



Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/16627

DOI URL: <http://dx.doi.org/10.21474/IJAR01/16627>



RESEARCH ARTICLE

PREVALENCE AND ASSOCIATED RISK FACTORS OF OSTEOPOROSIS AMONG ELDERLY PATIENTS IN AL-AHSA REGION, SAUDI ARABIA: A CROSS-SECTIONAL STUDY

Hussien Abdullmohsen Al Nasser¹ and Aqeel Saleh Alhaiz²

1. General Physician, Primary Health Care Center, Al Ahsa Health Cluster, Al Ahsa, Saudi Arabia.
2. Consultant Family Medicine, Al Ahsa Health Cluster, Al Ahsa Saudi Arabia.

Manuscript Info

Manuscript History

Received: 05 February 2023

Final Accepted: 09 March 2023

Published: April 2023

Key words:-

Prevalence, Osteoporosis, DXA

Abstract

Background: Osteoporosis, an ageing bone disease, where the bone mineral density and bone mass decreases leading to decrease in the bone strength, is a leading cause of bone fracture among the older population. Multiple risk factors participate in developing the osteoporosis which include age, gender, previous fractures, family history of osteoporosis diet deficient in calcium, sedentary lifestyle, Body Mass Index (BMI), smoking, corticosteroid medication, or having hyperparathyroidism and chronic liver disease. The present study was conducted to assess prevalence of osteoporosis and to determine its risk factors in Al Ahsa district of Saudi Arabia in order to control and manage this condition.

Material and Methods: It was a cross-sectional study conducted at all the primary health care centers of Al Ahsa district of Saudi Arabia. All the patients with bone ailment over 60 years of age attending the Primary Health Care Centers for their bone ailment were the study population. The minimum sample size for this study has been calculated to be 384. A probability sampling in form of multistage stratified random sampling technique was used to select the sample. A special data sheet was prepared based on a similar earlier study. The data were entered and analyzed by using the statistical package for social sciences, version 21. Descriptive statistics were presented using counts, proportions (%), mean \pm standard deviation whenever appropriate. The association of risk factors with the osteoporosis was tested by chi square test. Logistic regression analysis was also done for comparative study. A p-value cut off point of 0.05 at 95% CI was used to determine statistical significance.

Results: A total of 422 patients attended the selected PHCs for the treatment of bone ailment making the response rate of 90%. The mean age of the patients was 67.36 years Std. Dev. 6.46 years (Range 60-91 years). The sex of the patients were almost equally distributed (Male: 50.1%, Female: 49.1%). More than sixty one percent of the patients were detected on DXA as suffering from osteopenia (27.3%) and osteoporosis (34%). Majority of them (55.5%) had all the signs of osteoporosis while the rest had osteopenia on DXA. On logistic regression analysis, obese patients over 60 years old were having almost 3 times more risk to develop osteopenia and osteoporosis than

Corresponding Author:- Hussain Abdullmohsen Alhasser

Address:- General Physician, Primary Health Care Center, Al Ahsa Health Cluster, Al Ahsa, Saudi Arabia.

those with normal weight (OR;2.77, 95% CI 1.48-6.25, P= 0.032) . Similarly those patients who had family history of osteoporosis were 5 times more likelihood of developing osteopenia and osteoporosis (OR:5.56 ; 95% CI 2.58-8.34, P = 0.003) .The patients with smoking habit, those who were suffering from liver disease and those who were not involved in physical exercise were 3.5 times (OR 3.56 , 95% CI 1.58-6.34, P= 0.032) , 4 times (OR; 4.32 , 95% CI 2.12-5.63, P= 0.045) and 2,7 (OR ; 2.77 , 95% CI; 1.48-6.25, P= 0.032) times likelihood of developing osteopenia and osteoporosis among the patients above 60 years of age.

Conclusion:The present study has provided vital information on the prevalence of osteoporosis among the elderly population of Al Ahsa region of Saudi Arabia. Osteoporosis is a leading cause of fracture of bone among the elderly population leading to morbidity. The high prevalence of osteoporosis in this region necessitates developing an effective awareness programme among the elderly population for the prevention of osteoporosis at least by controlling the modifiable risk factors.

Copy Right, IJAR, 2023,. All rights reserved.

