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Role of Nutritional Status in the Prevalence of Osteoporosis among Postmenopausal Women

Umera Baba[1] and Sumera[2*]
[1]Assistant Professor, Department of Home Science, GDCW Anantnag (J&K) India.
[2] Research Scholar, Institute of Home Science, University of Kashmir (J&K) India.

(Corresponding author: Sumera [*])
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ABSTRACT: Osteoporosis is a chronic bone disorder characterised by the loss of bone density and modification in bone structure. These changes increase bone fragility and risk of fracture particularly among postmenopausal women. Certain challenges were faced during this study, particularly while data collection in opd of the government hospital. Owing to a lack of knowledge among respondents, it was a challenging task to gain the desired information from them. This study aims to investigate the possible relationship between nutrient intake and the risk of distress from osteoporosis in postmenopausal women who have recently been diagnosed with osteoporosis. A case-control study was intended to determine nutrient intake as well as lifestyle patterns. The study sample consisted of 380 postmenopausal women above the age of 45 years. Based on the diagnosis, the overall sample was divided into a study (osteoporotic) and a control group (non-osteoporotic). Thus, the study group comprised 260 respondents whereas the control group comprised 120 respondents. The results reveal that physical activity has a significant impact (p<0.001) on osteoporosis among post-menopausal women. In terms of BMI, an increase in body weight may be related to post-menopausal osteoporosis although differences were insignificant. The intake of protein and calcium in post-menopausal osteoporotic women was more deficient than RDA for this group.

Keywords: BMI, RDA, osteoporosis, post-menopausal.

INTRODUCTION

Osteoporosis is a health condition that weakens bones, making them brittle and more likely to break (Akkawi & Zmerly 2018). Fractures caused by osteoporosis can lead to complications such as long-term disability, reduced quality of life related to health and increased mortality. The majority of osteoporosis-related fractures occur in postmenopausal women (Black & Rosen 2016). Increased age, being female, postmenopausal status, reduced exposure to sunlight, hypogonadism, low body mass, racial history of rheumatoid arthritis, low bone mineral density, inadequate vitamin D consumption, low calcium, immobilization and long-term use of certain drugs are all triggers of osteoporosis. Before menopause, the loss in bone mineral density is less, however, three to four years of preceding menopause as well as after menopause the rate of bone loss increases (Sagarika *et al.,* 2023). A diet low in macro and micronutrients play an important role in the development of osteoporosis (Hardcastle *et al.,* 2011). Previous studies depicted that there is a negative effect of high protein intake on bone density. However, current studies report that about 50% of bone volume is composed of proteins so for the well-being of bone protein absorption is very important. As mineralization occurs, proteins are incorporated into the organic bone matrix in the collagen structure, thus indicating the role of protein in bone formation (Sellmeyer *et al.,* 2001). Moreover, calcium and Vitamin D are important micronutrients in preventing osteoporosis as they are part of the bone mineral matrix and are essential for bone strength (Chiodini *et al.,* 2018). Phosphorus is another important element for human health and has several biochemical purposes, such as structural functions. It is one of the most important components of cell membranes, nucleic acid sugar-phosphate and hydroxyapatite in bones and teeth (Vorland *et al.,* 2018). Other nutrients that have a vital role in the protection of bones include potassium and magnesium (Kong *et al.,* 2011). Magnesium stimulates the creation of osteoblasts (De Baaij *et al.,* 2015) and is also involved in the stimulation of vitamin D (Uwitonze *et al.,* 2018). In addition to nutrient intake, lifestyle factors also contribute to the development of osteoporosis in post-menopausal women. Increased physical activity levels have shown a positive correlation with improved health and quality of life (Llamas *et al.,* 2016).

Long-term physical activity affects bone metabolism and prevents the dwindling of the bone. It also prevents the loss of calcium and other minerals in bone tissue by increasing calcitonin and reducing parathyroid hormone (Soltani *et al.,* 2015). Studies have proven that increased BMI protects bone density and people with mild overweight have increased Bone Mineral Density

levels (Barrera *et al.,* 2004). More precisely, increased body weight was found to interact with the effect of endocrine modifications that can directly or indirectly affect bone metabolism (Zhao *et al.,* 2008). However, it was found that low body weight or BMI are susceptible to accelerated bone loss and low bone mass in post-menopausal females which are shown to play a key role in the development of osteoporosis (Fu X *et al.,* 2008). In the present study, an attempt was made to find out the relationship between dietary intake and osteoporosis among the respondents.

