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Impact of Diet and Dietary Supplements on Osteoporosis Among Indian Women- A Review

Ms. Meghabarna Deb

Student, Food Technology, Ramaiah University of Applied Sciences

Abstract

A chronic disease that is characterized by bone density and increases in the possibility of osteoporosis. fractures; therefore, this condition poses an epic problem of health among Indian women especially the women. whose age is postmenopausal. Through this review we will examine the pathophysiology associated with osteoporosis. laying stress that there is an increased rate of bone resorption due to the changes in hormones, especially estrogen deficiency. It also looks at the high levels of calcium and vitamin D in the diet. lacunae in Indian population, which is one of the greatest factors in bone demineralization. This paper summarizes evidence provided by recent epidemiological studies, which found the most important aspects of diet. and lifestyle risk factors at different points of age. Also, it determines the effects of nutritional interventions such as calcium, vitamin D and multinutrient supplementation and the synergistic effect of physical activity in prevention of bone loss. Despite promising outcomes of community-based strategies and supplementation trials, obstacles of community-based strategies and supplementation attempts, and Son, etc. There are still inappropriate awareness, poor access to screening, and inconsistent effectiveness of intervention. The review points out the need to increase early detection, individualized nutrition and community eating. Indian women health policies at the bone level to decrease future burden osteoporosis-related fractures.

Keywords: Osteoporosis; Bone health; Postmenopausal women; Calcium and vitamin D; Nutritional intervention

Introduction:

Introduction: 1.1 Overview of Osteoporosis

The bone is a dynamic living tissue, which is regularly called to breakdown and renewal. When this A situation in which the process is imbalanced to factors such as hormonal or dietary changes so that bones may lose important minerals making them weaker and less dense. This is called the early stage of loss of bones. as osteopenia. The severe stage of the development of the condition may lead to the development of osteoporosis a condition when bones get so brittle and easily broken. It has been called on many occasions a osteoporosis is a kind of a silent disease in which the individual does not display any symptoms, until the establishment of a fracture, usually as a hip, spine, or wrist injury, which may result in both excruciating pain and permanent disability. Wasti, Opoku, Yao, and Coba (2020) .

Bone loss is defined by the world health organization (WHO) based on bone mineral density (BMD) readings, and labeling osteoporosis as a BMD T-score less than T-score (-1.0 to - 2.5 SD) and osteopenia are -2.5 SD below the average of young healthy women. Although bone loss affects millions of people, people are not likely to notice it. proceeds silently and still underdiagnosed and under-treated.(Babhulkar

& Seth, 2021) Osteoporosis is a common bone disease that is characterized by bone loss. loss of bone microarchitecture which creates a more fragile state of the bones and an increased risk of fractures. Osteoporosis is becoming a major social problem especially in the wake of the world growing older. Health issue, it contributes largely to morbidity, mortality, and healthcare costs. (Zhivodernikov et al., 2023) Using the epithet as a synthetic unit, researchers were able to discover its use in a new phenomenon that has remained knowledgeable of the unit since then (et al., 2023). Bone remodeling is a continuous process, which is balanced whereby synthesis of bones occurs. production of the bone by the osteoblasts and destruction of the bone by osteoclasts. These two conflicting activities are serves to preserve the skeleton being tightly coupled and then resorbed followed by de novo formation to preserve it. the process of replacing the old or damaged bone with new one and that maintains the bone mass. strength(Wang et al., 2022). In case of osteoporosis, the bone resorption surpasses the bone loss, which leads to the ongoing reduction of bone density and the higher risk of fractures. According to (Clynes et al., 2020), you can go to the store to buy a jacket, but you might fail to find a jacket at the store. However, one thing that you may always get in the shop is a copy of a jacket.

