

**“CORRELATION OF VITAMIN D LEVELS WITH BONE MINERAL DENSITY IN  
PATIENTS OF AGE 45 AND ABOVE- A ONE YEAR HOSPITAL BASED  
OBSERVATIONAL STUDY”**

**BY**

**REGISTRATION NO. BL0120003**

## **Dissertation**

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**KAHER**

**JAWAHARLAL NEHRU MEDICAL COLLEGE**

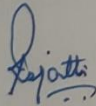
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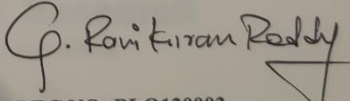
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## ABBREVIATIONS

BMD	BONE MINERAL DENSITY
DEXA	DUAL ENERGY X-RAY ABSORPTIOMETRY
DL	DORSOLUMBAR
DMP-1	DENTIN MATRIX PROTEIN
FRAX	THE FRACTURE RISK ASSESSMENT TOOL
GE	GENERAL ELECTRONICS
IGF-1	INSULIN-LIKE GROWTH FACTOR 1
FGF23	FIBROBLASTIC GROWTH FACTOR 23
ISCD	INTERNATIONAL SOCIETY FOR CLINICAL DENSITOMETRY
ICMR	INDIAN COUNCIL FOR MEDICAL RESEARCH
LS	LUMBOSACRAL
LVS	LATERAL VERTEBRAL STUDY
MRI	MAGNETIC RESONANCE IMAGING
MSCs	MESENCHYMAL STEM CELLS
NOF	NATIONAL OSTEOPOROSIS FOUNDATION
NSAIDs	NONSTEROIDAL ANTI-INFLAMMATORY DRUGS
OA	OSTEOARTHRITIS

OPG	OSTEOPROTEGERIN
PTH	PARATHYROID HORMONE
RA	RADIOGRAPHIC ABSORPTIOMETRY
ROS	REACTIVE OXYGEN SPECIES
SPA	SINGLE PHOTON AND X-RAY ABSORPTIOMETRY
TRPV1	TRANSIENT RECEPTOR POTENTIAL VANILLOID 1
VCF	VERTERBAL COMPRESSION FRACTURES
WHO	WORLD HEALTH ORGANIZATION

## ABSTRACT

**Background:** Osteoporosis is a skeletal disorder characterized by compromised bone strength with a consequent increased risk of fracture. Prediction of fracture risk is a key element in fracture prevention. Vitamin D plays a crucial role in the bone mineralisation. The present study aimed to study the Prevalence of Vitamin D Level Deficiency in Age Greater than 45 and its Correlation with Bone Mineral Density.

**Material & Method:** Present hospital based observational study included the patients in the age group of 45 years and above of male and female sex who were complaining of pain over lower back and hip pain who come to outpatient/in patient department of KLE Prabhakar Kore Hospital Belagavi were included in the study from January 1st 2021 to December 31st 2021. Patients were analysed for the serum vitamin D level, Bone mineral density by DEXA scan at different sites. The data were analysed using SPSS v21 operating on windows 10.

**Results:** Total of 62 patients fulfilling inclusion criteria are included in present study after obtaining the informed consent. The mean age of patients was found to be  $63.71 \pm 9.41$  yrs. Among them 58.1% were female patients and 41.9% male patients with slight female preponderance in the study. Vitamin D inadequate was seen in 54.8% of the patients included and among them 62.9% had the osteoporosis and 30.6% with Osteopenia. There is a significant association between the inadequate Vitamin D with the lower sun light exposure, female gender, T-score changes, socio-economic status and BMI of the patients. ( $p < 0.05$ )

**Conclusion:** The prevalence of vitamin D deficiency was found to be 54.8% in participants aged more than 45 years. The vitamin D levels significantly correlated positively with the BMI of participants and the T-score at spine and femur. There is significant higher incidence of osteoporosis noted among female compared to males, with 65.4% in female at

spine and 69.2% at femur, and in males it was 61.1% at spine and 47.2% at femur.

Keyword: Bone Mineral Density, Osteoporosis, Osteopenia, Vitamin D, Socioeconomic status.