MATERIAL AND METHOD

The study was conducted in the Kashmir region. The population of the study included postmenopausal women above the age of 45 years. Since no data in the recent past regarding the prevalence of osteoporosis among Kashmiri women was available, thus, deliberately District Srinagar, Ganderbal, Kupwara and Anantnag were selected to give due representation to all the areas of Kashmir division. The sample size was derived from the target population i.e. women above the age of 45 years (820321- census,2011) at a 5% error level with a confidence level of 95%. The sample size was determined using the formula given by Yamane, (1967).

$$SS = N/\ 1+N\ (e)^2$$

SS= Sample size
N=Population
e=Acceptance sampling error

Using the above formula, a sample size of 399 postmenopausal women was determined. A total of 410 questionnaires were given to respondents. After the scrutinization of the questionnaires, 30 respondents were disqualified because of missing responses/ incomplete information. The overall response rate was 93%, therefore, 380 respondents were included in the study. The women selected were postmenopausal women attending Govt. hospitals and health centres with complaints and symptoms as well as diagnostic reports suggestive of osteoporosis. Postmenopausal osteoporosis was labelled in women only when such women had confirmed osteoporosis (by symptomatology, X-Ray finding, BMD or from biochemical investigations) as per the relevant medical record. For more clear results, the overall sample was divided into a study (osteoporotic) and a control group (non-osteoporotic) based on a diagnosis of osteoporosis. The study group comprised 260 respondents and the control group comprised 120 respondents. After a thorough and detailed study of the problem and the related review of literature, a preliminary questionnaire was framed, and an inventory put forth by WHO with major modifications as per cultural requirements was used to collect data.

RESULTS AND DISCUSSION

The results given in the tables revealed the assessment of dietary intake and its relationship with osteoporosis.

1. Age and Postmenopausal Osteoporosis: The average woman is postmenopausal for one-third of her life, the incidence of certain conditions (e.g., coronary artery disease, diabetes, breast cancer, cervical cancer and osteoporosis) increases after menopause. It is evident from the table that postmenopausal osteoporosis is significantly ($p<0.0001$) more prevalent around menopausal age. The majority i.e. 2/3rds (62%) of confirmed postmenopausal osteoporotic women were between 45-55 years (36.2% in 45-50 years and 25.8% in 50-55 years). Another 20% belonged to the age group of 55-60 years.

2. Habitat and Postmenopausal Osteoporosis: The present study shows less occurrence of post-menopausal osteoporosis among rural women i.e. 48% as against urban women i.e. 51.2% and the differences were significant ($p<0.0001$). It can be inferred that urban women suffer osteoporosis in the post-menopausal period more than rural women.

3. Type of Menopause and Postmenopausal Osteoporosis: Menopause, whether natural or surgical is one of the established risk factors for osteoporosis. The findings of this study depicted that the majority of women with natural menopause i.e. 216 (83.1%) suffered from menopausal osteoporosis as compared to only 44 (16.9%) among women whose uterus has been surgically removed and were put on supplements.

4. Relevant Medical History and Postmenopausal Osteoporosis: Despite not having any family history of osteoporosis a significant number of women suffered osteoporosis in the postmenopausal phase. Similarly, 97.7% of osteoporotic women had no family history of fractures. Moreover, 114 (43.8%) osteoporotic women in the postmenopausal period had chronic disorders. It can be inferred that a family history of osteoporosis and fractures may not have an influence on osteoporosis among postmenopausal women.

5. Postmenopausal Osteoporosis and Physical Activity: Physical activity has an impact on osteoporosis among postmenopausal women. It is observed that postmenopausal osteoporosis was significantly ($p<0.001$) more commonly seen among sedentary women 204 (78.5%) as compared to 56 (21.5%) active women who suffered postmenopausal osteoporosis.

6. Postmenopausal Osteoporosis and BMI: Based on the findings, it is found that as the BMI increases, the percentage of women suffering from postmenopausal osteoporosis increases. It can be observed that only 71 (27.3%) women with normal BMI suffered postmenopausal osteoporosis. There was an increase in the occurrence of osteoporosis among women who were overweight 107 (41.2%) another 30.8% belonged to the obese group. A similar trend with increasing BMI levels among the non-osteoporotic group of postmenopausal women was also observed. The difference between the two groups did not show any significance.