Bone resorption is noticed in both genders, however, in women it is more pronounced and accelerated. women particularly women who are menopausal because of the sudden decline of estrogen, which is normally helpful protect bone. The decline in the level of hormones is slower and gradual in men. Usually, they protect them more because they have an increased peak bone mass. Consequently, A woman after menopause is at a higher risk of getting osteoporosis and having her bones porous fractures. Lack of estrogen increases bone resorption by promoting the number of osteoclasts. exercise which is a main factor in osteoporosis, particularly among postmenopausal ladies (Cheng et al.) al., 2022a) As a woman advances in life and towards menopause, the monocytes get reprogrammed to take up a more aggressive identity. through alterations in the DNA methylation protection that leads to the destruction of osteoclasts. This cell memory might be the reason that explains is an individual-level cause of bone loss and can have clinical ramifications.(Moller et al., 2020)

1.2 Pathophysiology

Osteoporosis is a long-lasting illness that deteriorates the bone density by reducing it. impairing the internal structure of a bone tissue further exposing them to the risk of fractures. It occurs when normal process of bone repairing is interrupted and breakdown of bones proceeds. increased resorption rate of osteoclasts over the rate of formation of bone by osteoblasts. This unevenness is most commonly occasioned by the hormonal changes, such as decrease of estrogen levels after the end of menopause increases the rate of bone loss. Also, aging is a factor since it causes a decrease in bone activity. forming cells. Additionally, bone health may be interfered with by poor intake or uptake of calcium and vitamin D. results leading to the elevation of parathyroid hormones and speeds up the process of mineralization bone resorption. Certain chronic illnesses as well as long-use drug habits are other risk sources. drugs such as steroids, and other life styles like lack of exercise activities, smoking, and over eating. alcohol use. All these contribute to making the bones duller, weaker and delicate. and even crackable, most likely in the spine and hips and wrists areas.)(Srivastava & According to Sapra, 2022), (Adejuyigbe et al., 2023)

1.3 The importance of diet in maintaining bone health

strong bones, which will serve as a good source of nutrients, such as calcium, vitamin D. and protein which help in the growth and maintenance of the bones. Consumptions of foods that are nutritious like dairy food, green leafy vegetables and fish prevent the loss of bone mass and decrease the likelihood of

getting osteoporosis. A good nutrition plays a special role during the process of growth and aging. _(Suhett et al., 2023)

1.4 Rationale of the study

- Indian Women are Highly Prevalent to the Osteoporosis- Indian women are very much prevalent to the Osteoporosis Among Indian women this is mostly a result of a combination of low peak bone before the age of 30, as well as an early start of losses. menopause, and prevalence of calcium deficiency as well as vitamin D deficiency. When combined with hormone alteration and age, other factors that contribute to a significant increase in fracture are considerable. Hazard among this population.
- Poor Dietary Consumption and Consciousness- The traditional Indian diet, especially the rural diet is deficient and low-income communities, who rarely have sufficient Essential that support bones. Vitamins such as calcium, vitamin D and protein. Moreover, the knowledge about it is scarce on the necessity to supplement bones with the diet, an issue that is an impediment to early prevention as well as efficient management of osteoporosis.
- Diet or Modifiable Risk Factor- In comparison with non-modifiable risk factors, such as genetics and aging, the practical and effective way of intercession is diet. Improving dietary consumption with the help of nutrition education, food fortification and supplements are crucial in the reduction of the effects of osteoporosis especially to the vulnerable groups. The possible reduction of the burden of fractures and enhance life quality- osteoporotic fractures affect mobility and independence as well as the quality of life tremendously postmenopausal women. The lifestyle can be optimized by making healthy changes in eating habits and through proper utilization among the nutritional supplements, the bone health could be reinforced, and the degree of despondency will be diminished. Bone fracture risks, and hence reduce the burden of long-term healthcare. Good nutritional planning helps not only in the physical well-being. promote social and economic productivity in old women of India.