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## INTRODUCTION

A skeletal condition called osteoporosis is characterised by reduced bone density and a resulting increased at risk for fracture. A crucial component of fracture prevention is the prediction of fracture risk.<sup>1</sup>

Osteoporosis, the most common bone disease in humans, is a serious public health problem. Aged persons, women, and Caucasians are more liable to have it.<sup>2,3</sup> Osteoporosis is a risk factor for fractures, just as high blood pressure. Millions of individuals of all ages and ethnicities suffer from osteoporosis, and as the population ages, its prevalence will escalate. Until fractures form, it is a silent condition, but once they do, it produces grave subsequent health problems and could even be fatal.<sup>4</sup>

Initially metabolized to 25 hydroxyvitamin D (25OHD), vitamin D is subsequently transformed into its hydroxyl form, 1,25(OH)<sub>2</sub>D. Calcium and phosphorus levels in the serum are controlled by vitamin D. By enhancing calcium absorption from the small bowel and enhancing calcium re - uptake by the renal distal tubules, it maintains plasma calcium levels.<sup>5</sup> The World Health Organization (WHO) characterizes an osteoporosis diagnosis based on assessments of bone mineral density (BMD) as: Osteopenia: T score between -1 and -2.5 SD; Osteoporosis: T score <-2.5 SD; Normal: T score >-1 SD. Dual energy x-ray absorptiometry (DEXA) imaging is the best method for quantifying BMD.<sup>6</sup>

More than 200 million individuals are believed to be suffering from osteoporotic hip fractures globally.<sup>7</sup> According to statistics, 30% of women in both Europe and the USA are osteoporotic, and 40% of post-menopausal women and 30% of men are predicted to sustain an osteoporotic fracture throughout the course of their lifetimes.<sup>8,9</sup> Osteoporosis, which is defined by diminished bone mass and deterioration of bone architecture, is becoming ever more prevalent among women in India. Researchers estimate that 20%, or 46 million, of 230 million Indians estimated being over the age of 50 in 2015 are women with osteoporosis. While figures on the frequency of osteoporosis amongst women in India originate from small-group studies conducted across the nation. Because of this, osteoporosis is a major public health problem for Indian women. The high prevalence of osteoporosis has been attributed to a low calcium consumption, a high frequency of vitamin D deficiency, advancing longevity, sex asymmetry, peri-menopause, a lack of diagnostic tools, and a lack of health education for women.<sup>10</sup>

Despite having abundance sunshine, India has been shown to have vitamin D shortage in individuals of all ages. Minimizing direct sunlight for socio-cultural grounds, not acquiring enough calcium, environmental degradation, and a larger 25(OH)-d-24-hydroxylase enzyme amongst Asian Indians are some of the reasons of hypovitaminosis D.<sup>10,11</sup>

The current study's goal was to find out the Prevalence rate of vitamin D deficiency in adults older than 45 and the way it related to bone mineral density in both the male and female population.

## **AIMS & OBJECTIVES**

### **Aim:**

Prevalence of Vitamin D Level Deficiency in Age Greater than 45 and its Correlation with Bone Mineral Density.

### **Objective**

1. Measure the bone mineral density among the study participants
2. Measure the vitamin D levels among the study participants
3. Correlate the vitamin D status with Bone mineral density among the males and females more than 45yrs of age.

