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Original Research Article

Prospective Study to Evaluate Calcium and Vitamin D Deficiency in Elderly Rural Population and Effect of Calcium and Vitamin D Supplementation on Bone Mineral Density

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Conflict of interest: Nil

Abstract:

Background: Vitamin D is essential for humans for calcium homeostasis and bone health. Vitamin D deficiency causes osteoporosis and other musculoskeletal disorders. This study is aimed to evaluate the levels of vitamin D among the elderly males and post-menopausal females, and prevalence of vitamin D deficiency in Konaseema region.

Materials and Methods: This correlational study was conducted on men and women above 50 years attending the hospital OPD in Konaseema Institute of Medical Sciences Hospital for a period of 2 years. Blood samples for serum 25-(OH) vitamin D, calcium and phosphorus were collected from the patients by venipuncture observing all safety and aseptic precautions. Data collected was analyzed for any correlation in the values between the biochemical parameters and vitamin D and calcium supplementation.

Result: Our study found that Vitamin D levels and bone mass density are inversely related to age which is more evident in post-menopausal women due to steep fall in estrogen levels after menopause. In this study, the individuals are supplemented with calcium (calcium carbonate) 1000mg per day and 800 IU of vitamin D (daily dose), and they were followed up at 3rd, 6th, and 12th month. In the present study, following vitamin D supplementation in osteoporotic elderly people, there was a significant increase in the bone mineral density, analyzed by T scores. Our study mainly relied upon serum calcium, serum vitamin D levels and T scores, whose improved values were significant ($p < 0.001$). Our study follow up was done for 1 year in 3 phases (3rd, 6th, 12th months).

Conclusion: The vitamin D deficiency is common in poor and lower middle class likely due to under nutrition. This study points out higher prevalence of Vitamin D inadequacy and low BMD in post-menopausal women and elderly persons in Konaseema region. It can be concluded with the recommendation that post-menopausal women and elderly males, especially from lower socioeconomic group in Konaseema region, should be administered vitamin D and calcium regularly.

Keywords: Vitamin D Deficiency, Osteoporosis, Calcium Deficiency, Bone Mineral Density.

Introduction

Vitamin D is a fat-soluble vitamin (sunshine vitamin), which is essential for humans for calcium homeostasis and bone health. (1) The major sources for vitamin D for most humans are sunlight. [2] It has been estimated that 1 billion people worldwide have vitamin D deficiency or insufficiency. [3] Several factors have recently thrust the concern over inadequate vitamin D levels in to the forefront- the significant rise in ageing populations due to increase in life expectancy worldwide and phenomenal rise of chronic health problems associated with vitamin D inadequacy. Vitamin D deficiency, a preventable disorder, is a common and important public health problem in general and for females and elderly in particular. Adequate vitamin D is an essential factor in the prevention of osteoporosis and may reduce the risk of other medical disorders unrelated to bone and mineral metabolism. [4] Os-

teoporosis is the most common human metabolic bone disorder. It is a major health and economic problem and poses a huge challenge in developing nations like India, due to demographic transition and increase in the ageing population coupled with limited resources. One in 4 women and one in 8 men older than 50 years are believed to have Osteoporosis. Bone mineral density (BMD) declines in women with the onset of menopause, which is associated with increased bone resorption due to reduced estrogen levels. Thirty minutes of exposure of the skin over the arms and face to sunlight, without application of sunscreen, preferably between 10 am to 2 pm, daily is adequate to avoid vit D deficiency. [3]

The identification of vulnerable population is important in clinical practice and from public health point of view because, vitamin D deficiency is readily amenable to dietary and therapeutic supplementation of Vitamin D and Calcium. There are several studies on vitamin D status and BMD status in general population, but not many studies have been done on vitamin D status in postmenopausal females. Studies of BMD without knowing the vitamin D status can be misleading. [3] Therefore, this study is taken up to evaluate the levels of vitamin D among the elderly males and post-menopausal females, prevalence of vitamin D deficiency in Konaseema region.

Aims & Objectives of the Study

1. To assess the levels of serum vitamin D, serum calcium, and BMD in men and women, aged more than 50years, attending a tertiary care hospital.
2. To monitor the levels of vitamin D, calcium, and Bone Mineral Density over a period of supplementation with vitamin D and calcium.

Materials and Methods

This correlational study was conducted on men and women above 50 years attending the hospital OPD in Konaseema Institute of Medical Sciences Hospital for a period of 2 years (October 2015 – October 2017). Patients who satisfied the inclusion criteria and given consent were included in the study.