7. Postmenopausal Osteoporosis and Nutrient Intake: The mean nutrient intake was much less than recommended among all respondents. The study shows that the mean caloric intake among postmenopausal osteoporotic women was not much deviating from RDA with hardly 8.64% deficit intake. However, the protein percent intake deficit was almost 42.4% and the calcium intake deficit was much higher i.e. 48.4% than recommended RDA among this group. A similar trend

was seen among the non-osteoporotic group also. However, the per cent deficit was slightly more among the postmenopausal osteoporotic group. An overall intake of nutrients was seen to be very less than normal. Age at the natural final menstrual period may be an important risk indicator for subsequent morbidity and mortality (Gold *et al.,* 2001). A woman's age at menopause influences health outcomes in later life. Early menopause is associated with a reduced risk of breast cancer, but increased risks of premature osteoporosis, cardiovascular disease and premature death (Davis & Baber 2022). The prevalence of osteoporosis has been significantly ($p<.0001$) observed more prevalent around menopausal age. This signifies that menopausal osteoporosis usually occurs in the age group of 45-55 years. This is the period of maximum impact of hormonal changes that occur around menopause (especially the decline of estrogens) resulting in osteoporosis. These findings are almost similar to the study done by Chaung *et al.* (2022) in which bone mass density was seen to decrease among respondents in the age group of 40-55 years. While the present study shows less occurrence of post-menopausal osteoporosis among rural women i.e. 48.8% as against urban women i.e. 51.2% and the differences were significant ($p<.0001$), it can be inferred that urban women suffer osteoporosis in the post-menopausal period more than the rural women. In a study by Martinz *et al.* (2013), urban women had a higher prevalence of cardiovascular and osteoporosis risk factors than rural women. The frequency of menopausal symptoms was more in urban women as compared with rural women and the results were highly significant ($p<0.01$). Menopause, whether natural or surgical is one of the established risk factors for osteoporosis. Surgical menopause, however, differs from natural menopause owing to the abrupt cessation of estrogen cessation. The present study reveals that the majority of women with natural menopause i.e. 216(83.1%) suffered postmenopausal osteoporosis as compared to 44(16.9%) women who attained menopause artificially (uterus surgically removed). One could assume that artificially attained menopause is often taken care of by medicines (like hormone replacement therapy and nutritional supplements) to prevent its immediate impact and hence less chance of osteoporosis. However, the findings were contradictory to the findings of Hadjidakis, (1999) that showed that surgical menopause results in lower vertebral and femoral neck densities compared to natural menopause. Thus, concluding that physiological (naturally induced) menopause is more often associated with Postmenopausal osteoporosis than pathological (surgically induced) menopause cannot be made from these findings as the differences were insignificant. Khan & Fortier (2014) in their study found that systemic hormone therapy has shown favourable benefits over harm in females under the age of 60 years or up to ten years after menopause. Hormone therapy is a preferable option for prevention of bone loss in symptomatic postmenopausal females. However, in females who have undergone hysterectomy, estrogen is given alone. Progestogens and the selective estrogen receptor modulator are added into estrogen base hormone therapy for females with an intact uterus to decrease the risk of endometrial hyperplasia (Rees *et al.,* 2020). Family history is a strong genetic component of osteoporosis, suggesting that a positive family history of this disease may be an important clinical risk factor. The present study reveals that despite fewer women (13.1%) reporting having a family history of osteoporosis, a sizeable number i.e. 226 (86.9%) had suffered osteoporosis in the post-menopausal phase. This percentage was still higher than the non-osteoporotic group. Similarly, only 2.3% reported a family history of fractures and 8.5% reported a history of fractures was again higher than a non-osteoporotic group of women. 114 (43.8%) osteoporotic women in the post-menopausal period had also reported chronic disorders. It can be inferred that a family history of osteoporosis and a history of fractures (in the family or past period of the individual) or chronic disorders can be important risk factors for osteoporosis among postmenopausal women. Similar findings by Kanis *et al.* (2004), report that a parental history of fracture (particularly a family history of hip fracture) confers an increased risk of fracture that is independent of BMD. Physical activity, combined with adequate calcium intake and hormone levels, is necessary for the formation and maintenance of bone tissue. The present study depicts that physical activity has a significant impact ($p<.001$) on osteoporosis among post-menopausal women. It was observed that post-menopausal osteoporosis was more commonly seen among sedentary women 204 (78.5%) as compared to only 56 (21.5%) active women who suffered post-menopausal osteoporosis. Also, a significant majority of women i.e. 206 (79.2%) who were not doing any exercise had been diagnosed with post-menopausal osteoporosis whereas the majority i.e. 75.0% of women in non- osteoporotic group exercised and yet suffered osteoporosis. Piehl-Aulin and Brahm (1999) also suggest that the effects of physical exercise on bone tissue variables are most beneficial when it is intensive, regular, and of weight-bearing character. Physical exercise may also be of value in the future treatment of osteoporosis. In addition to its skeletal effects, such exercise improves physical fitness, muscle strength and coordination, resulting in a reduced risk of fractures and improved quality of life. The above facts bring to light that women in menopause are 'at risk' of post-menopausal osteoporosis which has serious consequences on the quality of life and future health status of women. The role of body mass index (BMI) in fracture risk is of particular relevance. Underweight has consistently been reported as a risk factor for fracture when compared to normal weight. However, the effects of overweight and obesity are unclear. The present study reveals that the number of women suffering post-menopausal osteoporosis increases with an increase in BMI level. It can be observed that only 71(27.3%) women with normal BMI suffered post-menopausal osteoporosis with an overwhelming increase in the occurrence of osteoporosis among women who were overweight 107 (41.2%) another 30.8% belonged to the obese group. Thus, pointing towards an increase in