## **REVIEW OF LITERATURE**

### **Vitamin D**

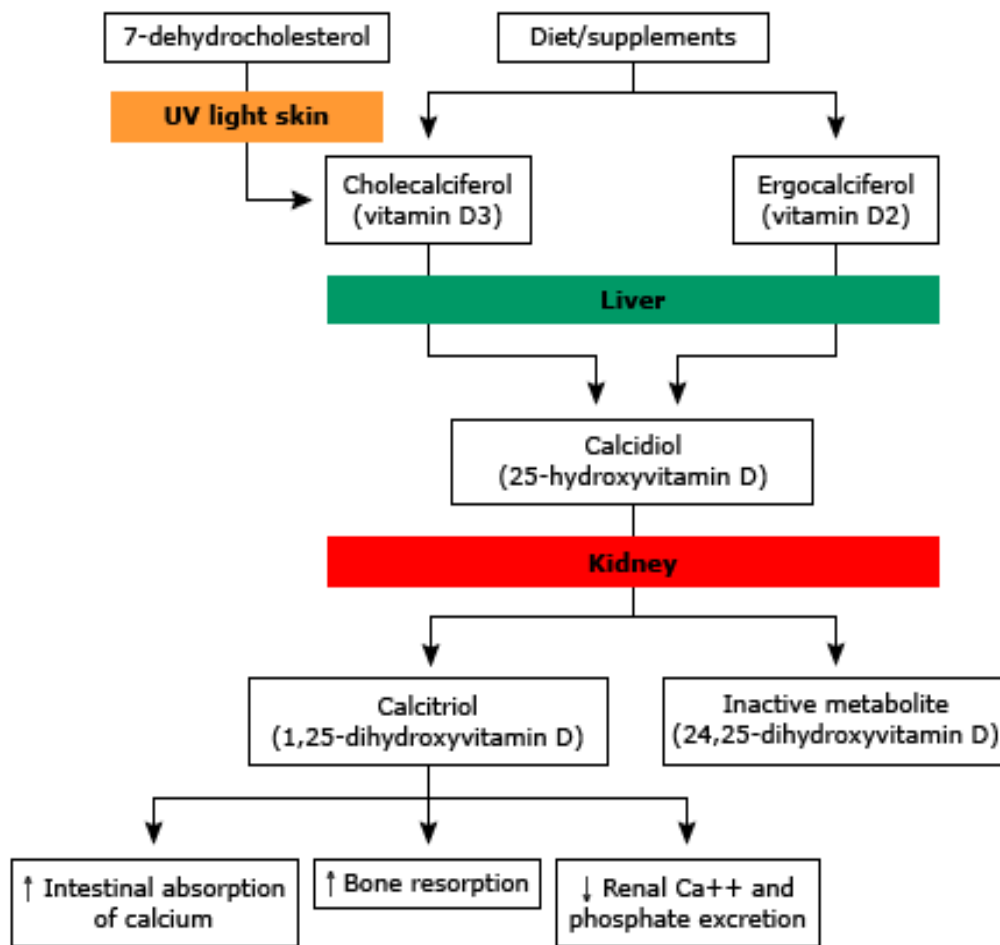
As a fat-absorbable vitamin, it is only present in a few naturally occurring foods such as the fatty liver of fish, and that has its main natural source in epidermis.<sup>12</sup> Vitamin D from diet or from the skin is physiologically inert and must undergo enzymatic modifications to become an active metabolite. Main circulating form of vitamin D is 25-hydroxyvitamin D, is created in hepatic system and is subsequently converted in kidney in the form of 1,25-dihydroxyvitamin D. vitamin D in this form is active.<sup>5</sup>

### **Absorption:**

Micelles made of dietary vitamin D are subsequently absorbed by enterocytes and packaged as chylomicrons. Disorders that lead to fat mal-absorption, such as gluten sensitive enteropathy, Crohn's disease, pancreatic diseases, cystic fibrosis, and renal diseases, short gut syndrome, and hepato biliary diseases, were associated with low blood 25-hydroxyvitamin D (25[OH]D) levels.

### **Metabolism:**

The physiologically inert vitamin D obtained from food or dermal production must be transformed into an active form by an enzyme mechanism in the liver and kidney. A hydroxyl group is added to the vitamin D molecules at the position 25 by the hepatic enzyme 25-hydroxylase, creating 25-hydroxyvitamin D. (25[OH]D also known (calcidiol). In addition to extrarenal locations, epidermis, mammary epithelial cells, vascular, gastrointestinal system, osteoblasts, and osteoclasts all express the 1-alpha-hydroxylase enzyme..<sup>13,14</sup>



**Figure 1: Synthesis of Vitamin D**

Concentration of 1,25-dihydroxyvitamin D in the blood is influenced by the availability of 25(OH)D and the activity of the kidney enzymes 1-alpha- and 24-alpha-hydroxylase. The following variables are primarily responsible for regulating the renal 1-alpha-hydroxylase

enzyme.<sup>15,16</sup>

PTH

Serum calcium and phosphate concentration

Fibroblast growth factor 23

## **Deficiency and resistance:**

### **Definition<sup>17</sup>**

The degree of blood 25-hydroxyvitamin D that suppresses serum parathyroid hormone is deemed to be ideal in terms of bone health.<sup>18</sup> According to the majority of experts, calcidiol levels in between 21 to 29 ng/mL indicate vitamin D insufficiency and less than 20ng/ml signifies inadequacy, respectively. Vitamin D level if over 30, it is regarded sufficient, and over 150 ng/mL, it is termed intoxicated. Cut-off levels for an inadequate or deficient vitamin D level vary amongst professional organisations.<sup>19,20</sup>

