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# The study of association between Bone Mineral Density and cognitive status in older people of Amirkola

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**ABSTRACT**

*Cognitive impairment and Osteoporosis are two chronic degenerative diseases in which each of them and in combination can cause significant functional impairment in the elderly. A few of studies have shown that low bone mineraldensity(BMD)is associated with increased risk of cognitive impairment and Alzheimer and vise versa. In this study, we aimed to measure the association between these two diseases in the elderly in Amirkola, Mazandaran ,north of Iran. This cross-sectional study, came from Amirkola Health an Aging Project (AHAP), the BMD was measured by dual-energy X-ray absorptiometry using Lexxos densitometry of the left femoral neck and lumbar spine (L2-4) and the results were expressed based on T-Score. Also, the MMSE standard questionnaire (Mini Mental State Examination) was used to assess cognitive impairment.Data were analyzed using SPSS17statistical software, chi-square test, t-test, Pearson correlation , and after adjusting for several confounding variables in multiple logistic regression models we stimated odds ratio and compared cognitive impairment and normal cognitive statuse groups with normal BMD and low BMD groups; P<0.005 was considered meaningful. In the total number of 1176 persons with the average age of 68.43±7, 839 older peopl e with normal cognitive status, hadBMDof the lumbar spine (0.9±0.18gr/cm$^2$) and 337 older adults had abnormal levels of cognitive status (0.79±0.18gr/cm$^2$) (P = 0.000). For femor results, (0.88±0.15gr/cm$^2$)and(0.77±0.15gr/cm$^2$)were obtained respectively (P= 0.000). Confounding factors in osteoporosis and cognitive impairment were considered in findingsin which there was no difference in the results. It seems that bone mineral density is associated with the cognitive status of older people, and this relationship holds true for both sexes.*

**Keywords**: cognitive impairment, bone mineral density, osteoporosis
**Ab. :**BMD (Bone Mineral Density) MMSE(Mini Mental State Examination)

## INTRODUCTION

Cognitive impairment and osteoporosis are two common chronic degenerative diseases that are strongly associated with increasing age (1). Cognitive impairment is an example of a complex interface between neurology, internal medicine and psychiatry.Medical or neurological disorders often lead tocognitive impairment, and cognitive impairmentis associated with behavioral symptoms. Along with cognitive impairment, attention, memory, language, orientation, praxis, executive function, judgment and problem solving would have difficulty and its main reasonis the measurement of the brain's memory. (2, 3)Cognitive impairment is a health problem and its adverse social and economic effects were imposedto patients and their family members and it is a risk factor for increased burden of home care, nursing care, hospitalization, and ultimately mortality in the elderly. (4) On the other hand, osteoporosis is the most common metabolic bone disease in elderly and it is a skeletal disorder as defined by the National Institute of Health of America and one of its prominent characteristics is the reduced bone strength. It is often asymptomatic, but due to bone density loss, it has some consequences such as fractures of the vertebrae and long bones (5).A number of studies have shown that low bone mineral density is associated with increased risk of cognitive impairment and Alzheimer's; they estimated thatit can be possible to prevent theloss and cognitive impairment that normally occurs with agingby preventing bone density loss and osteoporosis (1,6,7,8,9,10).In this study, we explore the relationship between these two diseases in the elderly of Amirkola, Mazandaran.

## MATERIALS AND METHODS

This cross-sectional study is part of Amirkola Health an Aging Project (AHAP) :AHAP[i] number (892917) which was performed on all older peopleaged 60 years old and over (11).Amirkola is one of the towns close to the city of Babol in the northern part of Iran. There are two health centers in Amirkola with the full list of all elderly people and their addresses available.All elderly people were invited to participate in the study through phone calls and visiting them at home, while providing the necessary information about the program. The referral placewasthe Health Research Center of Babol University of Medicalsciences , in Amirkola.Data including demographics, age, sex, marital status, education, living situation (alone or with family), and smoking and underlying chronic diseases and drugs consumed (by a trained nurse and midwife) were collected using a questionnaire.People with underlying disorders of bone metabolism diseases such as cancer, inflammatory bowel disease, , hyperthyroidism, primary hyper parathyroid, kidney insufficiency, adrenal disease, rheumatoid disease and the history of estrogen consumption were excluded from the study.

