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Study on Bone Mineral Density of Employed People in Dhaka City, Bangladesh

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Abstract
The study was carried out among employed people in Dhaka city. A sample of 100 employed people was selected through simple random sampling. Results indicated that 60% employed people were reported to be normal, whereas 40% were found to have osteopenia. It is a matter of being astonished that no one is found to posse osteoporosis. This is because they were educated and well conscious about their food habit. The study showed that the average age, height and weight of employed people were 37.42 years, 160.09 cm and 66.40 kg respectively with standard error 1.04, 0.88 and 1.06. On an average, the mineral and body mass index score were found to be 49.93 and 25.86 with standard error 0.55 and 0.33 respectively. Results also implied that age of respondent were significantly higher and body mass index score were significantly lower for the persons having osteopenia compared to the normal persons. Binary logistic regression showed that therisk variables like age (year), education, having diabetes and blood pressure of employed people were statistically significant with bone mineral density. Ensuring adequate calcium and vitamin D intake through the diet is one way to help slow or prevent the rate of bone loss.

Keynote: *Bone Mineral Density, Body Mass Index, Calcium, Vitamin D, Employed People*

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I. Introduction

A bone density test is the only test that can diagnose osteoporosis before a broken bone occurs. Bone density indicates normal bone density, low bone density (osteopenia) or osteoporosis. Other bone density tests, known as peripheral tests, measures bone density in the lower arm, wrist, finger or heel. Bone density test results are reported using t-scores. A t-score shows how much higher or lower one's bone density is than that of a healthy 30-year old adult [1].Osteoporosis is characterized by low bone mass and deterioration of bone tissue that is chronic and progressive, and can affect almost the entire skeleton [2,3,4]. The risk factors that lead to osteoporosis for the general population include low vitamin D serum level, chronic malnutrition, physical inactivity, history of fracture as an adult, low body weight, low calcium intake (lifelong), race (Caucasian or Asian), and estrogen deficiency at an early age (<45 years) [5,6]. Additional risk factors include the use of antipsychotics, antidepressants, anti-epileptics, and high-dose, long-term use of anti-secretory drugs. Low calcium intake and vitamin D deficiency result in a negative calcium balance [7]. This stimulates the secretion of parathyroid hormone (PTH) and induces age-associated secondary hyperparathyroidism, which enhances bone turnover and accelerates bone loss.8 Adequate intake of calcium and vitamin D, through diet and/or supplements, reverses this secondary hyperparathyroidism and is recommended in the prevention of osteoporotic fractures [9,10]. The National Osteoporosis Foundation (NOF) estimates that more than 9.9 million Americans have osteoporosis and an additional 43.1 million have low bone density [11]. The age adjusted prevalence of osteoporosis at either lumbar spine or femur neck was higher among women (24.7%) than men (5.6%) [12].According to the NOF, adults under 50 years of age need a total of 400-800 international units (IUs) of vitamin D every day; and adults age 50 or older need a total of 800-1,000 IUs of vitamin D every day [13]. People at high risk for vitamin D deficiency include individuals with malabsorption and other intestinal diseases (e.g., inflammatory bowel disease, gastric bypass surgery), chronic renal insufficiency, and those who are critically ill. Other risk factors for vitamin D deficiency include the use of anti-seizure medication, limited sun exposure, very dark skin, and obesity [14].

The purpose of this research is to examine the results of bone density studies in comparison with the intake of calcium and vitamin D with others factors that can affect BMD such as age, gender, height, weight and knowledge of sources of vitamin D and calcium.

II. Methodology

Area of the Study

The study was carried out among the employed people in Dhaka City, Bangladesh. All employed people of Dhaka City constituted the population under study and every one of them was the unit of analysis.

Sampling design and sample size

Considering the homogeneity of employed people of Dhaka City, simple random sampling technique was followed for selecting the respondents from the population. Among the population, finally 100 persons were randomly selected using appropriate sample size determination formula with prevalence rate, p=0.5 and a margin of error, d= 0.10 for this study.