2. Epidemiological trends of Osteoporosis in India

With a population of 1.2 billion people India is faced with greater challenges on how to manage the huge population. The management of osteoporosis, particularly in old age of the world population. Addressing this issue is It is crucial in improving the living standard and relieving the pressure on medical systems. Knowing the cause and reasons of having unhealthy bones and the barriers to manage good bones. treatment is a factor necessary in addressing this common condition. (Agrawal & Garg, 2023) Osteoporosis has become a concern of concern to the world particularly due to the extended life expectancy. its increased response rate amongst postmenopausal females. A fracture risk throughout their lifetime of Osteoporotic fractures impose a huge burden on healthcare systems by about 30-40%. Early diagnosis by clinical evaluation, bone mineral density, vertebral imaging and bone turnover It is necessary to have markers. Treatment interventions comprise life and dieting changes. personalized pharmacological treatment based on the need, and operative therapy. fractures. The early recognition and treatment are the keys in enhancing the health of bones. avoiding complications that result in fractures.(Chadha et al., 2022)

2.1 Prevalence Of Osteoporosis:

Each year osteoporosis affects around 200 million of people in the world. The According to World Health Organization (WHO), there is an important scarcity of accurate data concerning the attack of specific incidence. and the abundance and tendency to osteoporosis in developing countries. Osteoporosis prevalence in India is important between women is relatively high with a spectrum of between 8 and 62

per cent as it denotes a regional differences. Women and older adults, as well as, are severely hit compared to Males and young groups. As an example, a research study conducted in North India indicated osteoporosis is 3 percent in age 30-39 and 36.4 percent in older women more than 70. In men, there were significantly low percentages of 0% and 5.6%. It was also found that osteopenia was much more common in among women (40.3%) as compared to men (29.9%), and has been partly blamed on post menopausal hormonal changes. changes.

There are several variables related to bone health among them being the age, the sex or the educational status. exercise, body mass index, fracture history, hormone replacement therapy and eating behavior e.g. dairy intake. Such nutrients include, carotenoids, protein, vitamins C, B12, and K among others. omega-3 fatty has been discovered to help in the protection and preservation of bone health. Since India is a diverse country in terms of its culture and diet, differences in the burden should be expected regionally. An increase in bone loss is anticipated. As the number of elder adults in India has been as high as 104 million people According to the 2011 census (8.6 percent of the total population), there is an urgent need to deal with The health of bones within this growing yet at risk population. The data obtained is nationally representative. the prevalence rates of osteopenia and osteoporosis are also necessary to provide a basis of informed interventions healthcare planning. Babhulkar and Seth noted that older adults feature in only six percent of health planning research studies (2021).

2.2 Age and Gender distribution

The condition of osteoporosis is an evolving issue of public health in India, and it has disproportionately high occurrences. itch among the women especially postmenopausal. National estimates point out that some 26.3 percent of women and 10.9 percent of men have the disease. and women almost representing 80 percent of the 60 million osteoporosis cases in the country. The its prevalence rate is considerably high and, most remarkably, it reaches the highest point as one gets older after 50. one of the causes of death epidemics among women over 70 years. It is true that men also experience a growing threat with age, yet, it is the most usual one. less pronounced. Markedly, in the Indian, osteoporosis is seen at a younger age by 10-20 years. population against that of the West, which justifies the necessity of screening at an early age. prevention strategies. In all the regions, the rates are always higher among women than men. this is indicative of the need to have gender-sensitive health interventions. Besides the age and gender inequalities, there are gaps in the form of region and socioeconomic differences. affects the prevalence of osteoporosis in India.

It is stated that around 19.4 percent of women are those impacted by the osteoporosis in the country are very high with postmenopausal individuals obtaining the level of up to 37.5 percent of the cases. women. The precondition to osteoporosis- osteopenia is experienced by another 44.7%. wide society that poses a threat of future complications. The same trend is reflected on the regional level: in Punjab, There were 30.5 percent of women who were diagnosed with osteoporosis after post-menstruation and in low-income women, it was 0.8 percent. One in five (20.1per cent) peri- and postmenopausal women had low, a figure that is alarming because 81 per cent of such women experienced it in Mumbai. Driver at bone mineral density. These differences bring into notice the significance of socioeconomic status and life style validity of the previously observed results by considering it in relation to factors, and healthcare access in association with the outcomes of bone health. the value of specific population health interventions.

