Nutritional Aspect of The Prevention of Osteoporosis and Osteomalacia: A Comprehensive Review

Rashida Perven1, Kiran Yaqoob2, Sadia Sabir3, Maham Saleem4

ARTICLE INFORMATION

Corresponding Author:
 rashida.perveen@superior.edu.pk

Affiliations:
1Faculty of Food, Nutrition and Home Science, University of Agriculture Faisalabad
2Bahria International Hospital Lahore,  
3Department of Food Science and Technology, University of Lahore
4Department of Food Science and Technology, University of Veterinary and Animal Sciences Lahore

Citation:
Received: 13-February-2022
Revised and Accepted: 14-March-2022
Published On-Line: 24-March-2022

ABSTRACT

The topic under discussion is “Osteoporosis”. This study will highlight the factors associated to the degradation fragility and brittleness of bones. The prevention and cure of the affected bones through specific diet and related supplements will be focused due to the combo nutrients like calcium, vitamin D, phosphorus, magnesium and protein we can treat the weak and brittle bones. But this study will have an eye on the other side of the picture, the results showed that even calcium and vitamin D’s efficacy in dealing with osteoporosis is not satisfying and have to cover-up the deficiency through other aids. It has been observed that the awareness on the Nutritional aspects related to osteoporosis are still low and there is a need to improve the risk among patients, physicians and women.

Key words: Calcium, Protein, Nutritional aspects

Original Research Article

Introduction:
Osteoporosis refers to the degeneration of bones due to factors of aging and deficiency of two essential nutrients like calcium and vitamin D. (Harvey et al., 2008) As we grow in age, the density, mass, strength and bone tissues are deteriorated mostly in postmenopausal women (Society, 2006). Bruises are experienced along with the cracking of bones which clearly indicates the loss of flexibility and density of bone mass. All these symptoms appear in the body as humans age grows. The study can sweep aside this painful process by focusing on our diet. If we will take balanced diet we will never fall into the clutches of osteoporosis. (Stending-Lindberg et al., 1993). The main cause of illness and disability is osteoporosis. Premature death can occur due to hip fractures and disability. (Hofmann et al., 1997) Osteoporosis is defined by WHO as it is a Bone Mineral Density (BMD) which can be measured by dual x-ray energy absorption method. (Organization, 1994). BMD could result into death by inducing required amount of calcium to it. Skeletal wellness/stability is the hallmark of healthier life which should be maintained by taking the required necessary amount of significant nutrients like calcium and vitamin D. This can be helpful to our skeletal life by doing exercise and adopting the healthier lifestyle away from the risk factors of fractures and degeneration of our bones. This disease should be treated thorough balanced diet and if needed then with the pharmacological aid. For decades, normal status of Vitamin D has been balanced with normal status of calcium for the maintained, well-balanced bone metabolism and prevention of osteoporosis is considered the most important treatment. (Rossini et al., 2010) and (Chung et al., 2011). Furthermore, it has been observed that by the age calcium absorption is decreased in response to vitamin D. (Pattanaungkul et al., 2000). The causes and symptoms of osteoporosis depends upon the status of calcium and vitamin D. There is a correlation between both deficiencies, so decrease or increase in the dosage of one supplement can affect on the efficacy and working of another supplement. (Matkovic et al., 1994)

Epidemiology:
Osteoporosis affects almost 200 million people. In addition, studies shows that this disease is more common among females comparing males. There is a high risk of osteoporosis among Asian and White people as compare to Africans. (Wade et al., 2014). A recent literature review revealed that 1 in 4 people over the age of 60 has bone fractures associated with osteoporosis. However, males experience less osteoporosis unlike females. (Gruntmanis, 2007)

Osteoporosis:
Osteoporosis is a bone disease in which the body loses more bone strength and makes fewer bones because it has less bone mass. It enhances the fragility of bone, most prominently of wrist, vertebral column, shoulders and hips. The literal meaning of Osteoporosis is “porous bone”. Hive embarks the good health of bones. The hives and the holes in the hive get much bigger than the healthy bone, when osteoporosis occurred. Although in osteoporosis, the bones lose density. (Kalff et al., 2013)
Pathogenesis of osteoporosis:
Abnormal function among bone formation and bone regeneration can be caused by osteoporosis. Bone units if multiple cellular takes place in this process. Bone matrix is destroyed by transcription factor PU with the help of osteoclasts, but the bone matrix also rebuilds. When the bone matrix is destroyed rapidly by osteoporosis, there is an occurrence of lower density of bone mass. There are three main approaches in the development of osteoporosis; Adequate bone mass, high bone regeneration and adequate structure of newly formed bone. The bone regeneration rate is strongly regulated by hormones as the deficiency of estrogen is seen in people with osteoporosis. (Panisset et al., 2016). Adequate intake of calcium and vitamin D supplements can reduce the bone loss. Parathyroid hormones are secreted by parathyroid glands that responds to the low levels of calcium increases bone regeneration to protect blood. Calcitonin is a thyroid-producing hormone that enhances bone regeneration, which is less effective than PTH (Jacqueline, 2015).