Bone Mineral Density

Bone density or bone mineral density (BMD), is the amount of bone mineral in bone tissue. The concept is of mass of mineral per volume of bone (relating to density in the physics sense), although clinically it is measured by proxy according to optical density per square centimeter of bone surface upon imaging [15]. Bone density measurement is used in clinical medicine as an indirect indicator of osteoporosis and fracture risk. It is measured by a procedure called densitometry, often performed in the radiology or nuclear medicine departments of hospitals or clinics. The measurement is painless and non-invasive and involves low radiation exposure. Measurements are most commonly made over the lumbar spine and over the upper part of the heap [16]. The forearm may be scanned if the heap and lumbar spine are not accessible [17]. For those people who do have bone density tests, two conditions which may be detected are osteoporosis and osteopenia. The usual response to either of these indications is consultation with a physician [18]. Results are generally scored by two measures, the T-score and the Z-score. Scores indicate the amount one's bone mineral density varies from the mean. Negative scores indicate lower bone density, and positive scores indicate higher. The US standard is to use data for a 30-year-old of the same sex and ethnicity, but the WHO recommends using data for a 30-year-old white female for everyone [19]. Values for 30-year-olds are used in post-menopausal women and men over age 50 because they better predict risk of future fracture [20].

The criteria of the World Health Organization are [21]:

- Normal is a T-score of −1.0 or higher
- Osteopenia is defined as between −1.0 and −2.5
- Osteoporosis is defined as −2.5 or lower, meaning a bone density that is two and a half standard deviations below the mean of a 30-year-old man/woman.

The Z-score is the comparison to the age-matched normal and is usually used in cases of severe osteoporosis. This is the number of standard deviations a patient's BMD differs from the average BMD of their age, sex, and ethnicity. This value is used in pre-menopausal women, men under the age of 50, and in children [20].

Health status using BMI

The BMI or weight/height ratio are frequently used for adults and are employed for epidemiological studies because measurements of weight and height are easy to collect, quick, relatively non-invasive, more precise and easier to measure the nutritional status of adults [22]. The BMI is highly correlated with weight and consistently independent of height, less biased by height and weight/height [23]. It has been shown that BMI correlates well with body fat [24] and shows highest correlation with independent measures of body fat [25].

Statistical Analysis

Tabular analysis includes preparation of simple tables of proportions describing the concentration of categorical variables and preparation of bivariate tables showing the relationship or association between two categorical variables. Descriptive statistics includes computation of such summary measures as: means, standard error, proportions, etc. Chi-square ($\chi 2$) test was used to test the significance of the associations between two categorical variables. Bivariate analysis finds the relationship of different variables with bone mineral density of employed persons of Dhaka City, Bangladesh. Binary logistic regression was used to find the significant contributing factors that affect the bone mineral density of employed persons.

III. Results

Figure 01 represents graphically the percentage distribution of bone mineral density of the employed people in Dhaka City, Bangladesh, 2019-2020. Results indicated that 60% employed people were reported to be normal, whereas 40% were found to have osteopenia. It is a matter of being astonished that no one is found to posse osteoporosis. This is because they were educated and well conscious about their food habit.

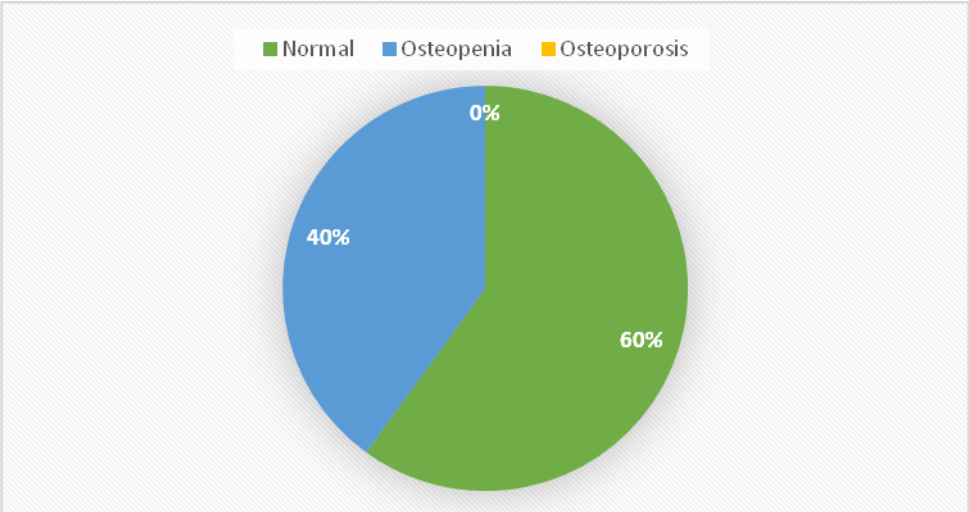

Figure 01: Percentage distribution ofBone Mineral Density of the employed people in Dhaka City, Bangladesh, 2019-2020

Table 01 presents the information in terms of mean, standard error, mean difference and p-value of some selected variables of the employed people. The study showed that the average age, height and weight of employed people were 37.42 years, 160.09 cm and 66.40 kg respectively with standard error 1.04, 0.88 and 1.06. On an average, the mineral and body mass index score were found to be 49.93 and 25.86 with standard error 0.55 and 0.33 respectively. Results also implied that age of respondent were significantly higher and body mass index score were significantly lower for the persons having osteopenia compared to the normal persons.