Bone mineral density (BMD) was measured using dual-energy X-ray absorptiometry (DEXA) byLexxos densitometry of left femoral neck and lumbar spine (L2-L4) and the resultswere expressed on T-Score.The bone mineral density with 2.5 standard deviations or below the peak bone mass in young adults (T-Score≤-2.5) was considered as osteoporosis, -2/5<T-Score≤-1asosteopenia and T-Score> -1 as normal (in both site) (12).

Folstein or MMSE Standard questionnaire was used to assess cognitive status in elderly. This test is a brief 30-point test which is used to screen cognitive disorders, especially dementia. It can also be used to estimate cognitive impairment in a specific time and track cognitive changes in a limited time. (13, 14, 15). It was introduced in 1975 by Folstein. Using this test can help to assess individual functions, including computing, memorizing and gaining knowledge in 10 minutes.Greater than or equal to 25 points (25-30) is considered normal and scores under this pointwere dividedas: Less than or equal to 9 was severe cognitive impairment, 10-19 moderate and 20-24 mild cognitive impairment (or suspected cognitive impairment).The test questions were done in an interview. Data were analyzed using SPSS software and chi square tests, t-test, Pearson correlation and logistic regression models, P<0.05was considered meaningful.

## RESULTS

Among the 1,616 elderly whoparticipated in the AHAP, 1176 persons were entered into the study, which had full information about cognitive status, bone densitometry and other variables. 654 participants were men and 522 women; the mean age was (68.43±7.01) , among which 839 persons (71.3%) had normal cognitive status and 337 (28.7%) abnormal. Among the abnormal participants, 260 cases (22.2%) had mild cognitive impairment, 72 cases (6.1%) moderate, and 5 cases (0.4%) severe . The prevalence of cognitive impairment in men was 17.58% (CI 95%: 14.66%-20.51%) andin women 42.53% (CI 95%: 38.27%-46.78%). (P =0.000)

Table 1shows the underlying data of these two groups.

**Table 1. Comparison of underlying data on normal and abnormal cognitive status in elderly**

| Variables | | Normal cognitive status(%) | Abnormal cognitive status(%) | P value |
|---|---|---|---|---|
| Sex | Male | 539(82.4) | 115 (17.6) | 0.000 |
| | Female | 300(57.5) | 222(42.5) | 0.000 |
| Age (years) | (Mean ±SD) | 67.45±6.43 | 70.88±7.56 | 0.000 |
| Marital status | Married | 755(73.7) | 269(26.3) | 0.000 |
| | Unmarried | 84(55.3) | 68(44.7) | |
| Living condition | With family | 798(72.6) | 301(27.4) | 0.000 |
| | Alone | 41(53.2) | 36(46.8) | |
| Education | Illiterate | 429(59.7) | 289(40.3) | 0.000 |
| | Elemtary school | 294(86) | 48(14) | |
| | High school Guidance | 79(100) | 0(0) | |
| | University | 37(100) | 0(0) | |
| Smoking | Yes | 186(82.3) | 40(17.7) | 0.000 |
| | No | 653(68.7) | 297(31.3) | |
| DM | Yes | 244(66.7) | 122(33.3) | 0.017 |
| | No | 595(73.5) | 215(26.5) | |
| HTN | Yes | 497(69.2) | 221(30.8) | 0.044 |
| | No | 342(74.7) | 116(25.3) | |
| History of consuming Vitamin D | Yes | 160(75.8) | 51(24.2) | 0.112 |
| | No | 679(70.4) | 286(29.6) | |
| History of consumingSteroid | Yes | 84(75.7) | 27(24.3) | 0.289 |
| | No | 755(70.9) | 310(29.1) | |
| History of consuming Ca | Yes | 173(75.5) | 56(24.5) | 0.117 |
| | No | 666(70.3) | 281(29.7) | |
| BMI | Mean ±SD | 27.40±46.4 | 27.08±5.03 | 0.302 |
| Vitamin D3 serum level | Mean ±SD | 34.72±32.25 | 33.72±30.54 | 0.626 |
| PTH | Mean ±SD | 56.79±60.85 | 58.09±50.68 | 0.729 |
| Physical activity | Mean ±SD | 56.50±34.29 | 52.39±32.20 | 0.066 |

The bone mineral density in people with and without cognitive impairment were compared. The BMD in patients with cognitive impairment was (0.79±0.18 gr/cm$^2$) and in normal people, (0.90±0.18gr/cm²) (P=0.000).This rate for femur was (0.88±0.15gr/cm$^2$)and(0.77±0.15gr/cm$^2$), respectively (P=0.000). Comparative data bysexesalso showed that: lower bone mineral density in people with cognitive impairment compared to normal subjects of both sexes, was significant (P. <0.001) (Figure 1).

