International Journal of Physiotherapy and Research,
Int J Physiother Res 2017, Vol 5(2):1920-25. ISSN 2321-1822
DOI: https://dx.doi.org/10.16965/ijpr.2017.102

Original Research Article

ASSOCIATION OF BONE MINERAL DENSITY AND BODY MASS INDEX WITH BALANCE AND MOBILITY IN YOUNG FEMALE ADULTS: A HYPOTHESIS

Sarala Khangare *[1], Bhavana Mhatre [2], Amita Mehta [3].

*[1] PhD Scholar, Physiotherapy School and Centre, Seth G.S Medical College and KEM Hospital, Mumbai, India.

[2]Associate Professor, Physiotherapy School and Centre, Seth G.S Medical College and KEM Hospital, Mumbai, India.

[3] Professor and Head of Department, Physiotherapy School and Centre, Seth G.S Medical College and KEM Hospital, Mumbai, India.

ABSTRACT

Background: Obesity and osteoporosis poses major health problems in India. Both have multifactorial etiologies including genetic and environmental factors. Osteopenia seems to start at an early age of 20 years in Indian female Population and after 35 years there is a sharp decline in bone mineral density with peak at old age. Recent studies show that low bone mineral density (BMD) and high body mass index (BMI) impairs physical function and may cause morbidity and mortality in older adults. However, there is a need to evaluate association of BMI and BMD with balance and mobility in young adults, so that risk factors can be modified and effective treatment strategies to improve BMD and BMI can be incorporated in young age.

Materials and Methods: Analytical correlational study includes 450 female participants in the age group of 20-40 years. BMI is calculated using height and weight measurements. BMD is measured by Ultrasound bone densitometer. For tests of balance and mobility, narrow walk test, obstacle walk test, figure-of-8 walk test, and gait speed is used.

Hypothesis: Risk factors such as dietary habits, sedentary lifestyle, decreased sun exposure, hormonal imbalance due to stress etc can result in decrease in BMD and increase in BMI in young female adults. Also, biomechanical and neurophysiological changes that occurs in osteoporosis and obesity can affect balance and mobility. We hypothesized that, decrease in BMD and increase in BMI can affect or impair balance in young female adults.

Clinical Importance: This study will help to create awareness socially in younger females about risk factors of osteopenia, osteoporosis and obesity and its detrimental effects on functional mobility in females. Therapeutic exercises and changes in diet and lifestyle can be incorporated in young age accordingly that will help them to achieve optimum healthy bone mass and body weight improving their health and quality of life in future.

KEY WORDS: Bone Mineral Density, Osteoporosis, Obesity, Body Mass Index, Balance, Mobility.

Address for correspondence: Dr. Sarala Khangare (PT), Physiotherapy School and Centre, Seth G.S Medical College and KEM Hospital, Parel, Mumbai, India.
E-Mail: saral.machhirke@gmail.com

Access this Article online

Quick Response code

DOI: 10.16965/ijpr.2017.102

International Journal of Physiotherapy and Research
ISSN 2321- 1822
www.ijmhr.org/ijpr.html

Received: 04-01-2017	Accepted: 09-02-2017
Peer Review: 04-01-2017	Published (O): 11-04-2017
Revised: None	Published (P): 11-04-2017

INTRODUCTION

Osteoporosis and Obesity are two common complex conditions which [1] poses major public health problems associated with significant

morbidity, mortality and socioeconomic burden [2-5]. Both have multifactorial genetic and environmental etiologies. Osteoporosis is a skeletal disorder characterized by low bone mass and changes in bone tissue leading to bone fragility and decreased bone strength [2,6]. In India, the osteoporosis is highly prevalent, with an estimated 30 million women diagnosed to have osteoporosis [7,8]. According to study conducted at Mumbai in Maharashtra in 2012 (Silvanus et al), the prevalence of osteopenia in the age-group of 20-39 years was 27.8% whereas osteoporosis was 8.3% [6]. Osteopenia and osteoporosis seems to start early at an age of 30-35 years in the Indian female population and after 35 years there is a decline in bone mineral density with its peak in older age [6-8].