Table 01: Mean, standard error, mean difference and P-value of some selected variables of the employed people in Dhaka City, Bangladesh, 2019-2020

Variables	Mean ± SE			Mean difference	P value
	All	Normal	Osteopenia		
Age of the respondent (years)	37.42±1.04	35.00 ± 0.74	41.05 ± 2.24	-6.05**	0.00
Height of respondent (cm)	160.09 ± 0.88	161.57 ± 0.92	157.88 ± 1.68	3.69	0.15
Weight of respondent (kg)	66.40 ±1.06	69.10 ± 1.38	62.35 ± 1.44	6.75	0.12
Mineral of the respondent	49.93 ±0.55	53.32 ± 0.46	46.10 ± 0.43	7.22	0.92
Body Mass Index score	25.86 ±0.33	26.44 ± 0.48	24.98 ± 0.38	1.46*	0.03

Note: Level of significance: *P<0.05, **P<0.01

Different variables were used to find the association on bone mineral density of employed people. Table 02 clearly reveals the association of bone mineral density of employed people according to different variables. Results indicated that the occupation of respondents, respondents having diabetes and blood pressure had significant association with bone mineral density.

Table 02: Bone Mineral Density according to some selected variables of the employed people in Dhaka City, Bangladesh, 2019-2020

Variables	Categories	Bone Mineral Density		
		Normal	Osteopenia	All
		%	%	%
Age of respondent (years)	21-29	16.7	20.0	18.0
	30-39	53.3	45.0	50.0
	40 & above	30.0	35.0	32.0
	Chi-square		0.67NS	
Gender of the respondent	Male	73.3	75.0	74.0

	Females	26.7		25.0	26.0
	Chi-square		0.04 ^{NS}		
Religion of the respondent	Islam	86.7		95.0	90.0
	Hindu	13.3		5.0	10.0
	Chi-square		1.85 ^{NS}		
Education of the respondent	SSC/HSC	23.3		40.0	30.0
	Graduate/Postgraduate	63.3		55.0	60.0
	M.Phil./Ph.D.	13.4		5.0	10.0
	Chi-square		4.167 ^{NS}		
Occupation of the respondent	Teacher	25.4		6.9	15.0
	Officer	38.1		81.6	12.0
	Staff	36.5		11.5	73.0
	Chi-square		14.90**		
Respondent having diabetes	Yes	3.3		35.0	16.0
	No	96.7		65.0	84.0
	Chi-square		17.91**		
Respondent having blood pressure	Yes	16.7		45.0	28.0
	No	83.3		55.0	72.0
	Chi-square		9.56**		

Note: Level of significance: *P<0.05, **P<0.01, ***P<0.10, ^{NS}P< Not Significant.

Figure 02 shows graphically the distribution of bone mineral density in percentage according to body mass index of the employed people. Among the respondents, 43.3% were found to be normal whereas 10% were found to be obese. About 55% were found to have osteopenia with overweight and 45% were found to have osteopenia with normal weight.