2.3 Risk Factor Specific to Indian women

The prevalence of osteoporosis is being caused due to many key risk factors. in India amongst women. Among these factors are old age, menopause at an early age or prolonged menopause. calcium and vitamin

D deficiencies, physical inactivity, low body mass index, etc. being pregnant many times. Such socioeconomic issues as inaccessibility of nutritious fish etc. It is worsened by the situation that transpires in the areas of food and healthcare. Indian perspectives to the treatment of osteoporosis demands special attention in terms of the public health measures that are aimed at early detection, better nutrition lifestyle change, and greater access to healthcare in order to prevent fracture and the long-term disability of the females. The exorbitant differences between regions, sexes, and classes of the prevalence groups emphasize the fact that the condition is multifactorial.

The Indian women and in particular postmenopausal women or women of lower socioeconomic status, are disproportionately are taken ill as a result of a mixture of biological, dietary, and life habits-related risk aspects. In addition, there is earlier age of osteoporosis development in the Indian population than on that of the Western one. The highlighted need to intervene as soon as possible comes out in counterparts. Appropriate Population health interventions it needs to focus on early detection, better diet, physical exercise. and increased access to healthcare. Introduction of population-specific, specific Implementation of tailored, population-specific implementation of strategies should play a vital role in reducing the risk of fractures and risks of implementing improved bone health outcomes across the country.

3. Dietary Risk Factors of Osteoporosis in women of different age groups:

Lack of calcium in the nutrition of Indian women is largely affecting the bones of the Indian women. which is also aggravated by the prevalence of vitamin D deficiency. During the last 50 years, it has been observed that there has been a progressive reduction in the calcium intake among the rural, tribal and urban populations of Even in the country being one of the major producers of milk and cereals, Indian has to face this. This ongoing malnutrition is a major threat to the health of the bone of the women especially at critical moments in life different stages like adolescence, pregnancy, breastfeeding and menopause.

Epidemiological according to studies, a significant percentage of Indian women fails in their daily struggles to meet their demands on a regular basis the recommended dietary allowance (RDA) of calcium and of vitamin D. This is the case. exacerbated by such factors as the lack of exposure to sunlight, and the clothing of a traditional nature, and mostly. indoor lifestyles, and commonly the sunscreen - all of this plays into the problem. the wide-spread vitamin D deficiency. The secondary hypocalcemia and the resultant hypocalcemia hyperparathyroidism aggravate bone resorption, degrade bone mineral density, and raise weakeness to osteoporosis and nutritional rickets.

The clinical significance of an interrelationship between metabolism of calcium and vitamin D dietary intake specified health care initiatives. These can be diversification of diet, mega-scale behavior change communication, complementary access to supplements and even food fortification interventions that focused at increasing awareness, and compliance. Multi-sectoral and region there must be a particular solution to this old public health issue and to foster the best quality of bones in Indian women.(Harinarayan et al., 2021) A study carried out on 180 women falling below the age of 20-25 years lacked it. They also include low levels of micronutrients in their diet such as calcium. Majority of young females were not vegetarians. were eating three meals every day, and were consuming less of critical nutrients such as calcium and vitamin D among others below of ICMR recommendations. Nevertheless, fat consumption was much higher than the below recommended levels, which show that diet is out of balance and likely to be deficient in such nutrients as osteoporosis.(Umarji et al., 2021)

A study conducted recently by Tyagi et al. (2024) examined the connection between calcium deficiency and the enhanced power of neurons in the brain. and osteoporosis risk among pregnant women through

functional parameters analysis of biochemical values. different trimesters. The study involved 78 pregnant subjects and 45 healthy control persons. it was revealed that the level of calcium during pregnancy was much lower in pregnant women and especially during a time like at pregnancy. third trimester. Conversely, parathyroid hormone (PTH), alkaline phosphatase (ALP) levels, were elevated in comparison with the control group. And vitamin D was raised, and PTH had an inverse correlation in the case of vitamin D. calcium levels. Such biochemical alterations pertain to the heightened requirement of calcium by the mother. to promote fetal skeletal in which women were predisposed to bone and demineralization and osteoporosis unless nutritionally treated.