Signs and Symptoms:
Osteoporosis is also known as “silent thief” as there are no prominent symptoms of bone loss occurrence. The symptoms of osteoporosis are the only pain and the severity of pain depends on the fracture location. (Shin et al., 2006)

Osteoporosis causes:
There are no prominent causes of osteoporosis until or unless the stable state of bone regeneration gets disturbed and in which old bones break down and new bones are formed. In adults the loss of bone mass is much faster than it is formed as compared to children. Lack of estrogen hormone in both males and females can be the main cause of osteoporosis. Risk factors of osteoporosis can be malnutrition, no physical activity, calcium and vitamin D deficiency, low body mass, genetic predisposition, excessive alcohol consumption, smoking, high intake of steroids and family history of rheumatoid arthritis and osteoporosis. (Lima et al., 2015)

Diagnosis:
The bone fractures are occurred due to osteoporosis. However, only the accurate and precise bone mass measurements are the basic information for osteoporosis diagnosis. Osteoporosis is the main component for fracture risk. (Kanis, 1994)

Bone Mineral Measuring Technique:
There are two methods that are widely used to estimate mass of bone. These methods are used to assess the mineral content of bone in different regional sites such as hip, vertebral column, the fracture of complete skeleton and wrist.

Single-Energy Absorptiometry:
This technique measures the absorption of iodine and other minerals in the bones. SPA determines the amount of mineral content in the bones with the help of photon. Through SXA we can scan all of the minerals from the wrist and we do not need isotopes. On the other hand, this one is more accurate as well.

Dual-Energy Absorptiometry:
Spinal cord and humps are measured more accurately with the help of DEXA by using photons to measure the mineral content of those areas. (Kanis et al., 1994)

Factors Contributing to Osteoporosis:
Constitutional or Genetic:
- Family history of fracture
- Asian or white race
- Premature menopause (<45 years)
- Hip length

Nutrition and Lifestyle:
- Smoking
- Nulliparity
- Amenorrhea
- Excessive intake of alcohol
- Physical inactivity
- Malnutrition
- Overweight people also have risk of osteoporosis.

Medical Disorders:
- Primary hyperparathyroidism
- Arthritis
- Diabetes
- Renal failure
- Anorexia nervosa
- Hypercritics
- Neurological disorders
- Mastocytosis
- Lung disease

Drugs:
- Chemotherapy
- Anticonvulsants
- Anticoagulants
- Thyroid treatment
- Corticosteroid’s treatment

Osteomalacia:
Bone softening is caused by the inadequate intake of vitamin D phosphorus calcium and the bone metabolism weakening is due to the calcium regeneration. These causes can lead to the mineralization of bone in children with osteomalacia known as rickets. (Figure 1) (Henriksen et al., 2016)

Figure 1 Shape of Bone

Signs and symptoms of Osteomalacia:
There may be no symptoms in the early stages of osteomalacia, although symptoms of osteomalacia may be evident on X-rays or additional clinical trials. Osteomalacia develops to the point of developing bone pain and muscle weakness. (Agrawal et al., 2015)
The most prominent osteomalacia symptoms is pain in the bones, mostly at night in the feet, backbone and hip joints. Deficiency of calcium and vitamin D can be the risk for osteoporosis, muscle cramps, numbness and tingling in the legs. Lethargic legs and unaligned muscle tone can lead to reduced gait in addition to the frequency of fractures. (Kanwar et al.)

**Causes of Osteomalacia:**
Osteomalacia is caused by defects in the bone modulation process. The body needs certain minerals in the form of calcium and phosphate during the process of bone synthesis in the metabolic process. So, osteoporosis develops as a result of depletion of these minerals. These problems can occur as follows: (Bikle, 2012)

**Inadequate Vitamin D:** Malfunctioning of vitamin D can be the major cause of osteomalacia. People who are not exposed to sunlight or do not have enough vitamin D can develop osteomalacia (Wacker and Holick, 2013)

**Certain Surgeries:** Deficiency of Calcium and Vitamin D happens in the body due to certain surgeries.

**Disease Celiac:** A disease that causes Calcium and Vitamin D dysfunction (Al-Mogbel, 2012)

**Disorders of Kidney and Liver:** Malfunctioning of kidney and liver can affect negatively on the efficacy of Vitamin D.

