49	0.082	-12.54**	0.01
	Osteopenic				
DFLXGS	Osteoporotic	49	2.100	-3.485**	0.01
	Osteopenic				
MS6	Osteoporotic	49	0.028	5.32**	0.01
	Osteopenic				
FBM	Osteoporotic	49	1.327	0.496	0.62
	Osteopenic				
LBM	Osteoporotic	49	1.323	-2.778**	0.01
	Osteopenic				

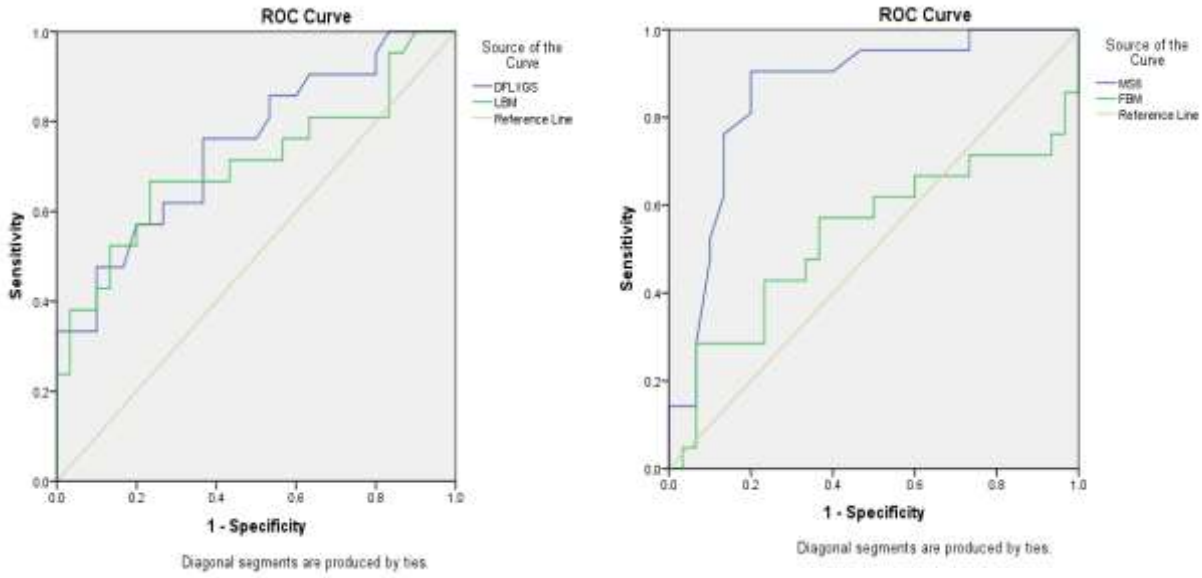

Figure 2, 3. ROC curve of physical functioning and body composition parameter.

Table 4. Area Under Curve (AUC) of ROC of physical functioning and body composition parameter.

Variables	Area	Std. Er.	Asymptotic Sig.
DFLXGS	0.747	0.070	0.001
LBM	0.707	0.079	0.013
MS6	0.857	0.055	0.000
FBM	0.532	0.090	0.702

Area Under the Curve of ROC of MS6 scored perfectly predicting the bone health status of osteoporotic women, the score value indicated good result. DFLXGS and LBM, AUC score fairly predicting the bone health status of osteoporotic women. FBM scored below 0.6 for the reason it was not considered as a predictor.

IV. DISCUSSION

From total selected subjects 41.18% were osteoporotic and 58.82% were osteopenic women. The average age of osteoporotic women were higher than osteopenic women. The result of the independent sample t-test shows

osteoporotic group BMD, grip strength, gait velocity and LBM were significantly lower than osteopenic group. Only the FBM didn't shown the significant difference between the groups. And the results of regression analysis shown that grip strength, velocity of gait, LBM and FBM significantly predict the BMD of distal radius. And with improvement in any one parameter BMD should be improved.

Modifiable factors associated with bone density were body composition and muscle strength. Both lean mass and fat mass increases the mechanical load on wt. bearing bones. LBM may have additional effects on the skeleton by reflecting physical activity, which associated with muscle contraction. FBM also especially influential on women because conversion adrenal androgen to estrogen. Muscle strength also a predictor of BMD [20]. Redistribution of FBM or adipose tissue was consequence of aging. This redistribution may not be detected by measuring weight or BMI. Therefore, body composition measurement might be appropriate and useful in aging [21]. Present study indicated that both LBM and FBM play a significant role for improvement of the BMD for both osteopenic and osteoporotic women. And the result of ROC curves shown that LBM weas fairly predicting the BMD of osteoporotic women. But FBM was not considered as a predictor. Pham et al. reported that there was a gender related difference in the association between body composition and BMD among the women, the association depends on menopausal status. In premenopausal women LBM, more important predictor than FBM, but in post-menopausal women FBM was better or equivalent predictor for BMD. The association between BMD and LBM indicated that greatest load in the skeleton come from muscle. Increase physical activity translate the mechanical load to the bone through the muscle where joined with bone which protected against bone loss. Moreover, the association between FBM and BMD indicated that sex hormone or estrogen and nutrients also play a crucial role in improving the density of bone. Especially female adipose tissue more sensitive and higher expression of estrogen receptor and with the help aromatase enzyme converts the androstenedione to estrogen, which prevent the bone loss [22]. Present study indicated that grip strength played a significant role for improving BMD for both osteopenic and osteoporotic women. And the result of ROC curve shown that grip strength was fairly predicting the BMD of osteoporotic women. Dixon et al. and Kim et al. concluded that low grip strength was associated with low BMD of the spine, femoral neck, total hip, forearm and with increased the risk of previous fragility fracture [23] [24]. Karkkainen et al. suggest that grip strength could be used in medical decision making to the women that would benefit from BMD measurement [10]. Present investigation shown that the velocity of gait may promote osteogenic effect on distal radius BMD. The result of ROC curve proved that velocity of gait perfectly predicting the bone health status of osteoporotic women. The impact of load against gravity, which stimulate the biomechanical component, help to prevent bone loss. For this reason velocity of gait associated with BMD. Minematsu et al. concluded that 10m gait time was a good predictor of low bone mass and easy to measure, low cost and self-measured [11]. Lindsey et al. concluded that gait speed, grip strength were associated with BMD of the whole body, hip, spine and forearm and physical functioning evaluation help with prevention and treatment of osteoporosis for postmenopausal women when bone density score had not been obtained [12].

V. CONCLUSION

From this study, it was concluded that, BMD, physical functioning and body composition parameters of Osteoporotic women was lower than Osteopenic women. Measurement of physical functioning and body composition parameters significantly predict the bone mass of both groups of women and specifically velocity of gait was a good predictor of BMD of Osteoporotic women. And with improvement of any one parameter BMD should be improved. This study was helpful in prevention and treatment of Indian Osteoporotic and Osteopenic women.

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