



The Synergy of Diet, Exercises and Lifestyle Modification for the Prevention of Osteoporosis

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

This paper did a review of literature on osteoporosis, the risk factors, the consequences, and the prevention through the synergy of diet, exercises and appropriate lifestyle modification. Osteoporosis is a condition in which bones become dangerously thin and fragile over time. Fractures are the most serious consequence of osteoporosis, and up to 20% of all people who suffer a hip fracture die within a year. Other problems associated with osteoporosis are loss of height and a stooped posture due to vertebral fractures, severe back and hip pain, and breathing problems caused by changes in the shapes of the skeleton. Women are at greater risk than men for osteoporosis because they have 10 – 25% less bone in their skeletons. Women's bones become dangerously thin sooner than men's bones after Menopause when oestrogen production is diminished. Oestrogen improves calcium absorption and reduces the amount of calcium the body excretes. Preventing osteoporosis requires building as much bone as possible during ones young years and then maintaining it as one age. Diet and exercises also play key roles. Other life style modifications, such as abstaining from cigarette smoking, and alcohol consumption are imperative in preventing osteoporosis.

Keywords: Osteoporosis; diet; exercise; fractures; oestrogen; menopause; calcium; copper.

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1. INTRODUCTION

Osteoporosis (thinning and weakening of the bones related to loss of calcium stores) is a debilitating disease that is primarily age – and gender – related. It is also described as a condition in which bones become dangerously thin and fragile overtime [1]. Osteoporosis is a disorder characterised by a reduction in bone density due to calcium loss and resulting in brittle bones. A National Institute of Health [2]. Consensus panel noted that although prevalent in white menopausal women, osteoporosis occurs in all populations and at all ages and has significant physical, psychological, and financial consequences.

Fractures are the most serious consequence of osteoporosis up to 20% of all people who suffer hip fractures die within a year. Other problems associated with osteoporosis are loss of height and a stooped posture due to vertebral fractures, severe back and hip pain, and breathing problem caused by changes in the shapes of the skeleton [1].

Osteoporosis occurs more frequently in women than in men [3]. Women are at greater risk than men for osteoporosis because they have 10 – 25% less bone in their skeleton. As they lose bone mass with age, women's bones become dangerously thin sooner than men's bones [1]. Bone loss accelerates in women during the first 5 – 10 years after the onset of menopause because of the drop in oestrogen production. Oestrogen improves calcium absorption and reduces the amount of calcium the body excretes.

Although osteoporosis is more common in women, it is also common among men. More than 2 million American men suffer from osteoporosis and millions more at risk [3]. Each year 80,000 men suffer a hip fracture due to this disorder [3]. Osteoporosis does not begin in old age. The bone weakness that increases the risk of osteoporosis may actually begin before birth. Infants undernourished in the womb are small when born, remain smaller than their age peers, and have low bone mass at age 25, and have an increased risk of fracture in late adulthood [4]. Other risk factors for osteoporosis are diet, lack of exercise, and lifestyle [4,1,3]. According to them, a positive family history, or heredity, and low levels of oestrogen are the two primary risk factors in women. Following menopause, oestrogen production is diminished. Oestrogen is

a hormone essential for optimal calcium balance in women. Reduced levels of oestrogen lead to negative calcium balance, and a rapid onset of bone demineralization. This softening of the bones predisposes to fractures, particularly in the spine, the end of the radius in the forearm, and the neck of the femur at the hip joint.

- An estimated 10 million Americans over age 50 have osteoporosis, and another 34 million are at risk [4] and many more are in the developing nations of the world where the health system is weak, and where poor vital statistics abound.
- [3] and [1] affirmed that most bone mass is built by age 18, and after, bone density peaks between ages 25 and 35, and that bone mass is slowly lost over time. So to prevent osteoporosis, the best strategy is to build as much bone as possible during one's youth and then to do everything one can to maintain it as you age. Since up to 50% of bone loss is determined by controllable lifestyle factors, especially diet and exercise habits, this paper reviewed the synergy of diet, physical exercises, and lifestyle modification for the prevention of osteoporosis.