Osteopenia is a condition of bone in which there is a generalized reduction in bone mass that is less severe than in osteoporosis, caused by the resorption of bone at a rate that exceeds bone synthesis [6]. In India, there is a high prevalence of risk factors such as darker skin pigmentation, sedentary lifestyle, reduced physical activity, limited sun exposure, dietary deficiencies of calcium and vitamin D, premature menopause, excessive intake of carbonated drinks, high intakes of salty foods which pulls urban women at a higher risk for osteopenia and osteoporosis [2,3,7,8]. Similarly, young girls and women with athletic amenorrhea, anorexia nervosa, excessive dieting and hyperprolactinemia are more prone to low bone density levels [9]. Factors affecting bone mass development during childhood or adolescence can have potential long standing detrimental effects on bone health predisposing individual to osteoporosis and fracture risk [10]. Sagesse et al suggested that the bone has a unique plasticity that can be therapeutically exploited in the osteoporosis prevention and management. The bone plasticity is present at any age, including old age, but it is more evident in children and adolescence [10].

Obesity is a condition in which there is a excess storage of body fat resulting from the chronic imbalance between energy intake and energy expenditure [1]. In India, according to Kalra (2012), the percentage of women who are overweight or obese is highest in Punjab (30%), followed by Kerala (28%) and Delhi (26%). According to National Family Health Survey in Maharashtra based on the data from the 2007, 15.9% males and 18.1% females were affected by obesity [11].

Risk factors like sedentary life-style, unhealthy food habits, cultural practices are posing more young adults prone for obesity [12]. Further, obesity is associated with multiple comorbidities such as type-II diabetes mellitus, dyslipidemia, cardiovascular diseases, polycystic ovarian disease, hypertension, some forms of cancers, sleep apnea and metabolic syndromes which are increasingly becoming common among children and urban adolescents which reduces overall quality of life [4,12].

Body Mass Index (BMI) is widely used inexpensive tool to measure degree of obesity with good validity [1,13]. Ultrasound bone densitometer uses a low dose of radiation in a simple and painless way to measure bone mass and measurements are usually performed at the calcaneous [14,15].

Obesity and osteoporosis, both are associated with reduced postural control and stability in older adults. It may cause difficulty in performing functional mobility leading to trips, slips and falls which can in turn hampers the health related quality of life [16,17]. Obesity is associated with alterations in biomechanical factors which can influence postural sway and can impair physical performance,[18] whereas in osteoporosis decreased bone strength and joint pains can increase the risk of impaired postural stability, falls and fractures even with minor trauma [2,19]. Thus, assessment of balance and mobility becomes integral part in evaluation of altered BMD and BMI.

Functional mobility is defined as the manner in which people are able to move around in the environment in order to participate in activities of daily living and move from place to place [16]. Movements include standing, bending, walking and climbing etc. Clinical assessments of balance and mobility can be a feasible measure of functioning in daily life [15,20,21].

Previous literature suggests that, high BMI is positively associated with disability and impaired physical function in older adults,

whereas low BMD is associated with low physical performance and a high risk of falls and fractures in elderly population [17,20,21,22]. However, there exists a paucity of research on how physical function is affected by BMD and BMI in younger age group. As more and more young adults are getting prone to low bone mass and increase in body weight, understanding the balance and mobility impairments associated with obesity, osteopenia and osteoporosis and addressing them, along with the personal and environmental factors that influence them is key to develop safe and effective interventions in young adults.

Hypothesis: Recent literature suggest that relationship between Bone Mineral Density (BMD), Bone Mass Index (BMI) and balance and mobility have been examined but in the individuals with severely obese and older adults population [2,15,17,20,22]. There is an decrease in mobility with decrease in Bone Mineral Density and increase in Body Mass Index in older adults affecting their health related quality of life [20,22]. It becomes difficult to manage disabilities in elderly, so there is a need to analyse it in younger age, so that effective management strategies can be incorporated early. Osteopenia seems to start early at an age of 20 years in the Indian female population due to various risk factors. Also, obesity is on the rise in young Indian females [11]. Obesity is also considered as a risk factor for osteoporosis [23]. Biomechanical and neurophysiological changes that occurs in osteoporosis and obesity can affect balance and mobility [24,25] in young adults leading to disability in future life. Risk factors like sedentary lifestyle, decreased sun exposure, dietary habits, hormonal imbalance due to stress, reduce physical activity can result in decrease in bone mineral density and increase in body mass index in young female adults.