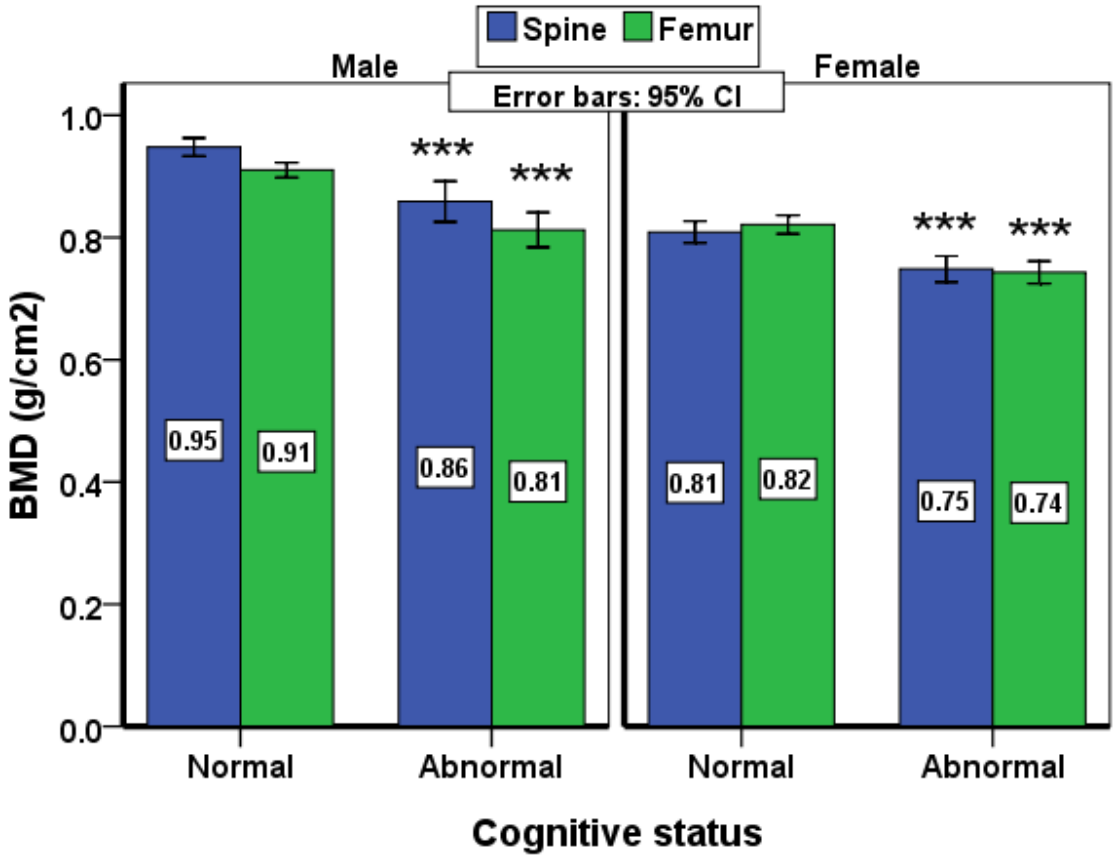


**Figure 1: Comparison of Bone Mineral Density of hip and spine bone in patients with normal and abnormal cognitive status by sex**
*BMD(Bone Mineral Density)*

**Table 2 – Relationship between cognitive status and Bone Mineral Density in both sexes**

| | Cognitive statuse | Bone MineralDensity | | | P value |
|---|---|---|---|---|---|
| | | Osteoperosis | Osteopenia | Normal | |
| | | N(%) | N(%) | N(%) | |
| Male | Normal | 71(13.2) | 301(55.8) | 167(0.31) | 0.000 |
| | Abnormal | 34(29.6) | 67(58.3) | 14(12.2) | |
| Female | Normal | 152(50.7) | 103(34.3) | 45(15) | 0.000 |
| | Abnormal | 149(67.1) | 60(27) | 13(5.9) | |
| Total | Normal | 223(26.6) | 404(48.2) | 212(25.3) | 0.000 |
| | Abnormal | 183(54.3) | 137(37.7) | 27(8) | |