Introduction:-

Osteoporosis, an ageing bone disease, is a leading cause of disability among the older population. A condition, where the bone mineral density and bone mass decreases leading to decrease in the bone strength causes increased risk of fracture. With the increasing aging population, osteoporosis has significantly increased worldwide making it a major public health problem.^[1] The World Health Organization (WHO) defines osteoporosis as a bone mass density(BMD) equivalent to or greater than two standard deviations below that of an average person at peak bone mass (often aged 20 to 30 years, depending on the measured skeletal region).^[2]

Literature Review:-

Study suggests that it is the most frequent cause of broken bones in elderly people. The vertebrae in the spine, the forearm bones, and the hip are among the bones that are prone to breaking.^[3] Bones may become so fragile that they can break spontaneously or under light force. Ordinarily, there are no signs until a broken bone occurs, Thus the disease is named as silent disease.^[4] After the broken bone heals, the person could have ongoing discomfort and have less capacity to perform daily tasks.^[1]Osteoporosis is also a public health problem in Saudi Arabia. According one study, a total of 174,225 osteoporosis-related fractures were reported in Saudi Arabia in 2019. ^[2, 3] There is a definite increase in the hospital-based prevalence of osteoporosis among the Saudi Arabian population.^[11]Compared with the previously published results, the recent research data figures are alarming. The present study was conducted to assess prevalence of osteoporosis in Al Ahsa district of Saudi Arabia in order to control and manage this condition.

Materials and Methods:-

It was analytical prospective cross-sectional study conducted between January 2022 and 30 October 2022 at all the primary health care centers of Al Ahsa district of Saudi Arabia..All the patients with bone ailment over 60 years of age attending the Primary Health Care Centers during the specific time period were the study population. The minimum sample size for this study has been calculated by the formula.

Where: n: Calculated sample size

Z: The z-value for the selected level of confidence (1- a) = 1.96.

P: An estimated prevalence.

Q: (1 – 0.50) = 50%, i.e., 0.50

D: The maximum acceptable error = 0.05.

So, the calculated minimum sample size was:

$$n = (1.96)^2 \times 0.50 \times 0.50 = 384$$

(0.05)²

An increase of 10% was added to the sample to increase the response rate so the total sample size was 422.

A probability sampling in form of stratified random sampling technique was conducted. The four clusters in Al Ahsa region which are named as middle sector, western sector, northern sector and southern sector were used to take a random sample according to the proportionate of referral from each sector. Total referral of patients above 60 years of age suspected of osteoporosis was 3044 in number which consisted of 24% from middle cluster, 43% from eastern sector 12% from western sector, 12% from northern sector and 9% from southern sector. A Systematic simple random sampling was done proportionate of referral from each sector to Al Jafar PHC which is the only DXA scan center in Al Ahsa, Osteoporosis was categorized status by WHO T-score which consisted of osteoporosis (T-score < -2.5), osteopenia (-2.5T-score < -1.0), and normal (T-score > -1.0). The data required for this study were collected using the electronic file and contacted by phone for missing data. Each patient was assigned to one of the osteoporosis status categories depending on which hip, right, and left hip has the lowest BMD T-scores. A special data sheet was prepared based on a similar earlier study which consisted of two sections. Section 1 contained the demographic characteristics of the patients such as age, sex, marital status, BMI, Smoking status, physical exercise status, family history of osteoporosis. Section 2 consisted of data related to diagnosis of osteoporosis, calcium intake and Vitamin D intake of the patients. Data were collected by electronic file and telephone contact for missing data. The data were entered and analyzed by using the statistical package for social sciences, version 21 (SPSS, Chicago, IL, USA). Descriptive statistics were presented using counts, proportions (%), mean \pm standard deviation whenever appropriate/ The association of risk factors with the osteoporosis was tested by chi square test. Logistic regression analysis was also done for comparative study. A p-value cut off point of 0.05 at 95% CI was used to determine statistical significance. This study was approved by the Institutional Review Board in the Ministry of Health in Saudi Arabia. Informed consent was taken from each participant.