Inclusion Criteria

1. Men and Women above 50 years of age
2. Men and Women not taking Vitamin D and Calcium supplement for the last 6 months

Exclusion Criteria

1. Men and Women with known hepatic or renal diseases
2. Men and Women with known overt diseases of bone and mineral metabolism
3. Men and Women with known disorders of Parathyroid Glands
4. Men and Women with known malabsorption syndromes or gastric banding surgeries
5. Men and Women on drugs like anticonvulsants, Thiazide Diuretics, Steroids, Bisphosphonates, Estrogens, Progesterones or SERM.

Method of collection of data

Informed consent was obtained from all the subjects who fulfilled the inclusion criteria for the study. The following demographic data were taken from patient or from case records.

1. Age
2. Religion
3. Place – Rural/Urban
4. Socioeconomic status
5. Duration of sun exposure – hours/day
6. Clinical history
7. Drug history – anticonvulsants/ Steroids/ Vitamins or calcium/ Bisphosphonates
8. Medical history – Chronic Liver diseases and Hepatic failure /Nephrotic syndrome and renal failure / Parathyroid disorders / Bone or mineral metabolic disorders Hypocalcaemia/ Gastrointestinal malabsorption disorders.
9. Anthropometry – height, weight, BMI

Method of Sample collection

Blood samples for serum 25-(OH) vitamin D, calcium and phosphorus were collected from the patients by venipuncture observing all safety and aseptic precautions. The sample was centrifuged and cell free supernatant was aliquoted and stored at -20^0 C until assayed.

Statistical Analysis: Data collected was analyzed for any correlation in the values between the biochemical parameters and vitamin D and calcium supplementation.

Ambit of study

The study needs the following investigation to be done

1. Serum Vitamin D (25-(OH)Vitamin D)
2. Serum Calcium
3. Bone mineral density

Parameters studied are:

a. Serum 25-(OH) vitamin D

Serum vitamin D is estimated using Elecsys Precicontrol Varia® (Cobas) which contains lyophilized control serum based on human serum in two concentration ranges. It is measured by chemiluminescence assay.

b. Serum Calcium

Serum Calcium is estimated using Siemens Dimensions® clinical chemistry system. It is estimated by a modified method of calcium-o-cresolphthale incomplexone (OCPC) reaction. Calcium reacts with OCPC to form a purple complex. The amount of

complex thus formed is proportional to the Calcium concentration and is measured using a bichromatic (577, 540nm) end point technique. Magnesium ions which also form a colored complex with OCPC, are removed from the reaction by the complexation with 8-quinolinol. Blood samples for serum vitamin D, calcium and phosphorus estimation were collected in red capped vacutainers.

Bone Mineral Density: Bone ultrasonography is used due to its cost effectiveness, easy portability. Ultrasonography is one at calcaneum

- In this study, the elderly patients attending the OPD with low back ache and bone pains were selected for the study. Based on the demographic data stated above and according to the inclusion criteria, the study group will be taken into consideration.
- The study group consists of individuals without any comorbidities and otherwise normal, except for back pain and bone pains.
- Initially the patients will be assessed by estimating serum vitamin D levels, serum calcium, and Bone mineral Density (BMD) with Quantitative ultrasound.
- Individuals will be categorized into two groups, one group with both calcium and vitamin D deficiency and the second group with only vitamin D deficiency.
- The first group will be supplemented with both calcium and vitamin D, while the second group will be supplemented with vitamin D alone, and will be followed up at 3rd month, 6th month, and 12th month respectively. The medication is started immediately after the assessment of initial parameters, and placebo study is not taken up.
- The supplementation will be continued until they achieved their normal serum values. Vitamin D dose of 800 IU units and calcium carbonate dose of 1000mg was used in this study.

Observation and Results

In this study, 230 individuals were evaluated according to the age, gender, and socio- economic status. Some individuals were supplemented only with vitamin D and others with calcium and vitamin D. All were monitored periodically. Table 1 shows the frequency distribution according to age and gender.

Table 1: Demographic details of the patients

	Frequency	**Percentage**
Age		
50-60	130	56.52%
61-70	83	36.08%
>70	17	7.40%
Gender		
Males	89	38.7%
Females	141	61.3%
Total	**230**	**100%**

In this study, there are 130 members in 50-60 age group, 83 members in 61-70 yrs. age group, 17 members in >70 years age group. 38.7% were males and 61.3% females. Out of 230 cases, the frequency distribution of calcium and vitamin D supplementation. (45 members in 50-60 yrs age group, 25members in 61-70 yrs age group, 7 members in >70 yrs age group.) represented in table 2.