Thus, it is hypothesized that, the decrease in bone mineral density and increase in body mass index can affect/impair balance and mobility in young female adults in the age group of 20-40 years. The present research aims to study how many female participants have Bone Mineral Density <-1(T-score) and Body Mass Index (BMI)≥25kg/m and to study the association/ correlation of BMD and BMI with balance and mobility in young female adults (age-group 20-40 years). A analytical correlational study will be carried out post ethical approval in hospital out patient department in urban region in Maharashtra. 450 normal young female participants in the age group of 20-40 years with or without obesity will be recruited for the study. Written consent will be obtained by them in the language they understand. Participants taking medications known to influence bone metabolism within the period of previous two years such as corticosteroids, hormone replacement therapy, those with severe osteoarthritis of hip, knee and ankle, neuromuscular disorders, major surgery in previous six months, hysterectomy, malignancy, vestibular disorders and angioplasty will be excluded from the study. After explaining the parts and procedure of the study participants will be assessed by primary investigator for a demographic assessment. The participant will have to be the part of the study for 30 min for clinical assessments for a single time.

BMI will be calculated by dividing an individual's weight (in kilograms) by her height without shoes (in meters square) [20] (ICC=.9). BMI will also be measured by Bioelectrical Impedance analysis device Omron Body Fat Analyzer HBF-362 . In addition lean mass, % fat will be measured.(ICC=.99)

BMI will be classified (according to WHO) into:

Normal weight – 18.5 to < 25kg/m2

Overweight – ≥ 25 to < 30kg/m2

Class I obesity– ≥ 30 to < 35kg/m2 (moderately obese)

Class II obesity– ≥ 35 to < 40kg/m2 (severely obese)

Class III obesity– ≥ 40 kg/m2

Bone Mineral Density will be measured by Ultrasound bone densitometer. The participants will be ask to place their right foot in an ultrasound bone densitometer and value of T-score will be noted [3,6]. (ICC=.7)

According to WHO the T-score is classified as:

1 and above – Normal

1 to -2.5 – Osteopenia

2.5 and below – Osteoporosis

After noting the value of BMI and BMD after

initial assessment, the participants will be asked to perform tasks for performance based measures of balance and mobility.

A pilot study was done on 31 subjects to see the correlation of body mass index (BMI) with balance and mobility in young females adults in the age group of 19-22 with years at Physiotherapy department, Government Medical Hospital. BMI was calculated by dividing an individual's weight (in kilograms) by her height (in meters square). Mean age was 21.12±1.2 and mean BMI was 24.45±4.85 kg/m2. The single leg stance, narrow walk test, obstacle walk test, figure-of-8 walk test, and gait speed were taken as a measure of physical performance of balance and mobility. Level of significance was set at $p < .05$ and $r = 0.6$. The pilot study results showed that BMI was positively related with narrow walk test ($r = 0.67$, $p<0.0001$), obstacle walk test ($r = 0.56$, $p<0.0009$), figure-of-8 walk test ($r = 0.45$, $p<0.009$) whereas BMI was inversely related to gait speed ($r = - 0.73$, $p<0.0001$). Single leg stance ($r = -0.01$, $p=0.93$) was not significantly correlated with BMI. Number of deviations from normal pathway was recorded more from figure-of-8 walk test. Thus, in the present study, the following tests for balance and mobility will be included :

1. Narrow walk test
2. Obstacle walk test
3. Figure-of-8 walk test
4. Gait speed

Measures of balance and Mobility: The procedures to perform the tests will be explained to the participants and trail will be shown by investigator before performing the test. The participants will perform the test barefooted.

Narrow walk test [20]: Participants will be asked to walk a distance of 4m at their usual walking pace within a 15cm wide path marked on the floor with colored tape (Bandinelli et al). The time taken to complete the task and number of deviations from the 15-cm-wide path will be recorded. (ICC=.76)

Obstacle walk test [20]: Participants will be asked to walk a 7-m course at their usual walking pace and step over 2 obstacles of different height. One obstacle will be 6cm tall and 2cm wide rectangular (6cmx2cm) and positioned 2 meter from the starting line, and the other obstacle will be 30cm tall and 2cm wide rectangular (30cmx2cm) and positioned 4 meter from the starting line. (Bandinelli et al). Time taken to complete this task will be recorded. (ICC=.89)

Figure-of-8 walk test [20]: Participants will be asked to walk in a figure-of-8 pattern drawn (5ft) apart on the floor. Time taken to complete the test in seconds and number of deviations will be recorded (ICC=.85-.92)

Gait speed [2,20]: The participants will be asked to walk at their comfortable walking speed on a 10-m walkway. Initial and last meter of walkway will not be included in calculating gait speed. Time taken to complete effective 8-m walkway will be noted and gait speed will be calculated by dividing the distance traversed by the time taken to complete the distance. (ICC>.90) To see the correlation/association of BMD and BMI with balance and mobility Pearson/Spearman correlation test will be used. Significance level will be set at $p<0.05$ with the agreement value $r=0.6$