Results:-

A total of 422 patients attended the selected PHCs for the treatment of bone ailment making the response rate of 90. The mean age of the patients was 67.36 years Std. Dev. 6.46 years (Range 60-91 years). The sex of the patients were almost equally distributed (Male: 50.1%, Female: 49.1%). More seventy eight percent of the patients (78.2%) were married while 11.2% were widow while 6.2% and 4.5% were unmarried and divorced.. The mean BMI of the patients was 30.19 M/Kg² \pm Std. Dev. 6.17 (Range 17-50). Many of the patients were obese (46.2%) while 33.3% were overweight and 19.5% were of normal weight. A small fraction (1.0%) of the patients was underweight. Majority of the patients (69.6%) were non smoker while 21% were current smoker and 9.4% were past smoker. One fourth of the patients (25.7%) were suffering from type diabetes while 26.7% of them were suffering from essential hypertension, 9.1% had hyperparathyroidism and 9.4% had liver diseases. More than thirty two percent of the patients (32.2%) did not have any chronic diseases. Fifty percent of the patients had family history of osteoporosis. The majority of the patients (20.5%) were always involved in physical exercise while 63.4% were never involved in physical exercise and 16.1% used to do physical exercise occasionally. The majority of the patients (74.3%) did not use steroids. The details of the demographic characteristics of the patients are shown in table 1.

Table 1:- Showing the demographic characteristics of the patients.

Variables	No.	Percentage
Age: Mean age: 67.36 years Std. Dev. 6.46 years (Range 60-91 years).		
Sex		
Male	193	50.1
Female	192	49.9
Marital status		
Unmarried	24	6.2
Married	301	78.2
Divorced	17	4.5
Widow	43	11.2
BMI Mean :30.19 Kg / M ² \pm Std. Dev. 6.17 Kg / M ² (Range 17-50 Kg / M ²) Range		

Below Normal	4	1
Normal weight	75	19.5
Overweight	128	33.2
Obese	178	46.2
Smoking status		
Non smoker	268	69.6
Current smoker	81	21.0
Ex smoker	36	9.4
Physical exercise		
Always	79	20.4
Sometimes	62	16.1
Never	244	63.4
Associated chronic disease.		
No chronic disease	124	32.2
Hypertension	99	25.7
Type 2 Diabetes	91	23.6
Hyperparathyroidism	35	9.1
Liver disease	38	9.4
Family history of osteoporosis		
Yes	196	50.9
No	189	49.1
Use of steroid		
Yes	99	25.7
No	286	74.3

Prevalence of osteoporosis

Almost thirty eight percent (37.9%) of the patients were detected on DXA as suffering from osteopenia and osteoporosis (30.9%). More than fifty four percent (54.3%) of the patients were on the treatment with calcium and 46.765 were on the Vitamin D supplementation. The details of the prevalence of osteoporosis and management are shown in table 2.

Table 2:- Showing the prevalence of osteoporosis and the management.

Variables	No.	Percentage
DXA finding.		
Normal	120	31.2
Osteopenia	146	37.9
Osteoporosis	119	30.9
Taking Calcium		
Yes	208	54.3
No	177	45.7
Taking Vitamin D		
Yes	180	46.75
No	205	53.25

Risk factors of osteoporosis: and osteopenia

The prevalence of osteoporosis and osteopenia were higher among the female than that of male. However, it was not statistically significant (66.69% vs 68.99%, $P=0.602$). As far as marital status is concerned, prevalence of osteoporosis and osteopenia was significantly more among the widow than the divorced and married patients (90.69% vs.67.10 % vs.58.82%, $P= 0.020$). As BMI increased from normal to obese, the prevalence of osteoporosis and osteopenia also increased significantly. (50%vs.54.66% vs.82.80.% vs. 65.15% $P=0.045$). The prevalence of osteoporosis and osteopenia was significantly high among the past smoker and current smoker than those who never smoked (76.57% vs.66.48% vs. 40.81%, $P=0.023$). The prevalence of osteoporosis and osteopenia was significantly

higher among the patients who were never involved in physical exercise than those who always did physical exercise and those who sometimes exercised (60.65% vs.60.31% vs.39.32%, $P=0.032$). The prevalence of osteoporosis and osteopenia was significantly higher among the patients suffering from liver disease, hyperparathyroidism, type 2 diabetes and essential hypertension than those without any chronic disease (72.22% vs.71.43% vs.67.74% vs.61.54% vs.57.25%, $P=0.045$). Similarly, the prevalence of osteoporosis and osteopenia was significantly higher among the patients with family history of osteoporosis (70.8% vs.56.04%, $P=0.005$). The prevalence of osteoporosis and osteopenia was higher among the patient's using steroid, but it was not statistically significant (65.65% vs.59.79%, $P=0.181$). The details of the association of risk factors with the demographic characteristics are shown in table 3.'

Table 3:- Showing the details of the association of risk factors with the demographic characteristics.