Table 2: Frequency distribution of calcium and vitamin D supplementation

Age	**Frequency**	**Percentage**
50 - 60	45	58.40%
61-70	25	32.50%
>70	7	9.10%%
Total	**77**	**100%**

Table 3 shows 85 members in 50-60 yrs age group, 58 members in 61-70yrs age group, and 10 members in >70 years age group receiving only vitamin D supplementation.

Table 3: Frequency distribution of only vitamin D supplementation

Age	**Frequency**	**Percentage**
50 - 60	85	54.8%
61 - 70	58	37.6%
>70	10	6.6%
Total	**153**	**100%**

The number of individuals affected with osteoporosis was classified according to socioeconomic group in the following table:

Table 4: Frequency distribution of Osteoporosis according to socioeconomic group

Socioeconomic group	Frequency	Percentage
Poor	133	57.81%
Lower Middle Class	58	25.21%
Middle class	27	11.77%
Upper middle class	12	5.21%
Total	**230**	**100%**

Calcium and Vit D supplementation were given at the end of 3 months, 6 months and 12 months to all the individuals who have shown improvement to normalcy are presented in the table 5.

Table 5: Calcium & Vit D supplementation at the end of 3 months, 6 months & 12 months

Months	Age	Vit - D	Calcium	T Score
3 Months	50-60	10	26	14
	61-70	5	16	8
	>70	1	3	1
6 Months	50 – 60	31	19	21
	61 -70	16	9	5
	>70	5	4	2
12 Months	50 - 60	4	0	10
	61 -70	4	0	12
	>70	1	0	2

At the end of 3 months, 6 months and 12 months, all the individuals who have shown improvement to normal range are depicted in the table 6 who received only vitamin D.

Table 6: Vit D supplementation at the end of 3 months, 6 months & 12 months

Months	Age	Vitamin D	T Score
3 Months	50-60	21	26
	61-70	23	18
	>70	3	1
6 Months	50- 60	53	34
	61-70	29	23
	>70	6	6
12 Months	50-60	11	25
	61-70	6	16
	>70	1	3

Analysis

Table 7: Analysis of Vitamin D levels

S. No.	Time	Mean ± S.D.	comparison	p- value
1.	0 Months	21.9± 4.38		
2.	3 Months	26.34± 4.45	Baseline vs 3months	p<0.0001
3.	6 Months	32.37± 3.81	Baseline vs 6 months	p<0.0001
4.	1 Year	38.76± 3.09	Baseline vs 1 Year	p<0.0001

The baseline mean value has been calculated and the baseline value is compared with mean values of 3 months, 6 months, and 1 year respectively. The P value has been derived with the help of the T – Test. The mean values of vitamin D showing linear increase in vitamin D levels with time

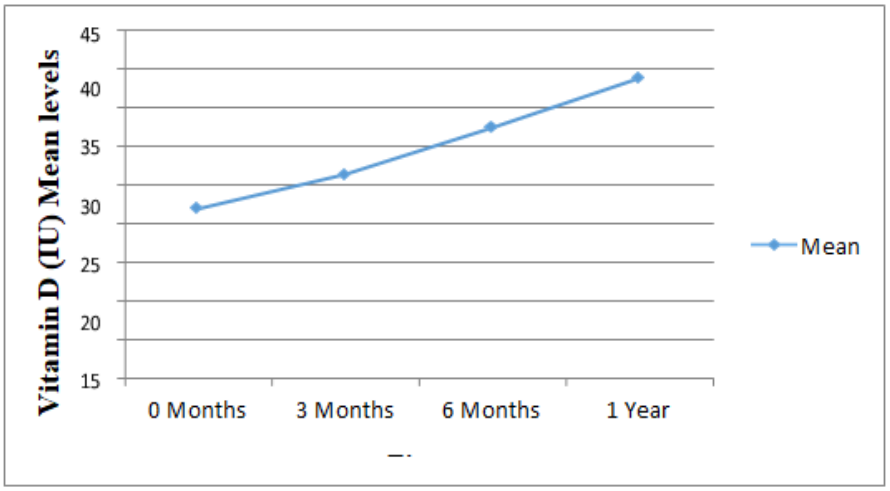

Figure 1: showing analysis of Vitamin D level

Table 8: Analysis of BMD levels

S. No.	Time	Mean ±S.D.	comparison	p- value
1.	0 Months	-2.73±0.19		
2.	3 Months	-2.63±0.23	Baseline vs 3months	p<0.0001
3.	6 Months	-2.37±0.24	Baseline vs 6 months	p<0.0001
4.	1 Year	-2.09±0.25	Baseline vs 1 Year	p<0.0001