These results stress the importance of significance of calcium surveillance of the status during pregnancy and take in to sufficient levels Protect the complications of bone health in the long and short term. Tyagi et al. (2024). Khanday et al. (2024) carried out a case controlled study to determine the association between vitamin D and bones In North India, mineral density (BMD) in reproductive and postmenopausal women. The study established that one third of the women in the two groups had a lack of vitamin D. relationship between low proportion of vitamin D and low BMD especially in postmenopausal women.

It was recorded that the incidence of osteopenia and osteoporosis was significantly before among them. hyperparathyroid vitamin D-deficiency, particularly at the lumbar spine. Such findings explain why the role of nature plays a critical role. possibility of sufficient vitamin D status in preserving bone health and inhibiting bone loss in female farmers at various periods of life.(Khanday et al., 2024) A comparative study was known to show that the osteoporosis case is far more common. the women who are postmenopausal compared to the premature women. Important causal factors It was discovered that advancing age, family history of the condition, a lack of Vitamin D were among these factors. lack of adequate exercise. The findings demonstrate that early screening is essential. prevention by applying life-style modification interventions.

After their menopause, women are more inclined to getting osteoporosis due to the sudden drop in estrogen levels. Estrogen is quite crucial in maintaining the bone strength, and with the lowering of the level, the rate of bone loss increases, and the risk of osteoporosis grows in size.(Rajan et al., 2020) declined estrogen in post-menopausal accelerates the destruction of bones and ascertains an increased vulnerability to bone breaks. women. As much as low levels of estrogen will contribute to this, there are other factors such as ageing, hereditary factors, etc. lifestyle factors also risk osteoporosis. “.Such a shift to global modes of operation is indeed a welcome one (Patel et al., 2024) A modern population-based cross-sectional study performed in Srikakulam district of Andhra Pradesh wanted to establish the occurrence and risk factors of osteoporosis among postmenopausal women. The research stated that an average incidence rate is 40%, and the prevalence is much more. increase with age in a remarkable way. The risk factors of low body mass index (BMI) played the major role. low consumption of calcium and vitamin D, family past history of osteoporosis, and smoking. physical inactivity. The other protection benefit of hormone was also brought out by the research. hormone replacement therapy (HRT) and emphasized the need of prevention and lifestyle to make any changes so as to help prevent osteoporosis among this group. Dodda et al. (2024)

4. Impact of Dietary Supplements:

4.1. Supplementation with Calcium and Vitamin D for the Prevention of Osteoporosis

Calcium and vitamin D are very important nutrients to the health of bones and also vital in the conditions of prevention and treatment of osteoporosis. Calcium plays a pivotal role in structuring of the it helps in the absorption of calcium and the maintenance of its balance in the bone matrix, and it is vitamin D. the

body. It was revealed that both calcium and vitamin D supplementation health care professionals through clinical studies have also revealed that supplementation of calcium and vitamin D has the potential to benefit health care professionals as well as the general population. in particular, when the amount of vitamin D is more than 700 IU a day, the probability of fractures may decrease reduced by 1825 percent in older people with a high risk. The research is based on developing mathematical models of the following issues: (Seshadri et al., 2021).

This protective effect is especially applicable in the aspects of aging and postmenopausal hormonal variation which hastens the resorption of bone. The rate of hypovitaminosis D and insufficient calcium intake is horribly high in India. elevated, particularly in postmenopausal females and old men who are susceptible to it. increased fragility of osteoporotic fractures. Research has mentioned that the portion of Indians exceeding 70-90 per cent has been reported. possess an inadequate serum 25(OH)D, mostly because of lack of exposure to the sun, as well as darker skin low dietary intake, pigmentation, and low intake (Harinarayan et al., 2011). Additionally, traditional The amount of calcium in the Indian diets is limited compared to the amount that a person is supposed to take which is 1000-1200 mg daily. especially in the rural and low-income groups. With these broad gaps in the country, there are community-based supplementation programs like primary screening by means of primary healthcare, mass information campaigns, and food fortification critically needed. These will help greatly reduce the effects of fractures caused by osteoporosis that besides being disabling have been characterized by high rates of disease, loss of life, and extra cost of health services.