DISCUSSION

Analysis of recent literature suggest that osteoporosis, obesity and disability associated with it, is on the rise which causes reduced health related quality of life as a result of combination of musculoskeletal, neurological, cognitive, personal and environmental factors in older adults [19,20-25]. But incidence of osteopenia and obesity is also rising at an alarming rate in young females due to sedentary lifestyle, less exposure to sun, dietary deficiencies of calcium, low socioeconomic status etc. in Indian population [7,8]. Biomechanical and neurophysiological changes that often occur in osteoporosis and obesity affects balance and mobility leading to disability [16,21,18,24]. However, the effect of obesity and osteopenia and osteoporosis on balance and mobility is not known in young female adults in India. In Indian female population lot of risk factors push more and more young women at a risk of obesity and osteopenia. As age increases the risk of osteoporosis and obesity increases, also automatic postural and balance control decreases. Balance and mobility, both require intact musculoskeletal and neurophysiological system working in sync with

each other [24].

Obesity and osteoporosis, both are associated with reduced postural control and stability in older adults [16,17]]. The increased body fat leads to change in centre of pressure and centre of gravity, which causes antero-posterior instability during static and dynamic balance [18,21]. This altered movement strategies results in muscle dysfunction and joint instability and arthritis of weight bearing joints which further impedes mobility and makes obese individual less physically active which in turn decreases bone mass and bone strength [16]. This decrease in physical activity can further precipitate obesity. This forms a vicious cycle such that obesity can lead to osteoporosis and viceversa. Also, from a neurophysiological point of view, Mignardot et al (2010) suggested that skin stretching resulting from obesity may increase the distance between the cutaneous mechanoreceptors,and may thus decrease the discrimination threshold of somato-sensory perception [24,25].

Proprioception at knee joint is also decreased. Sensory and motor nerve impulses decrease by approximately 20-40% in obese than in normal weight subjects. The recruitment of motor units also alters with obesity [25]. Thus, reduced motor unit activation and decreased strength can contribute to the impaired motor performances of the obese people. In addition, for reaching the goals of a postural or motor tasks, muscular activity must be regulated efficiently. The efficiency of this muscular activity depends on the synchronization between the efferent motor command and the afferent sensory perception of the movement, that is, on the internal models for action [25].

Sedentary lifestyle causes slower movement execution which results in altered body schema in obese patients. Body schema is built on the basis of multisensory inputs including cutaneous and proprioceptive receptors. In obese people, this receptors may provide altered information to the somatosensory cortical area, altering in turn the body schema representation and postural control [24]. Also, muscle strength is a strong determinant of bone mass and bone strength [19]. Muscle strength depends on muscle mass and efficient neuromotor function [24]. Decreased in muscle strength can lead to slow down of movement execution resulting in impaired motor control. Again in sedentary people, the insufficient stimulation of muscles results in bone fragility leading to osteoporosis [19].

Thus, the study hypothesize that decrease in BMD and increase in BMI will affect balance and mobility in young female adults. Adequate weight bearing, physical activity, nutrition, body mass and hormonal balance are essential in achieving optimal skeletal health. Optimizing peak bone mass and bone strength early in life and stabilizing it during young adulthood is believed to play significant role in preventing osteoporosis and fractures later in life. Thus, there is need for a better understanding of the impact of obesity and osteoporosis on balance and mobility in young age. Age can be a confounding factor in the present study, as age increases physical performance decreases. So to reduce the bias, age group of 20-40 years of females adults is taken. Also, the level and duration of daily physical activity associated with occupation and socioeconomic status of the participant which duly can affect the physical performance of participant will be thoroughly noted by investigator.

Clinical importance:

At the end of the present study we would know the predisposing and risk factors for osteoporosis and obesity and relation of BMD and BMI with balance and mobility. This can help to pick up the high risk population early in the life. It is necessary among the young female adults to make themselves aware to maintain optimum healthy bone mass and healthy body weight. The management strategies in the form of therapeutic exercises, dietary changes and lifestyle modifications can be instituted early in young age group if we know the bone status, body fat status and its effect on balance and mobility.

ABBREVATIONS

BMD – Bone Mineral Density
BMI – Body Mass Index

Conflicts of interest: None

REFERENCES

[1]. Zhao L, Jiang H et al. Relationship of obesity with osteoporosis. J Clin Endocrinol Metabolism, May 2007;92(5):1640-46.