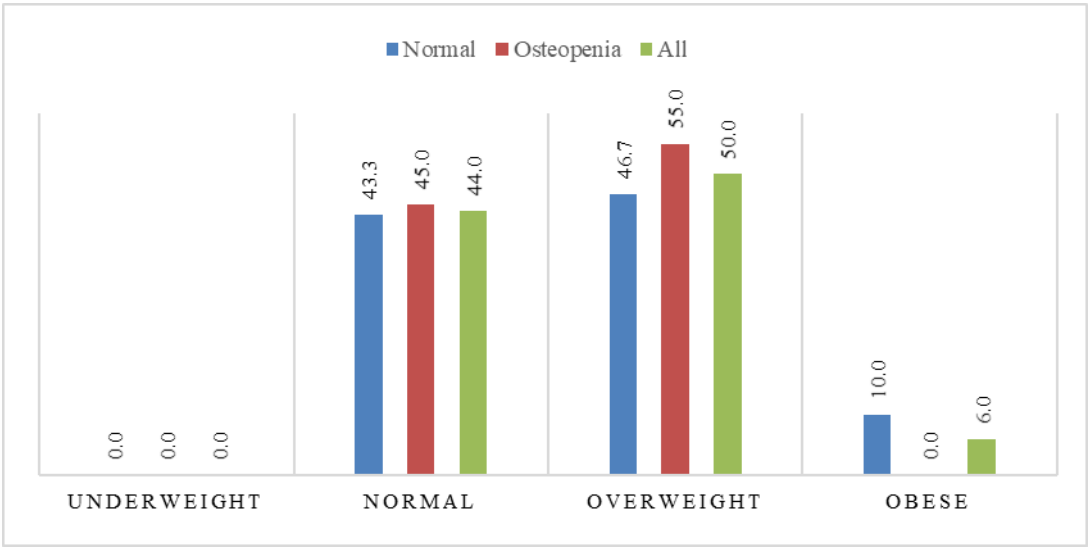

Figure 02: Percentage distribution ofBone Mineral Density according to Body Mass Index of the employed people in Dhaka City, Bangladesh, 2019-2020

Table 03 exhibits the knowledge about sources and intake of vitamin D and calcium of the employed people in Dhaka City. Results showed that most of the employed people (60% and 48%) had full knowledge, whereas 20% and 25% had partial knowledge about the sources of vitamin D and calcium. But 54% and 27% of the employed people had no knowledge about the sources of vitamin D and calcium. About 48% and 44% employed people had full knowledge, whereas 16% and 21% had partial knowledge on their intake of vitamin D and calcium. Quite a good majority of the respondents (58% and 34%) had no knowledge about their intake of vitamin D and calcium.

Table 03: Percentage distribution of knowledge about sources and intake of vitamin D and calcium of the employed people in Dhaka City, Bangladesh, 2019-2020

Knowledge	Sources of Vitamin D	Sources of Calcium	Intake of Vitamin D	Intake of Calcium
Full knowledge	60.0	48.0	48.0	44.0
Partial knowledge	20.0	25.0	16.0	21.0
No knowledge	54.0	27.0	58.0	34.0

Note: Multiple answer was recorded (n=100).

Table 04 displays the correlation matrix of bone mineral density with different causal variables of the employed people in the city. Bone mineral density was negatively correlated with age, height, weight, education and body mass index score of the respondents. This implies that when age, height, weight, education and body mass index score of the employed people increased, the bone mineral density also increased.

Table 04: Correlation matrix of Bone Mineral Density of the employed people in Dhaka City, Bangladesh, 2019-2020

Variables	Bone Mineral Density	Body Mass Index score	Age of the respondent	Height of the respondent (cm)	Weight of the respondent (kg)	Education of the respondent
Bone Mineral Density	1	-0.22*	-0.29**	-0.21*	-0.31**	-0.09
Body Mass Index score		1	0.15	-0.09	0.72**	0.09
Age of the respondent (years)			1	-0.01	0.12	0.11
Height of the respondent (cm)				1	0.62**	0.09
Weight of the respondent (kg)					1	0.14
Education of the respondent						1

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Logistic regression analysis was performed to identify the determinants of bone mineral density of the employed people. For this analysis, we coded 1 for osteopenia category and 0 for the other category 'normal'. In Table 05, we used different variables to fit the binary logistic regression model of bone mineral density of employed people. The table under reference shows the result of binary logistic regression analysis of significant studied variables. Therisk variables like age (year), education, having diabetes and blood pressure of employed people were statistically significant with bone mineral density. Respondents of age group 30-39 years and 40 & above years were 1.17 times and 7.32 times were more likely to run the risk of being osteopenia than the respondents whose ages were in the range 21-29 years. It implies that risk of osteopenia increases among respondents as their ages go up. Respondents with SSC/HSC and graduate/postgraduate level of education were 68 percent and 94 percent times less likely to have osteopenia than their counterparts having M.Phil. or Ph.D. degrees. It implies that the risk of osteopenia increases among respondents with the increase of their level of education. Respondents having diabetes were about 44 times higher risk of having osteopenia than respondents having no diabetes. It implies that risk of osteopenia reduces with the increase of having no diabetes. Respondents having blood pressure are 3.24 times as likely as the respondents having no blood pressure to run the risk having osteopenia. The results convey the message that osteopenia is reduced with the increase of having no blood pressure.