It has been considered that the deficiency of vitamin D is an important independent risk factor of reduced bone mineral density (BMD), secondary hyperparathyroidism and elevated bone turnover. This is a cause of serious concern in the case of Indian women especially since there are cultural norms to clothing practices. and short periods of outdoor activities tend to cause low sun exposure. Low vitamin D Although low vitamin D and correlations with the poor bone health on its levels are obvious, whereas the bright effect of the vitamin D supplementation is still yet unknown. the effects of BMD on how we can improve it, remain uninvestigated. However, in some of the randomized clinical trials, the following has been reported: slight changes or no changes at all in BMD they evidence continued doubts when it comes to the optimal dose, the levels of vitamin D prior to supplementing, how it interacts with other nutrients and the adequate duration of supplements.

The results of the study seem to be full of the experiences of the illness, the knowledge of the illness experience, and an examination of the illness experience and knowledge (Nair et al., 2020). To illustrate the point, a meta-analysis of Reid et al. (2014) concluded that vitamin D supplementation even alone, they did not have significant impact on bone mineral density in community-dwelling older adults when not accompanied by the sufficient consumption of calcium. older adults. This further proves that incorporation of nutrient supplements is superior. emphasizes the necessity of individual, situation-specific interventions taking the baseline into account Nutrient status, dietary habits and sun exposure. Moreover, new findings indicate that genetic polymorphism of vitamin D is involved in the risk of developing the disease. The efficacy of vitamin D regarding bone forming health may be affected by the receptor (VDR). they contribute in part to determine individual differences in response to supplementation. This underlines the require high precision nutrition strategies in future prevention of osteoporosis.

4.2 Synergistic Effects of Calcium Supplementation and Physical Exercise

Lifestyle, especially intervention composed of calcium supplement and physical workout, have proven to be more effective in the strengthening of bones. A paper has been made to study a study carried out in

Mumbai with 30 women 45 years old and above evaluated the effects of such an intervention. The experimental group that underwent calcium supplements together with physical exercise, showed a much positive serum calcium level and BMD as compared to the Improved attitudes with regard to integrative strategies that blend roles within the organization in general and in relation to the control group these results stand to support the usefulness and importance of integrative strategies. installed nutrition and physical activity in the clinical management of postmenopausal osteoporosis (Surve et al., 2022). A healthy bone is sustained by a complex process of remodeling which depends on sufficient availability of nutrients (especially calcium and vitamin D) and mechanical loading by means of physical activity. Calcium is one of the essential minerals in the development of bones yet the absorption of calcium plays a vital role. weight-bearing or resistance exercise should be used together with to increase the benefits of their use. promotes the growth of bones due to strain. Major factors motivating the merging of the strategies are:

- Enhanced Calcium Expenditure: Bone loading provoked by exercise enhances the requirement in areas of remodeling to increase the efficiency of supplementing with calcium.
- Weight bearing exercise increases the formation of bone: Weight bearing exercise drives bone building activity by osteoblasts. physical exercise, which it raises BMD, especially in the regions of spine and hip.
- Fall prevention: Exercise enhances balance, muscle strength and coordination, decreasing fall risks and by extension fracture risk.

4.3 Micronutrient-Fortified Protein Supplementation and Bone Turnover in Premenopausal Women

Interventions nowadays include not only calcium and vitamin D but also multi-nutrient interventions. strategies that attack bone turnover. In a randomized control trial, premenopausal Indian a highly protein-rich and micronutrient-enriched beverage was used by women aged 25-44 a day with a span of 6 months. A serving provided 600 mg calcium, 400 IU vitamin D and 55 mcg vitamin K and B vitamins. Findings showed the drop of 33 percent in the serum CTX and 21 percent in the PINP. which means the (essential) reduction in bone turnover rates. Also, the carboxylated to There was an improvement in vital K status seen by the increase in undercarboxylated osteocalcin ratio. The supplement also enhanced the serum intermediate levels of vitamin B6, B12, and folate, and it was safe through participants (Umarji et al., 2021b). Such results indicate the possibility of early nutritional appropriate treatment t uphold a long-term bone health.