Variables	Normal DXA No. (%)	Osteopenia and Osteoporosis diagnosed. No.(%)	P-value
Sex			0.323
Male	62(31.31)	136(66.69)	
Female	58 (31.01)	129(68.99)	
Marital status			0.02
Unmarried	10(41.66)	14 (58.33)	
Married	99(32.89)	202(67.10)	
Divorced	7(41.17)	10(58.82)	
Widow	4(9.30)	39(90.69)	
Below Normal			0.032
Underweight	2(50.0)	2(50.0)	
Normal weight	34(45.34)	41(54.66)	
Overweight	22(17.10)	106(82.80)	
Obese	62(34.89)	116(65.16)	
Smoking status			0.023
Non smoker	55(59.19)	40(40.81)	
Current smoker	68(33.53)	111(66.48)	
Ex smoker	26(23.43)	85(76.57)	
Physical exercise			0.320
Always	54(60.67)	35 (39.32)	
Sometimes	26(39.69)	36(60.31)	
Never	63(39.35)	181(60.65)	
Associated chronic disease.			0.045
No chronic disease	48(42.75)	66(57.25)	
Hypertension	35(38.46)	56(61.54)	
Type 2 Diabetes			
Hyperparathyroidism			

Liver disease	36(32.26)	63(67.74)	
	10(28.57)	25(71.43)	
	10(27.78)	26(72.22)	
Family history of osteoporosis			0.003
Yes	40(29.2)	97(70.8)	
No	108(43.96)	139(56.04)	
Use of steroid			0.181
Yes	34(34.35)	65(65.65)	
No	115(40.21)	171(59.79)	

Logistic regression analysis:

On logistic regression analysis, obese patients over 60 years old were having almost 3 times more risk to develop osteopenia and osteoporosis than those with normal weight (OR;2.77, 95% CI 1.48-6.25, P= 0.032) . Similarly those patients who had family history of osteoporosis were 5 times more likelihood of developing osteopenia and osteoporosis (OR:5.56 ; 95% CI 2.58-8.34, P = 0.003) .The patients with smoking habit, those who were suffering from liver disease and those who were not involved in physical exercise were 3.5 times (OR 3,56 , 95% CI 1.58-634, P= 0.032) , 4 times (OR; 4.32 , 95% CI 2.12-5.63, P= 0.045) and 2,7 (OR ; 2.77 , 95% CI; 1.48-6.25, P= 0.032) times likelihood of developing osteopenia and osteoporosis among the patients above 60 years of age.

Discussion:-

The present study was conducted in Al Ahsa region of Saudi Arabia to estimate the prevalence and risk factors of osteoporosis among the elderly people of the local population. The study has found that more than sixty one percent of the patients above the age of 60 years were suffering from osteopenia (27.3%) and osteoporosis (34.0%) which is higher than Netherlands (4.1%), African countries (26.9%). However, the prevalence of osteoporosis was higher in a Turkish study (52.0%).^[16] Overall prevalence of osteopenia and osteoporosis was 49.9 and 18.3% respectively in an Indian study.^[18] The prevalence of osteopenia (27.3%) was lower in the present study as compared to Indian study while the prevalence of osteoporosis was higher (34%).^[18] in a recently concluded Saudi study , the researchers have found a higher prevalence of osteoporosis specially among male(63.6%) than the female(52.8%).^[15] In a Chinese study a low prevalence of osteoporosis was detected (5.% in male and 20.6% in female).^[19] However, in this study the age group of the study population was 40 years and older. In the present study the age group of the study sample was 60 years and more. In a similar Chinese study the researchers have found a prevalence of osteoporosis among the elderly men to be 20.73% while among the elderly women it was 38.%. In the present study there was no much difference in the prevalence of osteoporosis between the two gender.^[20] A Bangladeshi study has revealed an overall prevalence of osteoporosis to be 37.3%.^[21] One Iranian study has also found a high prevalence (41.5%) of osteoporosis among the elderly population.^[22] A high BMI ,family history of osteoporosis ,current and past smoker and lack of physical exercise were found important risk factors in the present study. The Chinese study has documented smoking, female gender and low BMI as the major risk factors of developing osteoporosis among the elderly.^[23] However, in the present study obesity rather than Low BMI was detected as the risk factor. overweight and obesity were considered to be protective factors for osteoporosis with OR of 0.514 and 0.300, respectively in other Chinese study^[17] current smoking was an independent risk factor of osteoporosis in males (OR = 2.437, P = 0.046) in this study. Gender was not found as a risk factor in the present study. Like Bangladeshi study where diabetes (p = 0.003), and multimorbidity(p <= 0.001) were the significant risk factors ,the present study has also found diabetes and multimorbidity as the major risk factors for osteoporosis. However unlike the present study gender played important risk factor in the Bangladeshi study (p <= 0.001), In the Iranian study the risk factors of developing osteoporosis differed among the men and women. Among men, osteoporosis was positively associated with smoking, history of liver diseases but negatively associated with BMI and diabetes while BMI and