[2]. Khazzani H, Allali F et al. The relationship between physical performance measures, bone mineral density, falls, and the risk of peripheral fracture: a cross-sectional analysis. BMC Public Health.,Aug 2009;9:297.

[3]. Aggarwal N, Raveendran A et al. Prevalence and related risk factors of osteoporosis in peri- and postmenopausal Indian women. Journal of Midlife Health, Jul-Dec 2011;2(2):81-85.

[4]. Kopelman P . Obesity as a medical problem. Nature, April 2000;404:635.

[5]. Borges J. , Brandao C. et al. Low bone mass in children and adolescents. Arq Bras Endocrinol Metab, 2006;50(4):775-782.

[6]. Silvanus V., Ghosal K. et al. Screening of osteopenia and osteoporosis in an urban community in India. Nepal Med Coll J, 2012;14(3):247-250.

[7]. Jyothi Unni et al. Bone Mineral Density in women above 40 yrs. J Mildlife Health, 2010;(1):19-22

[8]. Shatrugna eta al. Bone status of Indian women from a low-income group and its relationship to the nutritional status. Osteoporosis Int, 2005;16:1827-1835.

[9]. Daly R, Petit M et al. Optimizing Bone mass and strength. The Role of Physical activity and Nutrition during Growth, Med Sport Sci. Basel, Karger, 2007;51:102-120.

[10]. Saggese G. et al. Osteoporosis in children and adolescents: Diagnosis, Risk factors, and Prevention. Journal of Pediatric Endocrinilogy and metabolism, Jul 2001;14(7):833-839.

[11]. Kalra et al. Obesity in India: The weight of the nation. 2012;1(1):37-41.

[12]. Parekh A et al Prevalence of overweight and obesity in adolescents of urban and rural area of Surat, Gujrat. National Journal of Medical Research. July-Sep 2012;2(3):325-329.

[13]. Blew R, Sardinha L et al. Assessing the validity of body mass index standards in early postmenopausal women., Aug 2002;10(8):799-808.

[14]. www.oif.org/ Osteogenesis Imperfecta OI foundation Inc.[Internet]

[15]. Courses.washington.edu/bonephys/, Osteoporosis and bone physiology: Bone density. [Internet].

[16]. Forhan M, Gill V. Obesity, functional mobility and quality of life. Best Practice & Research Clinical Endocrinology and Metabolism, 2013;27:129-137.

[17]. Apovian C et al. BMI and Physical function in older women Obesity Research, Aug 2002;10(8):740-747.

[18]. Holmberg et al. Knee osteoarthritis and body mass index: a population-based case-control study. Scand J Rheumatology 2005;34(1):59-64.

[19]. Russo C. The effects of exercise on bone. Basic concepts and implications for the prevention of fractures. Clinical Cases in Mineral and Bone Metabolism 2009;6(3):223-228.

[20]. Hergenroeder A, Wert D, et al. Association of Body Mass Index with Self-Report and Performance-Based Measures of Balance and Mobility. Journal of the American Physical Therapy Association, Aug 2011;91(8):1223-34.

[21]. King et al. Obesity and Osteoarthritis. Indian J Medical Research, Aug 2013;138(2):185-193.

[22]. Polambaro K, Hack L, Kline K et a. Gait variability detects women in early postmenopause with low bone mineral density. Physical Therapy. 2009;89(12):1315-1326.

[23]. Hsu Yi-Hsiang, Venners S, et al. Relation of body composition, fat mass, and serum lipids to osteoporotic fractures and bone mineral density in Chinese men and women. American J Clin Nutrition, 2006;83:146-154.

[24]. Mignardot JB, Olivier I et al. Obesity Impact on the Attentional cost for Controlling posture. Plos One December 2010;5(12):e14387.

[25]. Mignardot JB, Olivier I et al. Origins of balance Disorders during a Daily Living Movement in Obese : Can Biomechanical factors explain everything. Plos One April 2013;8(4):e60491.

How to cite this article:

Sarala Khangare, Bhavana Mhatre, Amita Mehta. ASSOCIATION OF BONE MINERAL DENSITY AND BODY MASS INDEX WITH BALANCE AND MOBILITY IN YOUNG FEMALE ADULTS: A HYPOTHESIS. Int J Physiother Res 2017;5(2):1920-1925. **DOI:** 10.16965/ijpr.2017.102