4.4 Vitamin E and Its Anti-Resorptive Potential

New study indicates that vitamin E can be useful in alleviating the process of bone resorption. antioxidant and anti-inflammatory properties. It was a randomized placebo-controlled, double-blind study In a trial assessing effect of 12 weeks of mixed tocopherol (vitamin E), postmenopausal women having osteopenia. The findings revealed that, the treatment group managed to maintain a constant level of bone resorption marker CTX even compared with the placebo-treated group. An increase of a great level. Another bone formation marker PINP did not show any significant changes. implicating that the major role of vitamin E might be an effect on bone loss inhibition other than It improves bone formation (Vallibhakara et al., 2021). These results point out the role of vitamin E. possibility as a supplement to prevention of osteoporosis especially in the postmenopausal female population. The evidence lays stress on the need to follow up multi-nutrient interventions in osteoporosis prevention and control especially in the nutritionally vulnerable groups like Indian women. Although calcium and vitamin D are at the centre, we have made some supplementary nutrients such as vitamin Those K, B vitamins and protein as well as vitamin E are

increasingly being known as having a role in regard to the preservation of the bone. turnover reduction and health. Communal based programs whereby supplementation is combined The lifestyle changes may reduce the osteoporosis burden that is increasing with promising effect. related fractures.

5. Early Diagnosis and Intervention

Timely intervention and early identification are very important in effective management of osteoporosis. Early detection of the condition before significant loss of the bones occurs means that an early managerial approach stands the chance. implementation of preventative strategies that can result in a substantial decline in the probability of arising fractures, enhancement of lifelong medical outcomes, and improve the quality of life particularly among older adults and post menopausal women, who are under the highest risk. The people at a higher risk of osteoporosis are the older people. be in periodical screening in order to check bone health and fracture risk. Comprehensive evaluation must involve tests of bone mineral density (BMD) and regular physical examinations, and appropriate laboratory research. History of health has to highlight previous Fractures, smoking and alcohol, menopausal status and current or previous medicines. Height, weight, and body mass index (BMI) ought to be observed in a physical examination. quantifiable, where a BMI of under 21 kg/m 2 or loss of height of 5 cm or more are significant. risk factors.

Moreover, they should be assessed by the gait abnormalities and muscle weakness. postural patients, and indications of thoracic kyphosis since they are involved in an increased chance of falls and Spinal bone breakages.(Chitra & Sharon.S, 2021) Preventive mechanisms in the avoidance of osteoporosis are important strategies of detection and quick intervention. fractures, especially in Indian women, who are over-represented and therefore more afflicted with them. under diagnosis and poor nutritional condition along with inaccessibility to healthcare. Investigations indicate that loss of bones is silent many years prior to the onset of clinical manifestations, such as a bone fracture. in order to evaluate proactively, and intervene in time.

5.1. Importance of Early Screening

- High prevalence, late diagnosis: Osteoporosis has a high prevalence of about 35-50 per cent with late onset. bone screening is not considered on a regular basis even among postmenopausal women in India (Agarwal et al., 2022). bonemass density (BMD) is also rare, most especially in rural and low-income groups. populations.
- Recommended Tools: The world health organization (WHO) recommends dual Therefore, the diagnosis of osteoporosis is based on energy X-ray absorptiometry (DEXA) as the golden standard. It is however limited to tertiary care facilities in cities in India.
- Cost Efficient Alternatives: Risk assessment mechanisms that include FRAX (Fracture Risk Assessment This process can be performed initially with the help of (Tool) to understand which women should be more helpful to receive. That can be spared of future testing.