**Medicines:** The efficacy of vitamin can also be compromised by some severe medications.

**Osteomalacia Diagnosis:**
The Osteomalacia biochemical features are familiar to rickets. The diagnosis of Osteomalacia can be done by: (Niemeier et al., 2013)
- Serum phosphate must be reduced
- Excessive serum alkaline phosphatase
- Excessive parathyroid hormone
- Urinary calcium and low serum
- Bone density test and bone x-rays determines the softness of bone which can be helpful for the Osteomalacia diagnosis.

**Osteomalacia Pathogenesis:**
Adequate amounts are required for bone synthesis from ionized calcium and phosphate. Effect of ration on calcium by vitamin D after dihydroxylation on calcitriol. Calcium concentrations decrease when vitamin D levels are weakened during the metabolic process. (Blaine et al., 2015) Secretion of parathyroid hormones increases due to the low levels of calcium. Ration itself increases pH as calcium but phosphate renal clearance increases. Mineralization stop functioning normally, when phosphate is decreased to minimal level. (Nam et al., 2017)

### Table 1: Osteoporosis and Osteomalacia Differences

<table>
<thead>
<tr>
<th>Osteoporosis</th>
<th>Osteomalacia</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone mineral density reduction</td>
<td>Demineralization of bones</td>
<td>Definitions</td>
</tr>
<tr>
<td>&gt;65 years women</td>
<td>Adults</td>
<td>Presence</td>
</tr>
<tr>
<td>Curving of the back risk for the fracture</td>
<td>Weakness of muscles and fragile bones</td>
<td>Signs and symptoms</td>
</tr>
<tr>
<td>Calcium and phosphorus deficiency, excessive alcohol consumption, endocrine disorders</td>
<td>Vitamin D deficiency</td>
<td>Causes</td>
</tr>
</tbody>
</table>

**Measures to Prevent Osteoporosis and Osteomalacia:**
Prevention of osteomalacia can be managed by containing the adequate amount vitamin D. The 3 months dosage of 10,000 IU of vitamin D can cured this disease. However, osteoporosis requires daily injections of vitamin D of melba’s of appropriate amount. Oral treatment of Osteomalacia can be done by containing the supplements of phosphorus, calcium and vitamin D. (Sahay and Sahay, 2012)

Treating osteoporosis or preventing bone fractures by increasing bone density. Medications used to treat osteoporosis includes:
- Bisphosphonates drugs can reduce the risk of bone fractures
- Spinal fractures can be inhibited by estrogen hormone
- Bone formation is stimulated by parathyroid hormone
- Spinal fractures in females with postmenopausal condition can be prevented by calcitonin.

Calcium and vitamin D supplements (Moyer and Force*, 2013)

Osteoporosis prevention is better than to be cured. It can be managed by:
- Healthy lifestyle can be adopted by quitting smoking, avoiding alcohol, fulfilling the daily requirements of calcium and vitamin D.
- Increase your bone strength and prevent the bone loss by taking medications.
- Consume the supplements that enhance the bones fragility. (Adler et al., 2016)

In the early stage of childhood osteoporosis prevention is important. Patients need appropriate dosage of vitamin D and calcium. If we want to avoid the risk of osteoporosis, we should adopt healthier lifestyle by quitting cigarette smoking, physical inactivity, alcohol, sodium and animal protein. Due to prolong medication patients often faces the troubles of bone loss. To compensate this bone loss, they should consume the adequate amount of calcium and vitamin D. (Nieves et al., 2012)

**Workout:**
By adopting the healthier lifestyle of regular exercise, we can sweep aside the dangers of osteoporosis. Due to the combination of different exercises, we can enhance and improve the correlation between the working parts of our body like balance, strength and nerve muscle functions. Regular exercise and workout boost up the bone mass and over all functions of our body. (Marcus et al., 2007)

**Pharmacological Prevention:**
If we will have an eye on pharmacological cure of osteoporosis the two closely associated supplements related to the prevention of osteoporosis are calcium and vitamin D.

**Calcium:**
Calcium is an essential and significant nutrient in the skeletal health and should be taken in every age for the observed maintenance of bone mass and density. On the other hand, the absorption and emission level of calcium should also be under observation. Adequate consumption of calcium can help to reduce the fractures. Mineralization of bone, in addition to decreasing bone turnover, indicates low remodeling sites, but in combination with milk promotes skeletal development. (Cassidy and Hillman, 1997) (Wosje and Specker, 2000) (Cadogan et al., 1997)
Contribution of calcium supplements:
People with insufficient calcium need to intake the proper adequate required amount of calcium on daily bases for the maintenance of healthy bones. (Watts and Diab, 2010)