The baseline mean value has been calculated and the baseline value is compared with mean values of 3 months, 6 months, 1 year respectively. The mean values of BMD (T score) showing linear increase in BMD values with time:

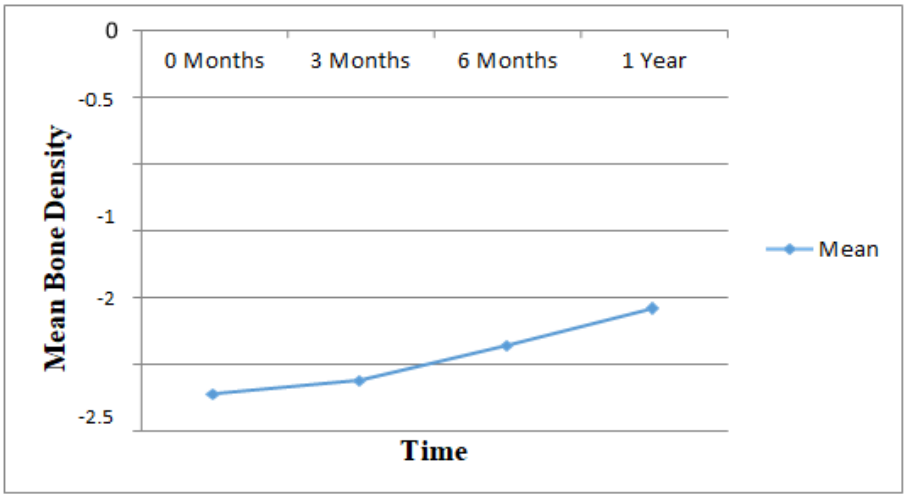

Figure 2: showing analysis of BMD mean levels

Table 9: Bone Density of study subjects at baseline and at end of 1 year of Vitamin D administration

	>-1	(-1 to -2.5)	<-2.5	Base line total
>-1(Normal)	0	0	0	0
(-1 to -2.5) (Osteopenia)	0	51	0	51
<-2.5 (Osteoporosis)	0	176	3	179
End line Total	0	227	3	230

McNemar's Chi square test for P<0.0001 Significant. Comparison of Bone Density of study subjects at baseline and at end of 1 year of Vitamin D administration

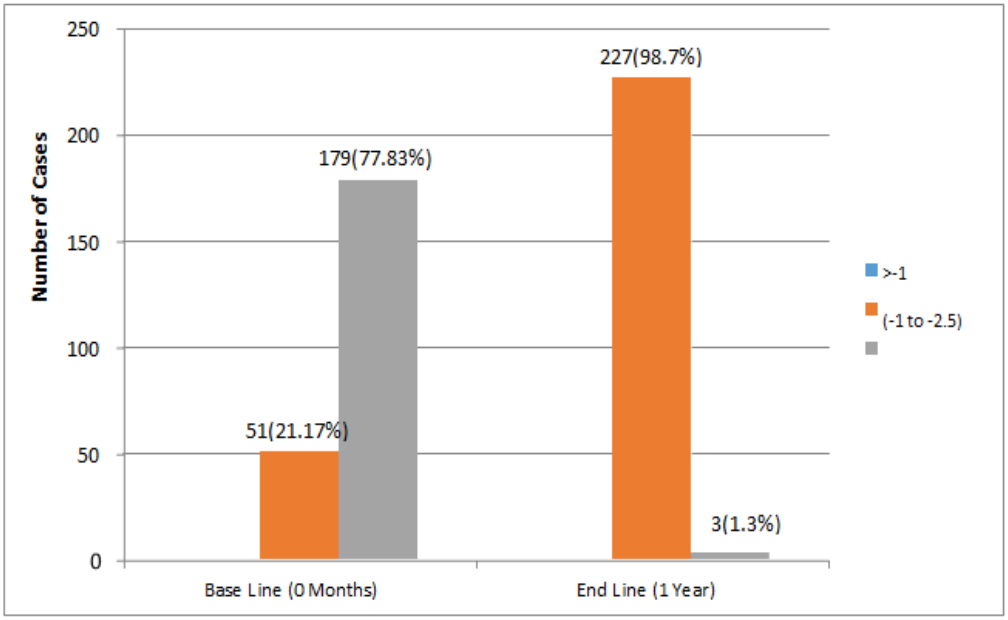

Figure 3:

Table 10: Comparison of mean values of calcium at 0 months and 3months

	At 0 month	At 3 months
Mean±S.D.	8.52±0.20	8.96±0.10

T test for P<0.0001 Significant. The linear graph of mean values of calcium at 0 and 3 months shows linear increase of calcium levels.