5.2. Critical Timing: Perimenopause as a Window of Opportunity

- Rapid Bone Loss and Hormonal changes: As a result of the fall in the level of estrogens, women develop: lose between 5 and 20per cent of their bony tissue in 5 or 7 years following the menopause.(Cheng et al., 2022b).
- Early Intervention: Decreased risk of fracture: Analytic study showed that early interventions indicate a decrease in fracture risk. There was a 12 percent decrease in calcium and vitamin D supplementation in women (50 years and above). A reduction in the rate of fracture of 25 percent, in particular pairing with good lifestyle modifications. The coronavirus pandemic initially affected, as well as led to the

fact that, at some point, more than 8,000 companies in this country were on the verge of bankruptcy (Lorentzon et al., 2022).

- Lifestyle, Diet: Kancherla et al. (2018) state that calcium rich diets (1000 mg′) have protective effects. 1200 mg/day), vitamin D (800 1000 IU /day), magnesium, and K2 vitamin in combination. Have been found to aid in preservation or betterment of, regular weight-bearing exercise bone mineral density (BMD) of the perimenopausal and postmenopausal women.

5.3. Community-Based and Primary Care Strategies

- In Primary Health Services: Inclusion of risk of osteoporosis assessment: incorporation of the exam into regular gynecological and maternal health visits might allow recognizing risky women much earlier.
- Awareness and education: The level of awareness is reported a low percentage below 20% Indian women do not know the risk factors of osteoporosis (Sharma et al., 2024). Community health interventions provided by community health workers (ASHAs) have had demonstrated positive efficacy on knowledge and compliance.
- Preventive Supplementation Programs: Preventive programmes based in a community that supply fortified foods or micronutrient selective supplementation (e.g. calcium, vitamin D, B) compared to sw(_potassium supplemented walking (WS) (complex) that has demonstrated great enhancement in bone turnover markers and nutrient The author(s) of the article in question note that status (Umarji et al., 2021b).

5.4. Detecting and Managing Osteopenia

- Osteopenia: Osteopenia is a disease that precedes osteoporosis and causes a BMD T-score of between The range of -1.0 to -2.5 is an early predictor of the possibility of eventual osteoporosis and should be addressed. careful attention.
- OsteopeniaTreatment Osteopenia: Intervention trials have confirmed that early dietary reverses bone loss in postmenopausal women. nutritional supplementation is helpful to increase BMD and decrease in women with osteopenia development to osteoporosis, particularly in combination with physical activity(Islamoglu et al., 2020) .

6. Challenges and Limitations:

Dealing with the problem of the bone resorption, especially in the women and postmenopausal women, there exists a number of problems. problems and obstacles. Multi factorial nature of bone loss is one of the major issues. affected by changes in the level of hormones, nutritional deficiencies, lifestyle, and genetic factors predisposition and intervention strategies are quite hard to implement in a standard manner. The briefness of the things in most clinical studies tend to limit the assessment of long term effects on bone density. More so, the differences in individual reactions to supplements or lifestyle changes can be considered as a risk of their fracture. subsequently the modifications, compliance issues and the variation in a baseline nutritional status may be influencing study outcomes. It also uses acute phases of other health realms such as reliance on surrogate markers like bone turnover markers clinical benefits may not be adequately reflected in terms of fracture instead of direct measures. Based on these limitations, it is expected that more extensive and large-scale studies covering a wider range of people should be conducted. find good, personalized strategies to bon health in women.(Thakur et al., 2020)

7. Conclusion:

To conclude, bone resorption is a problem in women especially postmenopausal women. multipronged process guided by alterations in hormonal levels, poor diet, oxidative stress and life style factors. This review indicates the importance of non-pharmacological The use of interventions like calcium and vitamin D supplements, antioxidant supplementation and the like may include the process of cleaning up. vitamin E, and geriatric diets that are plant-based, and physical exercise, in the prevention of bone loss as well as skeletal health. In as much as the current findings are encouraging, except in high-end applications. like limited research periods, limited case numbers, and outcome inconsistency point out at the lack of the following research applications like short periods of study and weak sample sizes, and outcome variation. requirement of stronger and long term clinical trials. Continued study and more awareness are play an important role in developing effective evidence-based strategies to prevent and treat bone It is resorption in women.

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