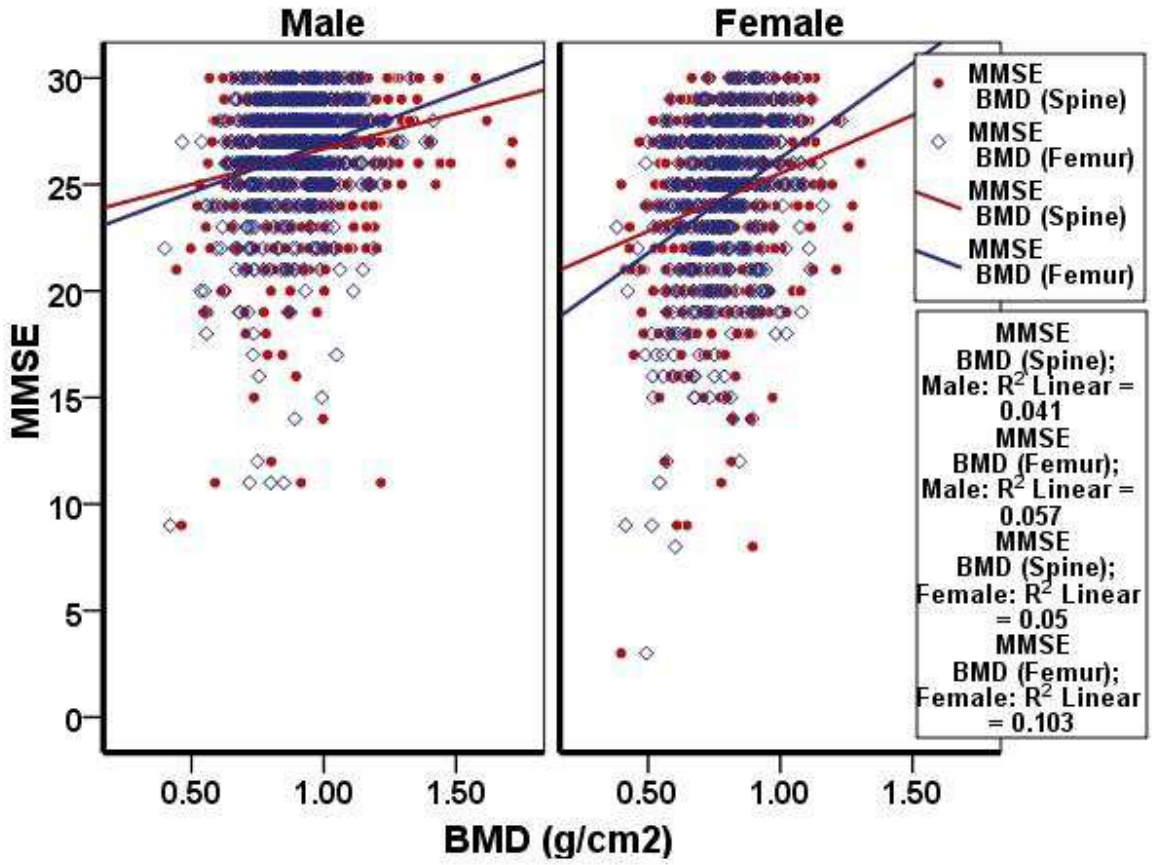


**Figure 2. Correlation between cognitive status score and Bone Mineral Density in both sexes**
*MMSE(Mini Mental State Examinitaion)*
*BMD(Bone Mineral Density)*

Table 2 shows the relationship between osteoporosis and osteopenia and cognitive status. The figure2expresses the relationship between bone mineral density in the spine and hip bone with MMSE scores in both sexes.

Due to the significant differences in demographic and underlying characteristics of the two groups, the logistic regression model was used to correct the possible effects of these variables which is shown in Table 3; and after considering these confounding effects, the relationship and the findings were still significant.OR ratio adjusted, is3.37(CI95% 2.01-5.65)(P=0.000) in osteoprosis ; and osteopenia is 2.30(CI 95% 1.41-3.76)(P=0.001).