2. CAUSATIVE FACTORS OF OSTEO-POROSIS

Osteoporosis does not begin in old age. The bone weakness that increases the risk of osteoporosis may actually begin before birth. Infants undernourished in the womb are small when born, remain smaller than their age peers at age 1, have low bone mass at 25, and have an increased risk of fracture in late adulthood [3]. Other risk factors of osteoporosis according to [3] include:

- ❖ Age:- Risk of osteoporosis increases as one grows older.
- ❖ Being Female:- women have less bone tissue than do men and tend to experience a rapid loss of bone in the first few years after menopause.
- ❖ Body Size:- Small, thin – boned women are at greater risk of osteoporosis.
- ❖ Ethnicity:- white and Asian women are at highest risk.
- ❖ Family History:- Having parents with a history of osteoporosis as well as fractures in adulthood can place individuals at increased risk.

- ❖ Sex Hormones:- Abnormal absence of menstrual periods (amenorrhea) or menopause can increase risk of osteoporosis.
- ❖ Anorexia
- ❖ Lifetime diet low in calcium and vitamin D.

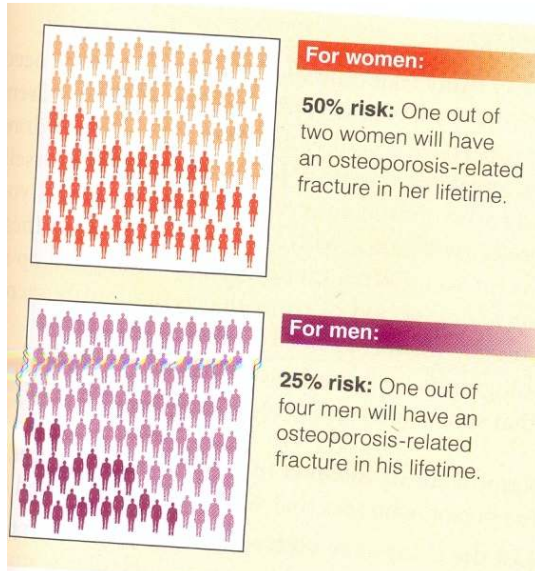


Fig. 1. Osteoporosis risk in women and men
Source: [3]

Other risk factors according to [1] include: early menopause (before age 45), abnormal or irregular menstruation, a history of anorexia, and a thin small frame. Other risk factors are thyroid medication, corticosteroid drugs for arthritis or asthma, and long-term use of the contraceptive Depo-Provera.

Similarly, Booth and Lees, according to [4] indicated that inactivity (lack of exercise) increase the risk of osteoporosis by 59%. Also several dietary substances may have a negative effect on bone health. Alcohol consumption reduces the body's ability to absorb calcium and may interfere with the bone-protecting effects of the hormone oestrogen. High sodium intake increases calcium loss in the urine, and this may lead to loss of calcium from the skeleton. Caffeine may also cause small losses of urinary calcium.

Furthermore, chronic excess intake of retinol, one form of vitamin A, is associated with decreased bone density. Drinking lots of Soda, which often replaces milk in the diet and which is high in phosphorous (a mineral that may interfere with calcium absorption) has been shown to

increase the risk of bone fracture in teenage girls, [4].

3. DELETERIOUS CONSEQUENCES OF OSTEOPOROSIS

Osteoporosis (thinning and weakening of the bones related to loss of calcium stores), is a debilitating disease that is primarily age- and gender-related. A [2] of Health (NIH) consensus panel noted that although prevalent in white post menopausal women, osteoporosis occurs in all populations, and at all ages, and has significant physical, psychological and financial consequences. [4] observed that each year, osteoporosis causes 1.5 million fractures, including 300,000 hip and 700,000 vertebral fractures. Although, more common in women, more than 2 million American men suffer from osteoporosis, and millions more at risk. Each year, 80,000 men suffer a hip fracture. Osteoporosis is known as a silent killer. The disease itself causes no pain but following a serious bone fracture, nearly a third or more of women and men die due to accompanying illness within a year.

Also, osteoporosis may lead to a condition in which losses in bone density become so severe that a bone will break after even slight trauma or injury.

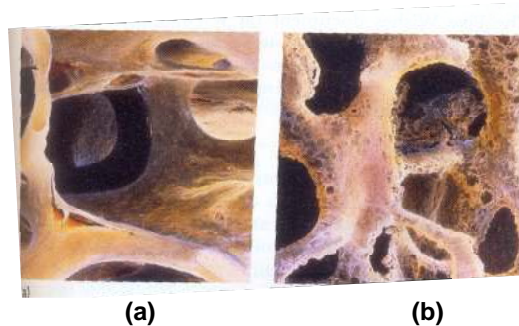


Fig. 2. Effects of osteoporosis on Bone density a) Normal bone tissue b) After the onset of osteoporosis, bone lose density and become hollow and brittle

Source: Dr. P. Motta, Department of Anatomy, University La Sapienza, Rome/Science Photo Library/Photo Researchers Inc. In (3)

A chronic disease, osteoporosis is silent for years or decades before a fracture occurs. Women who have smaller skeletons, are more vulnerable than men; in extreme cases, their spines become so fragile that just bending causes severe pain. But although commonly seen as an illness of women, osteoporosis

occurs frequently in men. One in every two women and one in four men over 50 will have an osteoporosis-related fracture in their life-times [3].