hypertriglyceridemia, were negatively correlated with osteoporosis in women. The present study has also shown liver disease as an important risk factor of developing osteoporosis among the elderly. The other Saudi study has reported the major risk factor of developing osteoporosis as being aged 61 to 70 years (OR 2.75, 95% CI: 1.32-1.48). The present study has included the study subject over 60 years of age only. Essential hypertension was significantly associated with the prevalence of osteoporosis in the present study. The same result was published in a Chinese case cohort study in which the prevalence of osteoporosis was significantly higher ($\chi^2=12.968$; $p=0.002$) among the patients with essential hypertension than the control group.^[23] BMI ($t=0.874$, $p=0.383$) did not play any role as risk factor in this study.

Limitation of the study:

Though the present study has provided valuable information on the prevalence and risk factors of osteoporosis but the true association with the risk factors can only be found by the case control study. The study included the population above the 60 years of age only and so prevalence in different age group could not be found. We require a larger population survey with other factors associated with female gender to assess the real prevalence and risk factors among both gender.

Conclusion:-

The present study has provided vital information on the prevalence of osteoporosis among the elderly population of Al Ahsa region of Saudi Arabia. Osteoporosis is a leading cause of fracture of bone among the elderly population leading to morbidity. The high prevalence of osteoporosis in this region necessitates developing an effective awareness programme among the elderly population for the prevention of osteoporosis at least by controlling the modifiable risk factors.

References:-

1. Nancy Garrick DD. Osteoporosis [Internet]. National Institute of Arthritis and Musculoskeletal and Skin Diseases. 2017. Available from: <https://www.niams.nih.gov/health-topics/osteoporosis#:~:text=Osteoporosis%20is%20a%20bone%20disease>
2. Goldman L, Schafer AI, Cecil RL. Goldman-Cecil medicine. 26th ed. Amsterdam: Elsevier; 2020.
3. Golob AL, Laya MB. Osteoporosis: screening, prevention, and management. Medical Clinics. 2015 May 1;99(3):587-606.
4. Guthrie JR, Dennerstein L, Wark JD. Risk factors for osteoporosis: A review. Medscape Women's Health. 2000 Jul-Aug;5(4):E1. PMID: 11109046.
5. Handa R, Ali Kalla A, Maalouf G. Osteoporosis in developing countries. Best Practice & Research Clinical Rheumatology. 2008 Aug;22(4):693-708.
6. Marshall D, Johnell O, Wedel H. Meta-analysis of how well measures of bone mineral density predict occurrence of osteoporotic fractures. Bmj. 1996 May 18;312(7041):1254-9
7. Stone KL, Seeley DG, Lui LY, Cauley JA, Ensrud K, Browner WS, Nevitt MC, Cummings SR. BMD at multiple sites and risk of fracture of multiple types: long-term results from the Study of Osteoporotic Fractures. Journal of bone and mineral research. 2003 Nov;18(11):1947-54.
8. Johnell O, Kanis JA, Oden A, Johansson H, De Laet C, Delmas P, Eisman JA, Fujiwara S, Kroger H, Mellstrom D, Meunier PJ. Predictive value of BMD for hip and other fractures. Journal of bone and mineral research. 2005 Jul;20(7):1185-94.
9. Eastell R. Treatment of postmenopausal osteoporosis. New England journal of medicine. 1998 Mar 12;338(11):736-46
10. Glüer CC. Monitoring skeletal changes by radiological techniques. Journal of Bone and Mineral Research. 1999 Nov;14(11):1952-62.
11. Kanis JA, Glüer CC. An update on the diagnosis and assessment of osteoporosis with densitometry. Osteoporosis international. 2000 Mar;11(3):192-202.
12. Kanis JA, Delmas P, Burckhardt P, Cooper C, Torgerson DO. Guidelines for diagnosis and management of osteoporosis. Osteoporosis international. 1997 Jul;7(4):390-406.
13. Klibanski A, Adams-Campbell L, Bassford T, Blair SN, Boden SD, Dickersin K, Gifford DR, Glasse L, Goldring SR, Hruska K, Johnson SR. Osteoporosis prevention, diagnosis, and therapy. Journal of the American Medical Association. 2001 Feb 14;285(6):785-95.