Resistance and vitamin D insufficiency may result from one of the following four pathways;

- Reduced vitamin D availability as a result of insufficient dietary vitamin D, illnesses that affect how fat is absorbed, and/or a lack of sunshine (photoisomerization)
- Impaired 25-hydroxyvitamin D production by the liver (25[OH]D)
- Poor kidney hydroxylation, which results in 1,25-dihydroxyvitamin D (vitamin D-dependent rickets type 1, chronic renal insufficiency)
- End organ hypersensitivity to vit D metabolite (hereditary vitamin D-resistant rickets)

[HVDRR, vitamin D dependent rickets type 2])

A apparent vitamin D deficit may cause rickets, osteomalacia in adolescents, and osteomalacia in adulthood. Subclinical vitamin D deficiency leads to osteoporosis, which might also increase the risk of fractures and of falling.

### Calcium homeostasis<sup>21,22</sup>

The normal range for calcium in blood is 8.5–10.5 mg/dl.

It is present as 3 forms;

Free ionic form (50% of total calcium)

Bound for (40% bound to albumin)

Complexed form (10% complexed to bicarbonate, phosphate, citrate)

Regulation of calcium occurs by

<b>3 Organs</b>	<b>3 Hormones</b>	<b>3 Mechanism</b>
Bone	Parathyroid	Calcium absorption from Gut
Kidney	Vitamin D	Calcium reuptake from renal system
Intestine	Calcitonin	Mineralisation or demineralisation from bones

### Vitamin D

Active form is 1, 25 dihydroxy cholecalciferol / Calcitriol

<b>Intestine</b>	<b>Bones</b>	<b>Kidney</b>
Promote absorption of calcium Increase Calbindin concentration	Stimulate osteoblast Increase alkaline phosphatase Increase in Ionic product of calcium and phosphate <b>Mineralisation</b>	Increases the reabsorption of Calcium & Phosphorus

## Parathyroid hormone

Secreted by parathyroid glands

PTH secretion is controlled by negative feedback by the ionized calcium in the serum

Acts via CAMP

Intestine	Bones	Kidney
Increases Calcium absorption via Vitamin D by activating Vitamin D Stimulates 1 hydroxylation in the Kidney.	Induce phosphatase in osteoclast cells Increase lactate concentration Increase collagenase and loss matrix <b>Demineralisation</b>	Decrease renal excretion of calcium by increasing the reabsorption Increased renal excretion of Phosphates

### Calcitonin

Secreted by thyroid para-follicular cells

Decrease Calcium levels

Inhibits resorption (demineralisation) of bone

Decreases activity of osteoclast & increases activity of osteoblast

Increases Excretion of Ca & Phosphorus

### Phosphorus

Reciprocal relationship

Ionic product of calcium & phosphorus is kept constant --- 40

Renal failure phosphorus excretion decreased --- increase in phosphorus & Ca level decreased

### Serum proteins

Hypo-albuminemia – decreased total calcium

0.8mg of Ca reduced per gm/dL decrease in albumin

Metabolically active form normal

### Alkalosis & Acidosis

Alkalosis favours binding of Ca to proteins hence decrease in ionic Ca

Acidosis favours ionization of Calcium

## Bone cells<sup>23</sup>

10% Of the total volume of bone is made up of bone cells. There are four distinct cell types;

Skeletal (Osteoprogenitor) Cells: <sup>24</sup>

Osteoblasts, the cells that form bones: osteocalcin and osteonectin are secreted by osteoblasts.