Other significant factors were age, sex, diabetes mellitus and hypertention as we can see in table 3 .

**Table 3: The results of the multiple logistic regression model of factors associated with cognitive impairment**

| | OR[ii] | 95%CI | | P.Value |
|---|---|---|---|---|
| sex (Female) | 3.75 | 2.53 | 5.55 | .000 |
| Marriage(Married) | 1.05 | 0.64 | 1.73 | .842 |
| Living alone | 1.04 | 0.53 | 2.02 | .908 |
| Smoking | .94 | .59 | 1.49 | 0.808 |
| Number of drugs | .052 | .31 | .88 | .015 |
| History of consuming Vitamin D | .60 | .25 | 1.46 | .264 |
| History of consuming Ca | .77 | .32 | 1.81 | .569 |
| BMD:Normal | 1 | - | - | - |
| Osteopenia | 2.30 | 1.41 | 3.76 | .001 |
| Osteoporosis | 3.37 | 2.01 | 5.64 | .000 |
| Vit D:<20 | 1 | - | - | - |
| 20-29.9 | .85 | .59 | 1.23 | .405 |
| >=30 | .80 | .56 | 1.15 | .234 |
| **Age** | | | | |
| 60-64 | 1 | - | - | - |
| 65-69 | 1.16 | .76 | 1.764 | .477 |
| 70-74 | 1.22 | .85 | 2.05 | .203 |
| 75-79 | 2.39 | 1.50 | 3.81 | .000 |
| 80-84 | 2.60 | 1.39 | 4.87 | .003 |
| 85-99 | 4.61 | 1.88 | 11.32 | .001 |
| DM | 1.44 | 1.04 | 1.99 | .025 |
| HTN | 1.15 | .84 | 1.57 | .373 |

## DISCUSSION

Based on the results of this study,there was a significant difference between bone mineral density in patients with normal and abnormal cognitive status, which is consistent with the results of Yaffe et al.'s study on lower bone density in older women with cognitive impairment (16) .Lui et al. conducted a large scale prospective cohort study on 4462 women. They concluded that the reduction in hip bone mass density was more likely to be associated with cognitive impairment (9) . Lee Dy et al.'s study in 2012 was also coducted on 120 women after menopause, which was confirmed the association between cognitive impairment and lower bone density in post-menopausal period (6) .As can be seen,in our study the association between cognitive status and bone mineral density was measured in both sexes that this association was significant in both sexes.Therefore, the possibility of the involvement of some factors other than estrogen levels, such as ApoE 4 (18), the level of IL-6 (18) , level of vitamin D (19) andincreased age-related parathormon hormone ,can be considered (17). and the need for future studies to examine these factors are determined.

Hyungoung Park et al. in a study in 2013 on 650 patients concluded that in the two groups with cognitive impairment and MMSE less than 24,the bone density was lower than those with higher MMSE (7). We considered MMSE cut of points 24 which is not consistent based on their educational level and age; But it seems ,the study sample sizes and type of education may reducethe difference between this cut of point and the actual one.In a number of studies (9 and 6) ,only hip bone mineral density was measured while in our study, the density of the hip and spine was measured and the similar results were obtained.In a study by Zhang et al., bone mineral density level in men and women with impaired verbal memory was assessed which implied that it was lower in persons withhigher memory impairment.In our study, the MMSE was generally measured; if it was considered more specificlike Zhang's study (verbal memory), a more specific and strongerassociation could be proposed (20).

The strength of our study is its relatively high sample size, which resulted in significant sample size in mild and moderate impairment categories;so the result will be more extensible to the population.Also, many confounding factors such as demographic factors, smoking, diabetes, hypertension, history of vitamins, steroid, calcium, BMI, serum levels of vitamin D, physical activity and PTU level were considered.Accordingly,the measured relationship certainly is stronger than other studies in which these factors are not considered.

In our study, the estrogen level and the history of estrogen consumption and thyroid hormones were not considered which is proposed to be considered in future studies. We also have not considered the influence of people's dietary habits on study variables.

Another weakness of the study was the lack of considering the family history of osteoporosis, cognitive impairment, and use of medications such as anticonvulsantdrugs which can affect the bone catabolism.

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[i] *.Amirkola Health and Ageing Project*
[ii] *Adjusted for educational level*