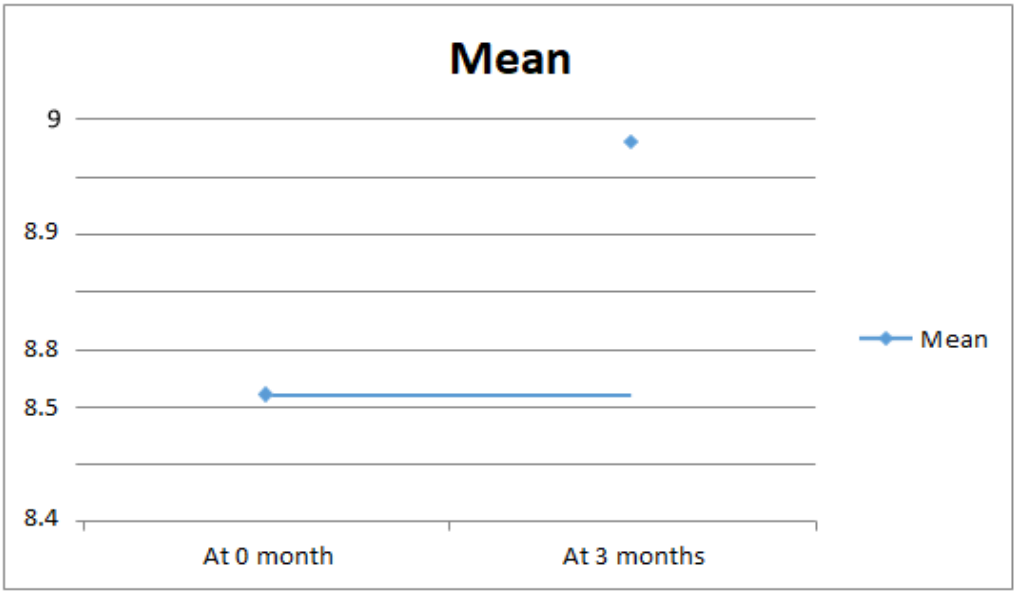

Figure 4: shows linear increase of calcium levels at 0 and 3 months

Table 11: Comparison of mean values of calcium at 0 months and 6 months

	At 0 month	**At 6 months**
Mean±S.D.	8.32±0.32	9.02±0.15

T test for P<0.0001 Significant. The following figure represents a linear graph of mean values of calcium at 0 months and 6 months:

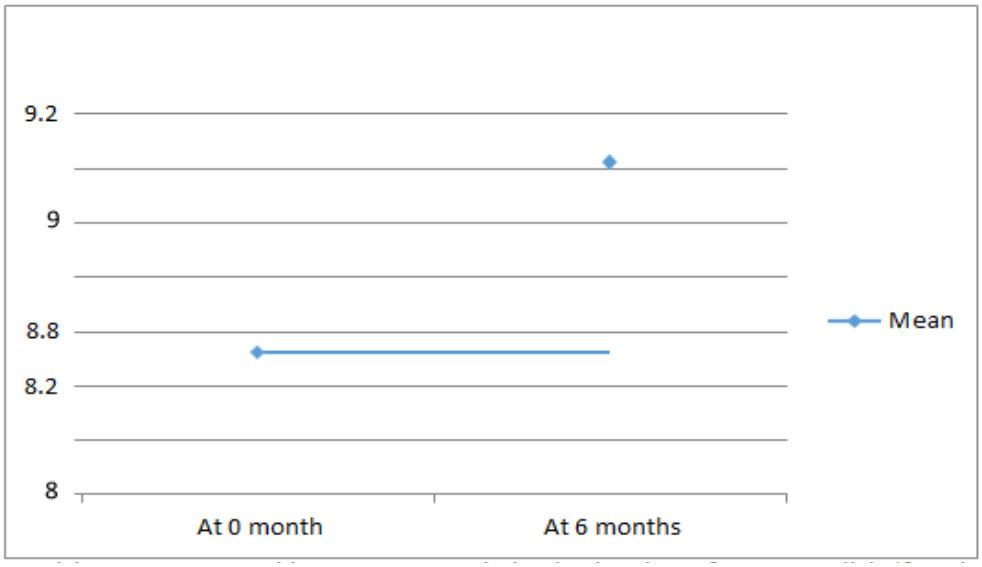

Figure 5: shows linear increase of calcium levels at 0 and 6 months

The p value and the McNamara's Chi square test are derived using the software Stat disk (free downloaded)

Results

In this study, 800 members were screened, out of which only 230 members were taken up for this study, as the remaining patients had other comorbidities, hence excluded as per the criteria. In this study, there are 77 individuals with both hypocalcemia (normal 8.8-10.1) and vitamin D inadequacy and 153 individuals with inadequate serum vitamin D levels. Of the 230, the youngest individual was of 50years and the oldest individual was of 85 years. Maximum number of individuals were in the range of 50 – 60 years (n=131).