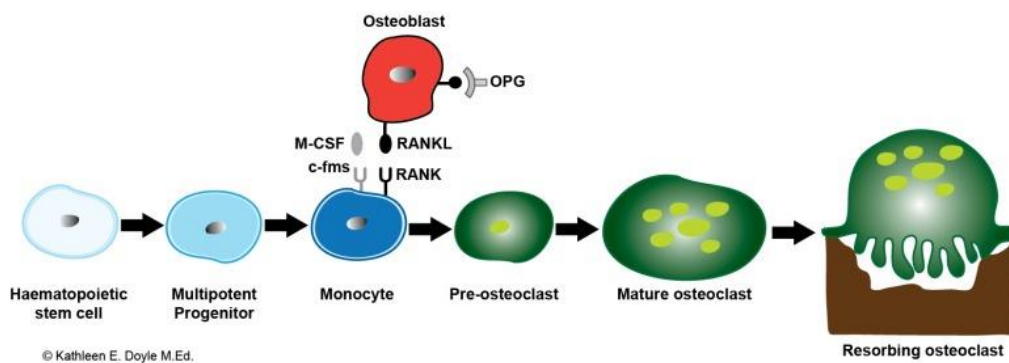
which control mineral deposition via controlling the formation of hydroxyapatite crystals.

Osteoblasts have two possible states: osteocyte differentiation or quiescence as osteoblast

lining cells.<sup>25,26</sup> Through cytoplasmic processes, they communicate with bone surfaces and one

another.<sup>27</sup>

Osteocytes can sense mechanical loads through the physical deformation of the bone-matrix and fluid-flow shear stress brought on the canalicular. Serum phosphate levels are altered by FGF-23. Increased renal phosphate excretion by both kidneys is the result of FGF23 decreasing the expression of sodium and phosphate co-transporters in the kidneys and intestine..<sup>28</sup>



**Figure 2: Schematic illustration of osteoclastogenesis**

Osteoclasts: Multinucleated cells known as osteoclasts, or bone resorbing cells, evolved from mononuclear cells monocytes and macrophages. RANKL and macrophage CSF (M-CSF) are both key cytokines for osteoclast development. These are required for the proliferation and differentiation of osteoclast precursors into mature osteoclasts.<sup>29,30</sup> A protein which is membrane-bound called osteoprotegerin (OPG) attaches to RANKL to restrict the activity at the RANK receptor, which in turn prevents osteoclastogenesis. Bone resorption requires the formation of H<sup>+</sup> by osteoclasts, tartrate-resistant acid phosphatase (TRAP), and cathepsin K enzymes. These enzymes crumble the protein matrix which is composed primarily of type I collagen (TRAP), whereas the mineral component of the bone matrix is broken down by hydrogen ions in resorption compartment below osteoclast. Osteoclast activity is decreased by calcitonin but increased by PTH.<sup>31</sup>

## **Bone extracellular matrix**<sup>23</sup>

This accounts for 90% of total bone volume. It is made up of both Nonorganic (mineral) and organic matrices.<sup>32</sup>

Nonorganic Bone Matrix: responsible 99% of calcium storage in the body, 85% of phosphorus storage, 50% of magnesium and salt storage. Mostly takes the outline of hydroxy-apatite  $[Ca_{10}(PO_4)_6(OH)_2]$  and is responsible for the bones firmness , rigidity, and opposition to compressive stresses.<sup>33</sup>

Organic-Bone Matrix: mostly type I collagen and is released by osteoblasts. Glyco-proteins, growth factors, proteoglycans are also present. Growth factors are necessary for the formation, mineralization, and remodelling of osteoid. Instances include osteocalcin, osteonectin, and bone sialoprotein. The organic matrix offers tensile resistance and lends the shape to a bone.<sup>34,35</sup>

## **Bone remodelling:**<sup>23</sup>

In this biomedical procedure, osteoclasts replace damaged or old bone and are substituted by osteoblasts, which create fresh bone. There is a close relationship among bone creation and bone resorption to guarantee that there is no net change in bone quantity or quality after each remodelling. It necessitates the coordinated work of all four kinds of bone cells. The process is broken down into four distinct but related steps.

Initial phase: Induction

Phase 2: Recruitment of osteoprogenitors and bone turnover.

Phase 3: Development and osteoid synthesis

Phase 4: completion of bone remodelling and mineralization of osteoid.<sup>36</sup>

## **Clinical significance**

### **Osteoporosis<sup>23</sup>**

Low bone strength and structural deterioration of the bone defines this common disorder of bone metabolism. It renders bones more brittle and prone to fractures.<sup>36-39</sup> Osteoporosis has two forms:

Primary Osteoporosis:

#### **Type I (Post-menopausal Osteoporosis)**

Cause: a decline in estrogen levels associated with menopause.