Furthermore, experts agreed that fractures are the most serious consequences of osteoporosis; and that up to 20% of all people who suffer a hip fracture die within a year [4,1,3]. Also, other problems associated with osteoporosis are loss of height and stooped posture due to vertebral fractures, severe back pain, hip pain, and breathing problems caused by changes in the shape of the skeleton [1]. Severe breathing problems may also occur. Severe breathing problems may lead to short of breath, lack of oxygen to the systems and organs of the body that are very vital, and complications in the cardiovascular and nervous systems may ensue.

In addition to the morbidity and mortality, osteoporosis may lead to many man-hour losses due to absence from duty. Huge sums of money are expended in the treatment and management of this disease at individual level, besides cost of drugs purchase by the government in addition to reduced productivity.

4. PREVENTION OF OSTEOPOROSIS

Preventing osteoporosis requires building as much bone as possible during the young years and then maintain it as you age. Diet and exercise play key roles. Diets containing calcium, vitamin D, and vitamin K are very useful in preventing osteoporosis. Also weight bearing aerobic activities must be performed regularly throughout life to have lasting effects. Strength training improves bone density, muscle mass, strength, and balance, protecting bone loss and falls, a major cause of fractures.

Both men and women can benefit from high impact exercises, such as running and jumping. Studies by [5] and [6] indicated that young, premenopausal women had significant higher bone mineral density; and that moderate exercises reduce hip fracture in both men and women by about 20%. Two other lifelong strategies for reducing the effects of osteoporosis are avoiding tobacco and managing depression and stress. Smoking reduces the body's oestrogen levels and is linked to earlier menopause and more rapid post menopausal bone loss. In addition, alcohol reduces the body's ability to absorb Calcium and may interfere with the bone-protecting effects of the hormone

oestrogen. Therefore, smoking and alcohol consumption must be avoided in order to prevent osteoporosis.

5. OSTEOPOROSIS AND DIET

Up to 50% of bone loss is determined by controllable lifestyle factors, especially diet and exercise habits [1]. Key nutrients essential for building and maintaining bone mass, and which must be factored into individual's diet include the following;

1. Calcium:- [1] affirmed that consuming an adequate amount of Calcium is important throughout life to build and maintain bone mass. Milk, yogurt, and calcium fortified orange juice, bread and cereals are all good sources of calcium [7,8]. Nutritionists suggest that one can obtain calcium from food first and then take supplements only if needed to make up the difference [9]. Another source of calcium in diet is through insects consumption, particularly *Vonocerus variegates*, and *Migratoria locusta* [1]. Insects are known to supply many minerals, most of which are essential for building and maintain bone mass.
2. Vitamin D:- Vitamin D is necessary for bones to absorb calcium. It has been suggested by [1] that a daily intake of 5ug is recommended for adult age 19-50. Vitamin D can be obtained from foods and is manufactured by the skin when it is exposed to sunlight. Candidates for vitamin D supplements include people who do not eat many foods rich in Vitamin D; those who have dark skin or who do not expose their face, arms, and hands to the sun for 5-15 minutes a few times each week; and people who live in Northern latitudes of Boston, Oregon-California border where the sun is weaker [4].
3. Vitamin K:- Vitamin K promotes the synthesis of proteins that help keep bones strong. Broccoli and vegetables are rich in leafy Vitamin K. Good plant sources of vitamin K include vegetable oils (Soya beans, olive), green and leafy vegetables such as Kale, peas, and spinach; while meats, and milk contain much lower amounts. Since vitamin K appears to enhance the function of osteocalcin a protein that plays an important role in strengthening bones [4], consumption of vitamin K is recommended for the prevention of osteoporosis.