77 members of the study group were administered calcium (calcium carbonate) 1000mg per day and vitamin D 800 IU until they have achieved their normal serum calcium levels i.e. above 8.8mg/dl. 45 persons achieved normocalcemia at the end of 3 months (mean=8.9 and p value <0.0001, significant) and 32 members by the end of six months (mean=9.02 and p value 0.0001, significant). All the members selected in the study are osteoporotic with T score -2.5 or less, which was analyzed using ultrasound technique measured at Calcaneum. In this study, the individuals are supplemented with 800 IU of vitamin D (daily dose), and they were followed up at 3rd, 6th, and 12th month.

Baseline vitamin D value was 21.9 with standard deviation of 4.38. Sixty-three members showed improvement (mean=26.34 with SD 4.45, p value <0.0001) in vitamin D at 3months.141 members achieved normal range in serum vitamin D levels by the end of six months (mean=32.37 with SD 3.81, p value < 0.0001). 26 members achieved normal range in vitamin D values by 12 months (mean=38.76 with SD 3.09, p value < 0.0001). Bone marrow density was estimated with T scores (baseline value -2.73 with SD 0.19). T scores improvement was observed at 3rd, 6th and 12th months. 68 members showed improvement at the end of 3 months (mean=-with SD 0.23, p value <0.0001), and 91 members by the end of 6 months (mean= -2.37 with SD 0.24, p value < 0.0001)),68 members at the end of 12 months (mean=-2.09 with SD 0.25, p value < 0.0001). All the 230 members have shown improvement in T score, with 227 members with T score ranging between -1 and -2.5 and the rest 3 members > -2.5. The 3 members, though showed improvement in vitamin D levels, remained in osteoporotic stage. Further follow up is required for these 3 members.

Discussion

Vitamin D deficiency is a pandemic-related health issue affecting musculoskeletal health and chronic diseases. [5] Insufficient levels lead to high parathyroid hormone (PTH) levels, bone remodeling, and decreased muscle strength and /or neuromuscular functioning and response time, increasing falls and fracture risks.

Many authors claim that the Vitamin D levels are inadequate, at the point when PTH starts to rise, evidence of homeostatic adaptation. In this study, the individuals with PTH abnormality were excluded.

The low Vitamin D status and increased bone turnover rate leads to accelerated bone mass loss and low BMD. The possible co-existence of a sub clinical malabsorptive state in some cases should also be borne in mind, given the high prevalence of under diagnosed gastrointestinal aetiology for the low Vitamin D. status. A strong correlation exists between BMI and BMD. Inverse correlation is known between markers of bone turnover and bone mass. Vitamin D is required for optimal calcium absorp-

tion and thus is also important for bone health. There is strong evidence that physical activity early in life contributes to higher peak bone mass. [6] Some evidence indicates that resistance and high impact exercises are likely to be most beneficial. There is a huge burden of hypovitaminosis D, the current recommendation for vitamin D supplementation is not supported by sufficient guidance, [7] Osteoporosis is a major public health issue in elderly. Left untreated, it can lead to fragility fractures with high morbidity. Low 25(OH)D status and low dietary calcium further aggravate osteoporosis because of chronic SHPT associated bone resorption, a problem well documented in Indian population. The reports of 25(OH)D status along with BMD, available from India, have used population-based reference values of 25(OH)D, to categorize the study population or the older classification of health-based reference values in post-menopausal women to relate it to the BMD measurements. [1] Maintenance of adequate serum 25(OH)D is of paramount importance as future bone loss is to be prevented in women once they have crossed the watershed of menopause. Significance of serum 25(OH)D status even in childhood has been demonstrated in terms of better BMD. [1]

Optimum intestinal absorption of calcium, necessary to prevent deleterious skeletal effects, requires daily calcium intake of 1 g to 1.5 g and serum25(OH)D more than 30 ng/ml. Vitamin D deficiency/insufficiency has adverse effects on calcium metabolism, osteoblastic activity, matrix ossification, BMD and bone remodelling. It is important to document dietary calcium and 25(OH)D status in elderly people. More than half of the individuals with a history of fracture, had vitamin D concentrations <15 ng/ml, (frequency ranging from 50% to 70%). [8]

Vitamin D insufficiency commonly occurs in patients with osteoporosis and could contribute to their clinical presentation of low bone density, fractures and falls. [4]

Loss of calcium from the body occurs through urine, faeces, as well as insensible loss. In adults, the minimum urinary loss is up to about 140 mg/day. This value rises with increased sodium intake and increased animal protein intake. Each gram of increased protein intake increases urinary calcium excretion by 1 mg per day.