Pathophysiology: deficiency of estrogen causes an increase in osteoclast activity by increasing RANKL and M-CSF expression and inhibiting apoptosis of osteoclast by reducing FasL expression by preosteoclasts.

#### **Type II (Senile-Osteoporosis)**

Cause: age-related and centered on osteoblasts (boneformation).

Pathophysiology: Changes in reactive oxygen species (ROS), insulin-like growth factor 1 (IGF-1), and PTH levels related to ageing are responsible for reduced bone production in both genders.

#### **Steroid-induced Osteoporosis (Secondary Osteoporosis)**

Cause: Multiple sclerosis and rheumatoid arthritis are two inflammatory diseases that are treated with glucocorticoids, which are immunomodulatory medications. Among

the typical side effects of glucocorticoid therapy are bone loss and an increased risk of fractures.

Pathophysiology: Glucocorticoids encourage the development of osteoprogenitors into adipocytes while inhibiting the differentiation of osteoprogenitors into osteoblasts (fat cells). Additionally, they worsen osteoblastic functions and raise apoptosis rates. Furthermore, in order to extend the lifespan of mature osteoclasts, glucocorticoids target them, which worsens the already existing imbalance between bone formation and bones resorption in favour of bone resorption

Reduced bone mass, micro architectural disturbance, as well skeletal frailty are all symptoms of the widespread condition osteoporosis, which raises the risk of fracture. The purpose of screening is to locate people who would benefit from intervention to reduce their chance of suffering a low-trauma fracture..<sup>34</sup>

**Definition:** Decreased bone mass, micro architectural disruption and increased skeletal brittleness are symptoms of osteoporosis, which decreases bone power and raises risk of fracture. Fragility fractures are characterised as fractures that develop with little or no stress, such as one brought on by a fall from a standing position. Fragility fractures most frequently occur in the wrist, hip, and spine (vertebral compression fractures). Also susceptible to fragility fractures are the humerus, rib, and pelvis.

### **Risk factor assessment<sup>6</sup>**

All of us are prone to fractures, although postmenopausal women, men over 50, and anybody who experiences a fragility or low-trauma fracture are at higher risk.

More chances of fractures in persons with decreased bone mass (T-score -1.0 and -2.5), despite the fact that those with osteoporosis had a higher relative risk of fracture.<sup>40</sup>Therefore, it is

crucial to evaluate risk factors that are independent of BMD in order to predict fracture. The following are validated risks variables which are independent of BMD.

Advancing age

Long term glucocorticoids therapy

Low body weight

Previous fracture

Cigarette smoking

Excess alcohol intake

Parental history of hip fractures

### **Assessment of Bone mineral density**

For osteoporosis screening, BMD tests are utilised in combination with fracture risk assessment. Low BMD, regardless of assessment technique, is related with an ascending risk of fracture.<sup>41</sup>

Measuring T-score in men solely because they are above a certain age is controversial. Some groups, including the Endocrine Society, National Osteoporosis Foundation, and International Society for Clinical Densitometry, advise BMD testing for all males over the age of 70. (and in men 50 to 70 years when risk factors are present)<sup>42</sup>

- Single Photon and X-Ray Absorptiometry (SPA)
- Radiographic Absorptiometry (RA)
- Dual Energy X-Ray Absorptiometry (DEXA)
- Quantitative Computed Tomography Can Be Used

## **Dual energy x-ray absorptiometry**

One of the best methods for assessing BMD because it gives incredibly accurate readings at clinically significant bone locations. The main drawbacks of DXA are its size (it cannot be carried around), cost, and use of ionising radiation, albeit at a very low dose.<sup>43,44</sup>

DXA of the hip and spine are common site for screening measurement. Spinal osteophytes are frequent in elderly persons, making BMD testing at this location difficult. In this case, measuring hip BMD alone may be adequate.<sup>45,46</sup>

Osteoporosis was also defined by the World Health Organisation (WHO) using dual-energy X-ray absorptiometry (DXA) data.