4. Vitamin C:- Vitamin C plays an important role in bone health. Vitamin C with calcium and other minerals are essential to build bone; it also helps to reduce the connective tissue collagen, which forms the scaffolding in bones. Vitamin C is obtained from food sources such as fruits and vegetables, primarily the Citrus fruits and leafy parts of green vegetables. Excellent sources include oranges, grape fruit, broccoli, and salad greens. Other food sources are green peppers, potatoes, strawberries and tomatoes. Some products are fortified with vitamin C and they could also be obtained from supplements.
5. Magnesium:- Magnesium aids in bone formation. The body stores about 50-60% of its magnesium in the skeletal system, which may serve as a reserve during short periods of dietary deficiency. [10], indicates that magnesium influences bone metabolism and helps prevent bone fragility. Sources of magnesium include nuts, seafood, green leafy vegetables, fruit vegetables, black beans, and whole-grain products.
6. Potassium:- Potassium helps bones retain calcium [1]. Potassium is found in most foods and is especially abundant in bananas, citrus fruits, fresh vegetables, milk, meat and fish.
7. Manganese:- Manganese may help lessen calcium loses. Apart from the function of Manganese in many enzymes involved in energy metabolism, manganese is also involved in bone formation. Sources of manganese include whole grain products, dried peas and beans, leafy vegetables and bananas.
8. Fluoride:- Fluoride helps form bones and teeth. Sources of fluoride include milk, egg yolks, drinking water and sea foods.
9. Zinc:- Zinc, according to [11] helps in bone formation, and wound healing. Good sources of Zinc are found in animal protein, such as meat, milk and sea food such as Oysters.
10. Copper:- Copper is essential in helping maintain collagen. [12], also indicate that copper is involved in bone formation, being an essential cofactor in enzyme involved in the synthesis of various bone matrix constituents. Copper is widely distributed in foods and is high in sea foods, meat, nuts, beans, and whole grain products.
11. Boron:- Boron may increase Calcium absorption. Boron is known to be involved in the metabolism of steroid hormones, such as oestrogen. [13] indicated that the effects of boron on calcium and oestrogen metabolism could favourably affect bone development. Boron is found naturally in many plant foods, particularly dried fruits, nuts, peanut butter, legumes, fresh vegetables, apple source, milk and dairy products, grape juice and wine.

6. EXERCISE AND OSTEOPOROSIS

The beneficial effect of exercises on health has been known for centuries. [14] and others discussed the cost of physical inactivity overtime. The shorter-term cost of physical inactivity is metabolic deterioration and weight gain; the intermediate-term cost is an increase in disease, such as type 2 diabetes, and the long-term cost is an increased premature mortality. [4] affirmed that physical inactivity increases osteoporosis by 59%. Clinical, epidemiological and basic research evidence clearly supports the inclusion of regular physical activity as a tool for the prevention of chronic diseases, including osteoporosis and the enhancement of overall health. Specifically, [4] asserted that regular moderate physical activity and exercise, among others, increases bone density and strength, thus preventing osteoporosis. In the same vein, [3] opined that exercises, both aerobic exercise and weight training can help preserve bone density.

In addition, [15] concluded that physical activity offers strong protection against osteoporosis in postmenopausal women but is less effective in preventing this disorder in premenopausal women. Furthermore, evidence has accumulated suggesting that physical activity can protect both men and women against loss of bone mineral density, especially if they have a history of athletic performance. To this end, weight-bearing aerobic activities must be performed regularly throughout life to have lasting effects on osteoporosis prevention. Strength training improves bone density, muscle mass, strength and balance, protecting against bone loss and falls, a regular cause of fractures. Even for people in their seventies, low-intensity strength training has been shown to improve bone density.