The mechanism is thought to be the high phosphate (and perhaps sulphate) content of protein, which form complex calcium in the renal tubule and enhance its excretion. Similarly, each gram of increased sodium intake increases urinary calcium excretion by 15 mg per day. Here, the mechanism is through direct competition between the two ions for tubular reabsorption. [10] These two conditions which alter urinary calcium loss and calcium balance might be of relevance to calculate calcium requirements in those populations, whose daily intake of animal protein and salt may be less than that in Western diets. Hither to, all the calcium balance studies in the literature have been performed on the background of Western diets only. Insensible loss from skin, hair and nails accounts for 40 to 80 mg calcium loss per day. These amounts are unrelated to calcium intake. [9]

In men and women 65 years of age or older, who are living in the community, dietary supplementation with calcium and vitamin D moderately reduced bone loss measured in the femoral neck, spine, and total body over the three-year study period and reduced the incidence of non-vertebral fractures (Bess Dawson-hughs et al). [11] Serum 25(OH)D level is the best clinical indicator of the vitamin D status in blood. Wat et al., reported that an optimal level of 25(OH)D to suppress serum PTH concentrations was 30 ng/ml. Because PTH began to rise when 25(OH)D levels were below 30 ng/ml, whereas PTH levels did not change when 25(OH)D levels were above 30 ng/ml. [12]

In this study among 230 individuals, the vitamin D deficiency is common in poor and lower middle class, with 57.81% incidence in poorer section of society, 25.21% in lower middle class, 11.77% in middle class, 5.21% in upper middle class. Despite their better exposure to the sunshine, the poorer section is most commonly effected, likely due to under nutrition. Other studies have shown that vitamin D supplementation may contribute to gains in bone mineral density. [10]

In the present study, following vitamin D supplementation in osteoporotic elderly people, there was a significant increase in the bone mineral density, analyzed by T scores.

In this study, it was observed, significant rise in BMD and vitamin D levels on daily supplementations of Vitamin D and Calcium. BMD, T scores were done on calcaneum by ultrasound technique rather than DEXA. The drawback compared to the above study is, ultrasound technique is less specific and less sensitive. But our study mainly relied upon serum calcium, serum vitamin D levels and T scores, whose improved values were significant ($p < 0.001$). Our study follow up was done for 1 year in 3 phases (3rd ,6th,12th months).

In this study the daily dose of vitamin D supplementation was 800 IU and calcium supplementation (calcium carbonate) for hypocalcemic individuals is 1000mg/day.

Robert Y. van der Velde et al. reported, that daily supplementation with 800 IU vitamin D is a practical and safe strategy without the need for prior determination of vitamin D levels. Calcium supplementation should be tailored to the patient's need,

based on total daily dietary calcium intake. As per Robert Y. van ervelde, in most patients 500 mg per day is required to achieve a total intake of 1,200 mg, or in some 1,000 mg per day. More calcium is absorbed from calcium citrate compared to calcium carbonate. [13]

In this study, we used calcium carbonate, which is less efficiently absorbed as reported by the above study. We used calcium carbonate as its availability was free of cost in our institute. Richard E Semba et al. [6] concluded that Vitamin D deficiency is a common and important public health problem for older disabled women living in the community; black women are at higher risk than are white women.

In this study both elderly women and men more than 50 years were included with no variation in skin pigmentation (as all of the individuals are dark skinned), season (as we conducted study in temperate zone), and body mass index as in the above study. It was proved in this study that vitamin D deficiency is a preventable disorder and amenable for treatment.

Micheal F Holick, [14] conducted a study on elderly people and reported that the easiest method of correcting vitamin D deficiency is to give the patient one pill that contains 60,000 IU vitamin D once a week for 8 wk. This will usually increase the 25(OH)D concentration to 50 nmol/L (20 ng/mL). If not, the vitamin D "tank" may still not be full, and another 8-wk course of therapy usually corrects the vitamin D deficiency. One should suspect a fat- malabsorption problem or poor compliance if the 25(OH)D concentration does not increase by 25% after these treatments. Exposure to sunlight or a tanning bed will correct vitamin D deficiency in patients with severe intestinal fat-malabsorption syndrome.