**Table 1: Diagnostic categories for osteoporosis and low bone density based upon BMD assessment by DXA<sup>6</sup>**

<b>Category</b>	<b>Bone mass</b>
<b>Normal</b>	<b>A value for BMD within 1.0 SD of the young adult female reference mean (T-score greater than or equal to -1.0 SD).</b>
<b>Low bone mass (osteopenia)</b>	<b>A value for BMD more than 1.0 but less than 2.5 SD below the young adult female reference mean (T-score less than -1 and greater than -2.5 SD).</b>
<b>Osteoporosis</b>	<b>A value for BMD 2.5 or more SD below the young adult female reference mean (T-score less than or equal to -2.5 SD).</b>
<b>Severe (established) osteoporosis</b>	<b>A value for BMD more than 2.5 SD below the young adult female reference mean in the presence of one or more fragility fractures.</b>

**Patient:** [Redacted]  
**Birth Date:** [Redacted] 53.3 years  
**Height / Weight:** 156.0 cm 48.8 kg  
**Sex / Ethnic:** Female White  
**Facility ID:** [Redacted]  
**Referring Physician:** [Redacted]  
**Measured:** [Redacted]  
**Analyzed:** [Redacted]

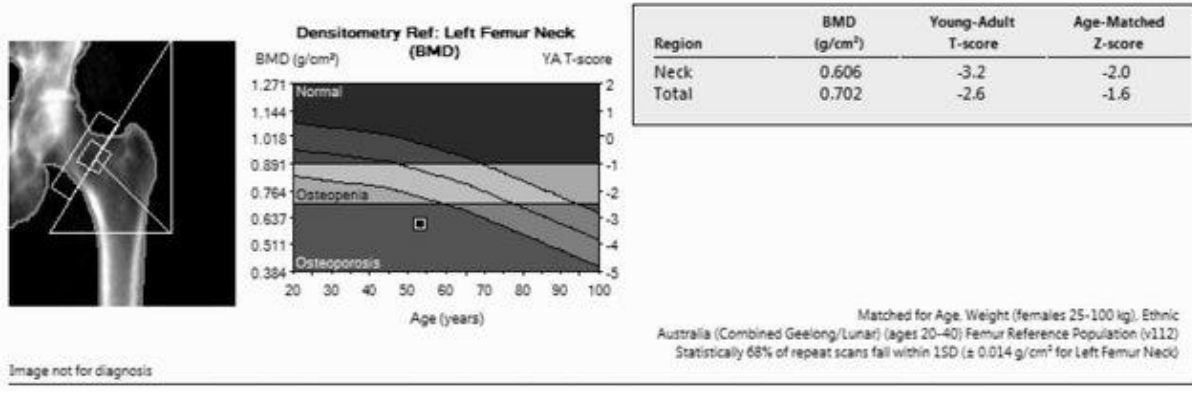
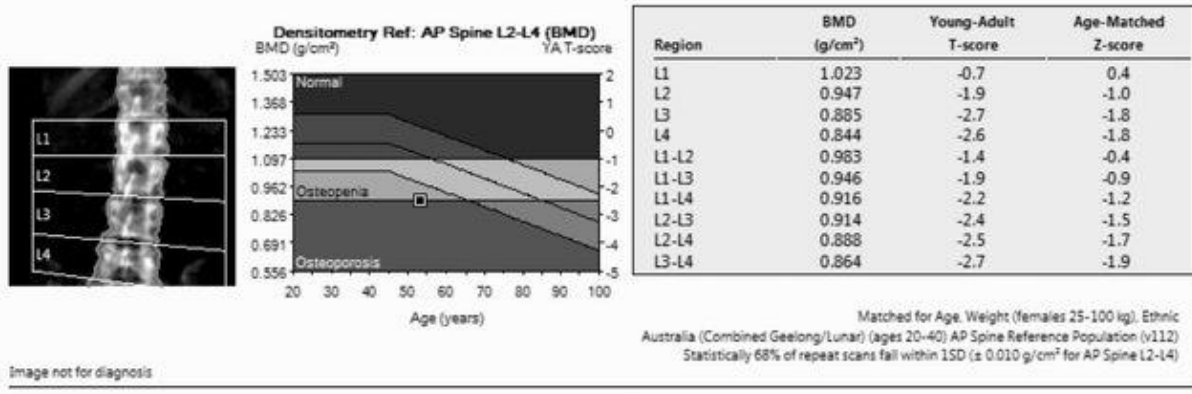


Figure 3: Osteoporosis<sup>47</sup>

**Singh Index<sup>48</sup>**

Singh-index a grading system for femoral neck bone mass based on the visibility of trabecular types in femur neck.