body weight may be related to postmenopausal osteoporosis although differences were insignificant. This increase in overweight or obese women number may be because of the lack of activity due to excess weight. Some of the studies suggest that obesity may impair physical function and increase the risk of falls (Nielson *et al.,* 2011). Diet, a modifiable osteoporosis risk factor, plays an important role in the acquisition and maintenance of bone mass. The influence of diet on bone begins in childhood; even maternal diet can influence bone mass in the offspring. A good general nutritional status and adequate dietary protein, calcium, and vitamin D nutrient intake especially in food groups like animal and dairy products, fruits, and vegetables have a positive influence on bone health. Calcium has been shown to have beneficial effects on bone mass at all ages, although the results are not always consistent Levis and Lagari (2012). Results from the study reveal that the mean nutrient intake by respondents was inadequate as per ICMR recommendations. The study shows that the mean caloric intake among post-menopausal osteoporotic women was not much deviating from RDA with hardly 8.64 % deficit intake. However, the protein percent intake deficit was almost 42.4 % and the calcium intake deficit was much higher i.e. 48.4 % than recommended RDA among this group. The deficient food intake of various food groups like dairy products, animal foods, green leafy vegetables and fruits observed mostly among Post-menopausal osteoporotic groups as against non-osteoporotic Post-menopausal women, may have contributed to low protein, calcium and Vitamin D intake. A similar trend was seen among the non-osteoporotic group also; however, the per cent deficit was slightly more among Post-menopausal osteoporotic group. Thus, dietary deficiency of protein, calcium and vitamin D-rich foods may have contributed to and increased the risk of Post-menopausal osteoporosis among women.

Table 1: Age and Postmenopausal Osteoporosis.

Age in Years	Osteoporotic Group (N=260)	Non-Osteoporotic Group (N=120)
45-50 years	94 (36.2)	68 (56.7)
50-55 years	67 (25.8)	17 (14.2)
55-60 years	52 (20.0)	16 (13.3)
Above 60 years	47 (18.1)	19 (15.8)

Chi-square value: 15.381, p-value: 0.002
Values within parenthesis are percentages

Table 2: Habitat and Postmenopausal Osteoporosis.

Habitation	Osteoporotic Group (N=260)	Non-Osteoporotic Group (N=120)
Rural	127 (48.8)	23 (19.2)
Urban	133 (51.2)	97 (80.8)

Chi-square value: 30.271, p-value: .0001
Values within parenthesis are percentages

Table 3: Type of menopause and Postmenopausal Osteoporosis.

Type of menopause	Osteoporotic Group (N=260)	Non-Osteoporotic Group (N=120)
Natural (Physiological)	216 (83.1)	92 (76.7)
Artificial (Surgical Removal of Uterus)	44 (16.9)	28 (23.3)

Chi-square value: 2.197, p-value: 0.138
Values within parenthesis are percentages

Table 4: Relevant Medical History and Postmenopausal Osteoporosis.