Table 05: Result of binary logistic regression analysis of significant studied variables for Bone Mineral Density among the employed people in Dhaka City, Bangladesh, 2019-2020

Variables	Level	B	S.E.	P Value	Odds Ratio (OR)	95% C.I. for OR	
						Lower	Upper
Age of the respondent (years)	21-29 **(RC)**	-	-	-	1.00	-	-
	30-39	0.16	0.63	0.08	1.17***	0.25	2.95
	40 & above	1.99	0.93	0.03	7.32*	0.02	0.84
Education of the respondent	SSC/HSC	-1.13	0.56	0.04	0.32*	0.12	0.97
	Graduate/Postgraduate	-2.75	1.12	0.01	0.06**	0.01	0.58
	M.Phil./Ph.D. **(RC)**	-	-	-	1.00	-	-
Respondent having diabetes	Yes	3.77	1.18	0.00	43.47**	4.31	438.47
	No **(RC)**	-	-	-	1.00	-	-
Respondent having blood pressure	Yes	1.17	0.70	0.09	3.24***	0.82	12.74
	No **(RC)**	-	-	-	1.00	-	-
Constant		0.26	0.54	0.63	1.29		

Note: RC-Reference category; Level of significance: *P<0.05, **P<0.01, ***P<0.10.

IV. Discussion

BMD results are determined from the ratio of calcium and phosphorus in bones, therefore calcium is a major nutrient needed to form new bone cells and to maintain bone health [4]. Bones store more than 99 percent of the calcium in the human body [4,14]. Calcium works with other nutrients including vitamin D, vitamin K, potassium, fluoride and magnesium to increase bone density and strength [4]. Osteoporosis and osteopenia are health problems often seen in the population with IDD. The individual with IDD can often be vulnerable to loss of bone mass by one or more variables that can lead to fractures, loss of mobility, and possibly a decrease in quality of life. Adequate daily calcium and vitamin D is a safe and inexpensive way to help reduce fracture risk [14]. Controlled clinical trials have demonstrated that the combination of supplemental calcium and vitamin D can reduce the risk of fracture [26]. There is a high prevalence of vitamin D deficiency in patients with osteoporosis, especially those with hip fractures, even in patients taking osteoporosis medications [27, 28]. Weaver et al. conducted a meta-analysis and reported that calcium plus vitamin D supplementation produced a 15% reduced risk of total fractures and a 30% reduced risk of hip fractures [29]. Vitamin D facilitates calcium absorption and plays an integral part in building and maintaining healthy bone[6]. Vitamin D promotes calcium absorption in the gut and helps to maintain adequate serum calcium concentrations to enable normal mineralization of the bone [29]. Vitamin D is needed for bone growth and bone remodeling by osteoblasts and osteoclasts.38 Vitamin D can be supplied three ways; through the sun, the diet, and supplements [26,27,28,30,31]. The skin can make vitamin D from the sun, but too much sun can be harmful [13]. Small amounts of vitamin D can be obtained from foods such as fortified milk, liver and fatty fish (e.g., wild mackerel, salmon, sardines and tuna)[13]. Many people require a vitamin D supplement to ensure the intake of the recommended amount since very few foods naturally contain vitamin D. Calcium, the major nutrient needed to form new bone cells, is vital for bone health [4]. Calcium stored in the bone is continuously exchanged with calcium circulating in the bloodstream [6]. When calcium intake is sufficient, levels within the bone remain stable [6]. When the diet is low in calcium, especially in the elderly, a negative calcium balance can occur [7]. Negative calcium balance stimulates the secretion of parathyroid hormone (PTH) and induces age-associated secondary hyperparathyroidism, which enhances bone turnover and accelerated bone loss [8]. Food sources rich in calcium include sardines, cheddar cheese, milk, yogurt, and fortified foods such as oatmeal and orange juice[32]. Calcium rich vegetables include collard greens, broccoli, turnip greens, kale, and cooked soybeans[13]. Typically, a daily consumption of three calcium rich dairy foods such as milk, yogurt and cheese, in addition to fortified foods, and other food sources such as fruit and vegetables, should allow an individual to meet their daily calcium needs. Individuals with lactose intolerance can consume calcium and vitamin D rich foods such as fortified soy or almond milk [13,33]. Heaney and Weaver found that when a calcium rich food such as milk was consumed together with a high oxalate food such as spinach, there was no interference of oxalate in milk calcium absorption [34].

V. Conclusions

Overweight persons are more likely to have osteopenia whereas educated persons are well conscious about their food habit, intake of vitamin D and calcium. Bone mineral density was negatively correlated with

age, height, weight, education and body mass index score of the respondents. But the risk variables are age (year), education, having diabetes and blood pressure. Ensuring adequate vitamin D and calcium intake through the diet is one way to help slow or prevent the rate of bone loss. Calcium supplementation is required if the diet is lacking sufficient calcium and can be recommended in a variety of forms. Thus concluding that supplement could be taken to maintain bone density.

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