Contribution of Vitamin D supplements:
Vitamin D plays significant role in the growth and maintenance of bones, along with the calcium absorption. The daily dosage of vitamin D to patients varies in accordance to the intensity of the disease. Vitamin D could be taken in oral and in injection form. Vitamin D in cooperation with metabolic plays pivotal role in calcium absorption and if it’s malfunction then degeneration in bones take place. (Daly et al., 2008) (Ross et al., 2011)
Less consumption of vitamin D and calcium can lead towards the destruction or degeneration of bones and fractures after menopause in women. (Goodacre et al., 2000)

Figure 2 Parathyroid Hormone
A mixture of Calcium and Vitamin D:
In order to deal with the issues of bone mass, fractures and bone structures the combo therapy of calcium and vitamin D are in vogue. This therapy is in the focus to cure the bone fractures and all problems related with health and growth of bone specifically vertebral fractures. However, if the consumption of both calcium and vitamin D of adequate amounts can be helpful in reducing the bone and hip fractures. (Feber et al., 1994) (Dawson-Hughes et al., 1997)

Magnesium:
The studies shows that magnesium has played significant role in the regeneration of bones in women. (Phipps et al., 2000). Further no strong evidence related to the bridge between magnesium and osteoporosis is found but studies shows that magnesium facilitates the mineral balance, bone growth and stabilization of bones. (Gemnari, 2001) Magnesium can be found in fruits and vegetables on the contrary supplements can also be taken.

Phosphorus:
Phosphorus is an important factor in bone formation and in addition to calcium, phosphorus needs to be adequately supplied to the bone throughout life. Proper calcification of the skeleton requires calcium and phosphorus. (Prentice, 2004) The diet rich in phosphorus and calcium ratio have the ability to absorb and retain any mineral or to properly mineralize the ability of bone (Intakes, 1997b) and the Department of Health to make it possible. Low intake of calcium combo with the high consumption of phosphorus can alter calcium metabolism and has been shown in short-term studies to increase parathyroid hormone secretion (Calvo et al., 1990) although they are affected by less intake of calcium, they also appear together. Doubling phosphorus intake had very little effect on bone turnover (Intakes, 1997a) (Bizik et al., 1996) and carbonated beverages containing phosphorus (Fenton et al., 2009). As a result, there is no study has used the phenomenon of osteoporosis fracture.

Protein:
On a global scale, if excessive amount of protein is taken then it lead towards the degeneration of hip bones and finally lead to hip fractures. (Edo et al., 2011) Consumption of protein from animal source determines that it can be contributed to acidic environment but there is no evidence for negative results. It can be balanced if we consume adequate amount of vitamin D, calcium and phosphorus with high meat diet. (Hunt et al., 1995) However, protein should be taken very carefully because excessive intake will affect the efficacy of bone mass. On the contrary, less consumption of protein will lead towards the weak bone growth. To avoid all this, ideal requirement of protein should be taken. (Rizzoli and Bonjour, 1999)

Other nutrients:
- Significant amount of salt and protein from animal sources should be incorporated.
- Consumption of vitamin K should be adequate.
- Lentils and soy products derive dietary Phytoestrogens. (Colhoun et al., 2012) (Clarke et al., 2004)

Conclusion:
Nutrition plays a major role in skeletal health, resting from childhood to maximum bone density during the thirtieth year of life, and throughout adulthood to maintain bone health. To conclude its crystal clear to us that balanced diet always plays a pivotal role in the skeletal health, strength, regeneration and mass of bones. Through exercise and related diet in the form of calcium and vitamin D we can keep our bones in remarkable health. As, degeneration of bones start after middle age instead of medication we should cover up the ailment of bones by taking balanced diet specially closely associated nutrients like calcium and vitamin D. (Weaver et al., 2016) Due to healthy lifestyle away from alcohol and smoking we can keep our bone density and mass in ideal health. However, for decreasing the risk of bone fractures and improving the healing process after fracture we should consume the significant amounts of micro and macronutrients.

References
5. BIZIK, B. K., DING, W. & CERKLEWSKI, F. L. 1996. Evidence that bone resorption of young men is not
increased by high dietary phosphorus obtained from milk and cheese. Nutrition Research, 16, 1143-1146.


13. DALY, R. M., HAIKERWAL, A. & EBELING, P. R. 2008. Elderly men may benefit from vitamin D. Agrofoodindustry hi-tech, 19, 32-34.


diagnosis of osteoporosis. Journal of bone and mineral research, 9, 1137-1141.

31. KANWAR, G., SHARMA, N., SHARMA, P. & SHEKHAWAT, M. STUDY OF VITAMIN D LEVELS AND ITS CORRELATION WITH BMI IN ASTHMATIC FEMALES.


mass development and lifestyle factors: a systematic review and implementation recommendations. Osteoporosis international, 27, 1281-1386.