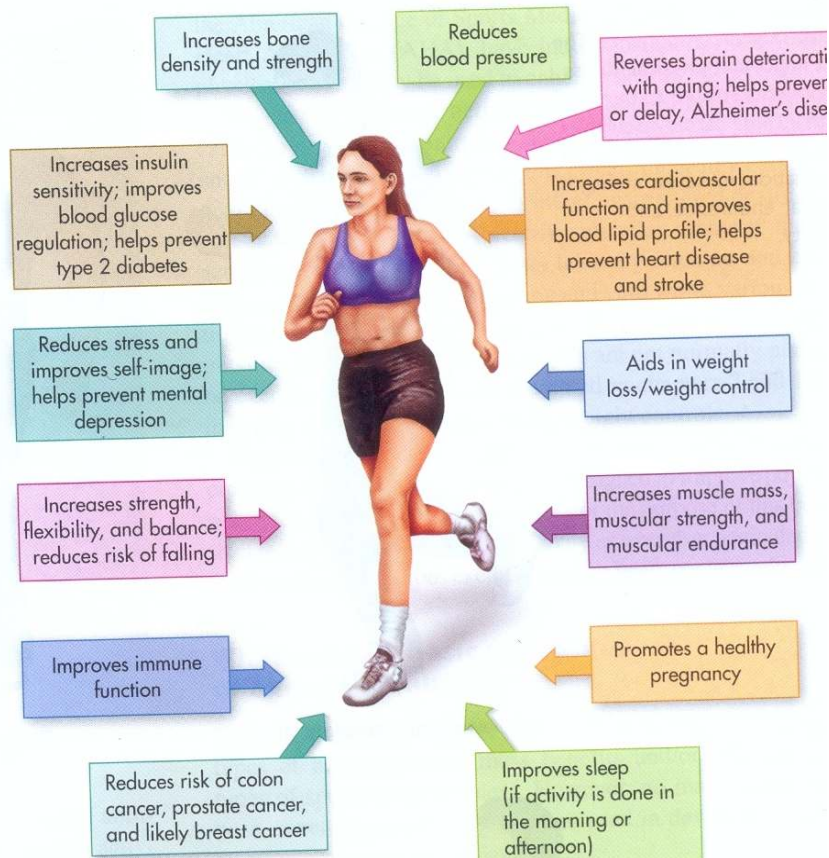


Fig. 3. 'Exercise is Medicine' Fig. 3 shows some of the benefits of regular, moderate physical activities and exercises. Among others, exercises increases bone density and strength
 Source: [4]

7. OSTEOPOROSIS AND LIFESTYLE MODIFICATION

Lifestyle modification, in this case, means doing certain things you have not been doing but which promotes your health, and abandoning things which are detrimental to your health. Lifestyle modification is very pertinent in preventing osteoporosis. One type of healthy lifestyle modification is the participation in physical activities. Clinical, epidemiological and basic research evidence clearly supports the inclusion of regular physical activity as a tool for the prevention of chronic disease, including osteoporosis and the enhancement of overall health. Specifically, [4] affirmed that regular moderate physical activity and exercise, among others increases bone density and strength, thus preventing osteoporosis. In view of this, [3] suggests that that one should exercise regularly and that both aerobic exercise and weight training can help preserve bone density. The

values of physical activity may have informed the [16] and the American Medical Association [AMA] to launch a programme entitled "Exercise is Medicine" designed to encourage physicians and other health care professionals to include exercise as part of the treatment for every patient.

Another lifestyle modification that may help in preventing osteoporosis is cessation of cigarette smoking. Cigarette smoking has many deleterious health consequences, including a risk factor for osteoporosis. Smoking cigarette reduces the body's oestrogen levels and is linked to earlier menopause, and more rapid postmenopausal bone loss [1]. Also, [3] affirmed that smokers tend to be thin and enter menopause earlier, thus extending the period of jeopardy from oestrogen loss. But since oestrogen improves calcium absorption and reduces the amount of calcium the body excretes, smoking cigarette should be avoided so as to preserve the body's oestrogen levels.

8. CONCLUSION

- This paper did a review of literature on osteoporosis, the risk factors, the deleterious consequences, and preventive measures through the synergy of diet, physical exercises and appropriate lifestyle modification, and therefore concludes as follows;
1. Osteoporosis affects both males and females, but the occurrence is greater among women than men.
 2. Osteoporosis may begin among undernourished infants in the womb.
 3. Occurrence of osteoporosis is faster among women shortly after menopause when oestrogen secretion is diminished, and calcium is depleted.
 4. Osteoporosis may be prevented through physical exercises, diet rich in calcium, Copper and vitamin D; and through cessation of cigarette smoking and alcohol consumption.

9. RECOMMENDATION

In corollary to the conclusion, the following recommendations were made;

1. Everybody should be encouraged to participate in physical exercises at youth to build up bone density as a reservoir to draw from in later years.
2. Since osteoporosis is much more common among women, and the risk factors include post menopause when oestrogen secretion is diminished, diets rich in Calcium, Copper and Vitamin D should be taken by women, particularly the postmenopausal women.
3. To prevent osteoporosis, ingestion of alcohol, and cigarette smoking should be avoided.
4. Pregnant women should be placed on balanced diet to prevent infant undernourishment in the womb.
5. Individuals should regularly go for medical check-up to examine their bone tissue levels.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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