In this study, vitamin D 800IU was supplemented until the individuals have been achieved adequate serum vitamin D levels. As noted in Heaney's McCollum Awar presentation and as indicated in a considerable number of published reports, including that of Heaney et al, the new recommendations are totally inadequate, especially, if a person has no exposure to sunlight. Without exposure to sunlight, a minimum of 1000 IU vitamin D/d is required. [14]

This study group has adequate sunlight exposure but is dark skinned, so 800IU were recommended. Tao Fan et al. [15] in their study concluded that insufficient consumption of vitamin D is a prevalent condition among osteoporotic postmenopausal women in Spain. To prevent major negative effects on bone health in older populations, more efforts are required to encourage appropriate vitamin D consumption, such as better patient education, lifestyle modifications, and vitamin D supplementation or medication. In our study exact dietary vitamin D intake was not estimated and very few participants are aged more than 75 years. 800 IU of Vitamin D was given as per the guidelines recommended in the above study.

As per the study done by Sameer Aggarwal & Nityanand [8] women taking supplemental vitamin D and calcium have a statistically increased incidence of renal stones, according to evidence from the Women's Health Initiative. Studies have shown association between calcium use and increased risk for cardiovascular disease. In a recent review of evidence from 6 randomized trials evaluating the use of vitamin D and calcium to prevent fractures in postmenopausal women who are not living in a nursing home or other institution, the United States Preventive Task Force (USPTF) found no evidence of a benefit from supplementation with 400 IU or less of vitamin D3 and 1000 mg or less of calcium. Also in a report from institute of Medicine Committee, there was insufficient evidence, particularly from randomized trials, that vitamin D treatment affected the risk of non-skeletal outcomes like risk of cancer, cardiovascular disease, diabetes, infections, autoimmune disease, and other extra-skeletal outcomes.

This recommendation is consistent with the findings of a 2011, Institute of Medicine (IOM) report which found that most US individuals get enough calcium and vitamin D from their diet & sun exposure and that supplementation may lead to excess levels of these nutrients. Overdoses of vitamin D intake can cause vitamin D toxicity; taking in too much calcium can cause constipation, kidney stones, and other systemic problems.

In this study, complaints of vitamin D toxicity or side effects of calcium supplementation were not noted as they were supplemented with baseline calcium dosage.

Three members in our study still have osteoporosis after twelve months of supplementation, due to less compliance; they may require further continuation of vitamin D and follow up.

Strengths of this study: The work i.e. history taking, physical examination, monitoring of laboratory values, tabulation of results and analysis was done by single person. Hence no observational bias. Care is taken in regular follow up and monitoring.

Weakness: Results are restricted to specific set of persons presenting to tertiary care center which is not representative of status in general community. Ultrasound technique at Calcaneus is only alternative modality& site.

As many were illiterate and unaware of importance of Osteoporosis, it became very difficult to make the patients come for review. Recommendations - An adequately powered community-based study is

expected to give better incidence in general population. Further studies are needed to elucidate the clinical impact and precise mechanism of above findings.

Limitations: Non availability of advanced investigations prevented me to study precisely various parameters. This is a cross-sectional design; hence no causal relationship can be demonstrated between serum 25 (OH) D and other variables.

Further study can be taken up by evaluating BMD and Osteoporosis by better investigation methods.

Projection of implications: As this study revealed significant Vitamin D deficiency in majority of elderly persons, it is recommended all the elderly people in Konaseema region be supplemented Vitamin D and Calcium.

Clinical implications: Vitamin D deficiency and insufficiency are linked to higher mortality rates, greater fall and fracture risks, greater risk for Breast and Colorectal cancers & Diabetes. All the post-menopausal women shall be supplemented with 800-1,000 IU of Vitamin D daily or 15 minutes of sun exposure 3 to 4 times a week. Women with risk factors need higher and tailored doses of Vitamin D supplementation.

Recommendations: Further studies with better investigative modalities and long-term monitoring, are needed to elucidate the comprehensive analysis.

Conclusion

This study points out higher prevalence of Vitamin D inadequacy and low BMD in post-menopausal women and elderly persons in Konaseema region. Calcium and vitamin D supplementation leads to moderate reduction in loss of bone mass and may substantially reduce the risk of non-vertebral fractures among elderly men and women.

Vitamin D insufficiency was common but largely ignored health problem in otherwise healthy post-menopausal women and elderly males living in Konaseema. It can be inferred from this study that the administered doses of Vitamin D and Calcium are optimum for people of this region, as evidenced by good response to supplementation.

It can be concluded with the recommendation that post-menopausal women and elderly males, especially from lower socioeconomic group in Konaseema region, should be administered vitamin D and calcium regularly. They should be given protein rich foods. Necessity of exposure to sunlight is to be impressed upon. All these measures will improve their BMD and decrease bony injury.

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