Relevant Medical History in Osteoporosis		Osteoporotic Group (N=260)	Non-Osteoporotic Group (N=120)	Chi-square, p-value
Family history of osteoporosis	Yes	34 (13.1)	14 (11.7)	0.148 0.700
	No	226 (86.9)	106 (88.3)	
Family history of fractures	Yes	6 (2.3)	0 (0.0)	2.814 0.093
	No	254 (97.7)	120 (100.0)	
Previous history of fractures	Yes	22 (8.5)	7 (5.8)	0.805 0.370
	No	238 (91.5)	113 (94.2)	
Chronic Disorders	Yes	114 (43.8)	45 (37.5)	1.359 0.244
	No	146 (56.2)	75 (62.5)	

Values within parenthesis are percentages

Studies have already shown that Calcium and protein intake interact constructively to affect bone health. Intakes of both calcium and protein must be adequate to fully realize the benefit of each nutrient on bone. At low protein intakes, intestinal calcium absorption is reduced and levels of parathyroid hormone increase, causing the release of calcium from bone Heaney and Layman (2008). Ring, (2017) stated that a balanced diet, adequate physical activities, cessation of smoking and limited alcohol consumption are recommended for osteoporosis prevention. Protein restriction is associated with muscle and bone loss thus increasing fragility in bone de Quadros *et al.* (2019). Thus, a balanced diet is very important for the prevention of osteoporosis.

Table 5: Postmenopausal Osteoporosis and Physical Activity.

Physical activity	Osteoporotic Group (N=260)	Non-Osteoporotic Group (N=120)
Active Women	56 (21.5)	94 (78.3)
Sedentary Women	204 (78.5)	26 (21.6)

Chi-square value: 1.29.5, p value: 0.001
Values within parenthesis are percentages

Table 6: Postmenopausal Osteoporosis and BMI.

BMI	Osteoporotic Group (N=260)	Non-Osteoporotic Group (N=120)
<18.5kg/m^2 (malnourished)	2 (0.8)	4 (3.3)
18.5-24.9kg/m^2 (normal)	71 (27.3)	22 (18.3)
25-29.9kg/m^2 (overweight)	107 (41.2)	54 (45.0)
≥30kg/m^2 (obese)	80 (30.8)	40 (33.3)

Chi-square value: 6.578, p-value: 0.087
Values within parenthesis are percentages
Source: Adapted from Body Mass Index classification WHO 2004.

Table 7: Postmenopausal Osteoporosis and nutrient intake.

Mean Intake of Nutrients	Osteoporotic Group (N=260)	Percentage deficiency	Non-Osteoporotic Group (N=120)	Percentage Deficiency
Calories (kcal)	2037.32±113.42	-8.6	2092.93±127.65	-6.14
Proteins (gms)	31.66±5.34	-42.4	32.68±6.22	-40.58
Calcium (mg)	309.11±54.65	-48.48	333.13±47.87	-44.47

RDA Calories-2230 kcal, Proteins-55 gms, Iron-21 mg and Calcium-600 mg (ICMR, 2010).
(Percentage deficiency means deficiency as against RDA expressed as percentages)

According to studies by Eisenberg Center at Oregon Health & Science University, adequate physical activities have a positive effect on bone health, muscle strength and balance which can lower the risk of falling and fractures.

CONCLUSIONS

Based on the present study findings from postmenopausal osteoporotic women of the Kashmir region and subsequent analysis it can be inferred that postmenopausal osteoporosis remains a disease mainly of women in the 45-55 years age group. Contributing factors like low physical activity, early menopause and use of certain medications for conditions of cardiac ailments, diabetes and gastric acidity plays an important role in the development of postmenopausal osteoporosis. It can therefore be concluded that not just attention by medical doctors is simply going to help such women but a comprehensive approach taking a holistic view of the health problem with support from other areas like nutritionists, social scientists, psychologists and educationists will go a long way in alienating the disease and its impact.

FUTURE SCOPE

Further studies and awareness programmes could go a long way in creating and improving awareness levels about the health issue, providing advice, guidance and counselling on nutrition-related issues as well as supporting women on mental and emotional levels for better well-being and quality of life.

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