14. Nielsen BR, Andersen HE, Haddock B, Hovind P, Schwarz P, Suetta C. Prevalence of muscle dysfunction concomitant with osteoporosis in a home-dwelling Danish population aged 65–93 years-The Copenhagen Sarcopenia Study. *Experimental gerontology*. 2020 Sep 1;138
15. Sadat-Ali M, AlZamami JF, AlNaimi SN, Al-Noaimi DA, AlDakheel DA, AlSayed HN, Al-Turki HA, AlOmran AS. Osteoporosis: Is the prevalence increasing in Saudi Arabia. *Ann Afr Med*. 2022 Jan-Mar;21(1):54-57. doi: 10.4103/aam.aam_79_20. PMID: 35313406; PMCID: PMC9020622.
16. Xiao, PL., Cui, AY., Hsu, CJ. et al. Global, regional prevalence, and risk factors of osteoporosis according to the World Health Organization diagnostic criteria: a systematic review and meta-analysis. *OsteoporosInt* 33, 2137–2153 (2022). <https://doi.org/10.1007/s00198-022-06454-3>
17. Wang L, Yu W, Yin X, Cui L, Tang S, Jiang N, Cui L, Zhao N, Lin Q, Chen L, Lin H, Jin X, Dong Z, Ren Z, Hou Z, Zhang Y, Zhong J, Cai S, Liu Y, Meng R, Deng Y, Ding X, Ma J, Xie Z, Shen L, Wu W, Zhang M, Ying Q, Zeng Y, Dong J, Cummings SR, Li Z, Xia W. Prevalence of Osteoporosis and Fracture in China: The China Osteoporosis Prevalence Study. *JAMA Netw Open*. 2021 Aug 2;4(8):e2121106. doi: 10.1001/jamanetworkopen.2021.21106. PMID: 34398202; PMCID: PMC
18. Sushrut, Shobhit ,Prevalence of osteoporosis in India: an observation of 31238 adults,International journal of research in orthopedics,VOL. 7 NO. 2 (2021): MARCH-APRIL 2021
19. Yang, X., Tang, W., Mao, D. et al. Prevalence and risk factors associated with osteoporosis among residents aged above 20 years old in Chongqing, China. *Arch Osteoporos* 16, 57 (2021). <https://doi.org/10.1007/s11657-021-00910-z>
20. S, Shi Q and Wang YJ (2023) The prevalence of osteoporosis in China, a community based cohort study of osteoporosis. *Front. Public Health* 11:1084005. doi: 10.3389/fpubh.2023.1084005Osteoporosis (CCCO) collaborative group
21. Mohammad Ali,ZakirUddin,AhmedHossain,Prevalence and Patterns of Risk of Osteoporosis in Bangladeshi Adult Population: An Analysis of Calcaneus Quantitative Ultrasound Measurements,*Osteologie/Osteology* 1(4):187-196, October 2021,DOI:10.3390/osteology1040018
22. Noorali S, Yousefi S, Gharibzadeh S, Shafiee G, Panahi N, Sanjari M, Heshmat R, Sharifi F, Mehrdad N, Raeisi A, Nabipour I, Larijani B, Ostovar A. Prevalence of osteoporosis among the elderly population of Iran. *Arch Osteoporos*. 2021 Jan 21;16(1):16. doi: 10.1007/s11657-020-00872-8. PMID: 33475880.
23. Hai-Long Wu¹ , Jie Yang¹ , Yu-Chi Wei¹ , Jian-Yu Wang¹ , Yu-Yan Jia¹ , Luan Li² , Lu Zhang¹ , Yan Lu¹ , Zong-Jian Luo^{3*} and Xiang-Yang Leng , Analysis of the prevalence, risk factors, and clinical characteristics of osteoporosis in patients with essential hypertension *BMC Endocrine Disorders* (2022) 22:165
24. AlQuaiz, A.M., Kazi, A., Tayel, S. et al. Prevalence and factors associated with low bone mineral density in Saudi women: a community based survey. *BMC MusculoskeletDisord* 15, 5 (2014). <https://doi.org/10.1186/1471-2474-15-5>.