Trabeculae types in proximal femur

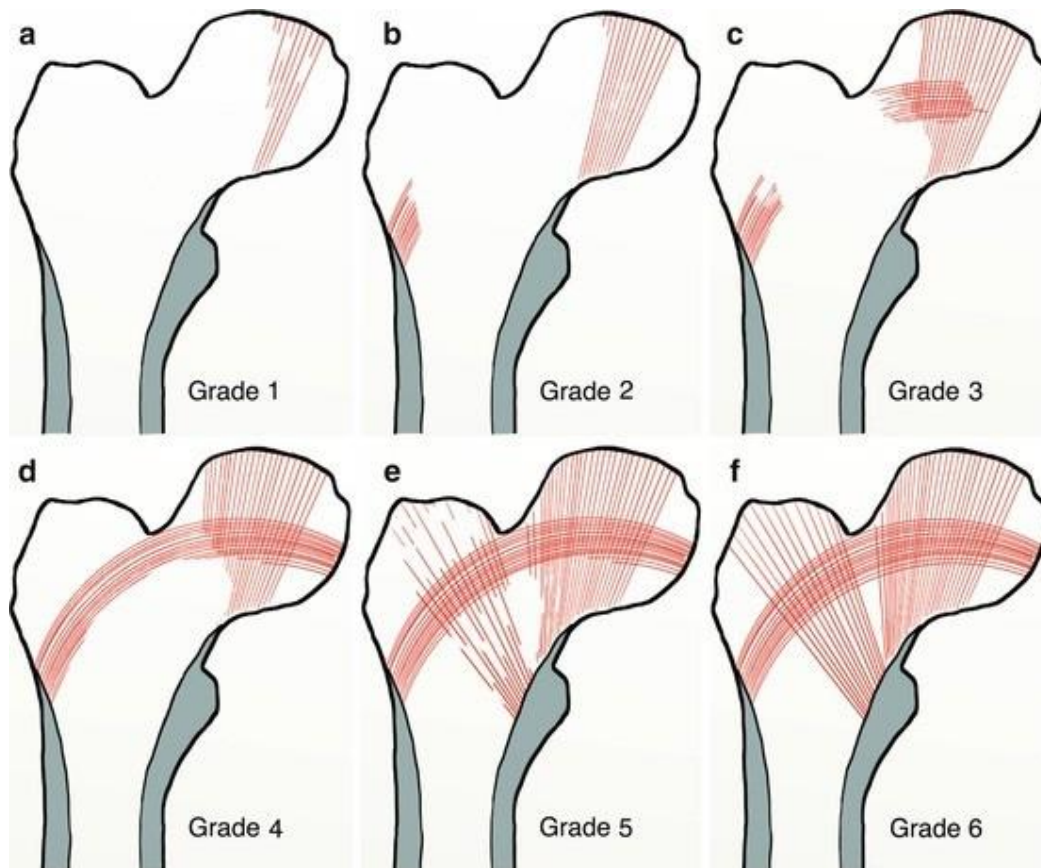
Some trabecular types present in the proximal part of the femur:

- Principal compression
- Secondary compression
- Primary tensile
- Secondary tensile
- Inter-trochanteric

As osteoporosis develops these trabeculae get thinner and eventually vanish.

- Grade 1: Only the principal compression trabeculae visible.
- Grade 2: Principal Compression trabeculae present, other trabeculae nearly resorbed
- Grade 3: Principal Tensile trabeculae thinned and break in continuity present.
- Grade 4: Principal Tensile trabeculae thinned without loss of continuity.
- Grade 5; Principal Tensile and Compression trabeculae readily visible with prominence of Wards triangle
- Grade 6: All trabeculae visible and of normal thickness.

Grade 3 and below indicates definite osteoporosis.



**Figure 4: Singh- index**

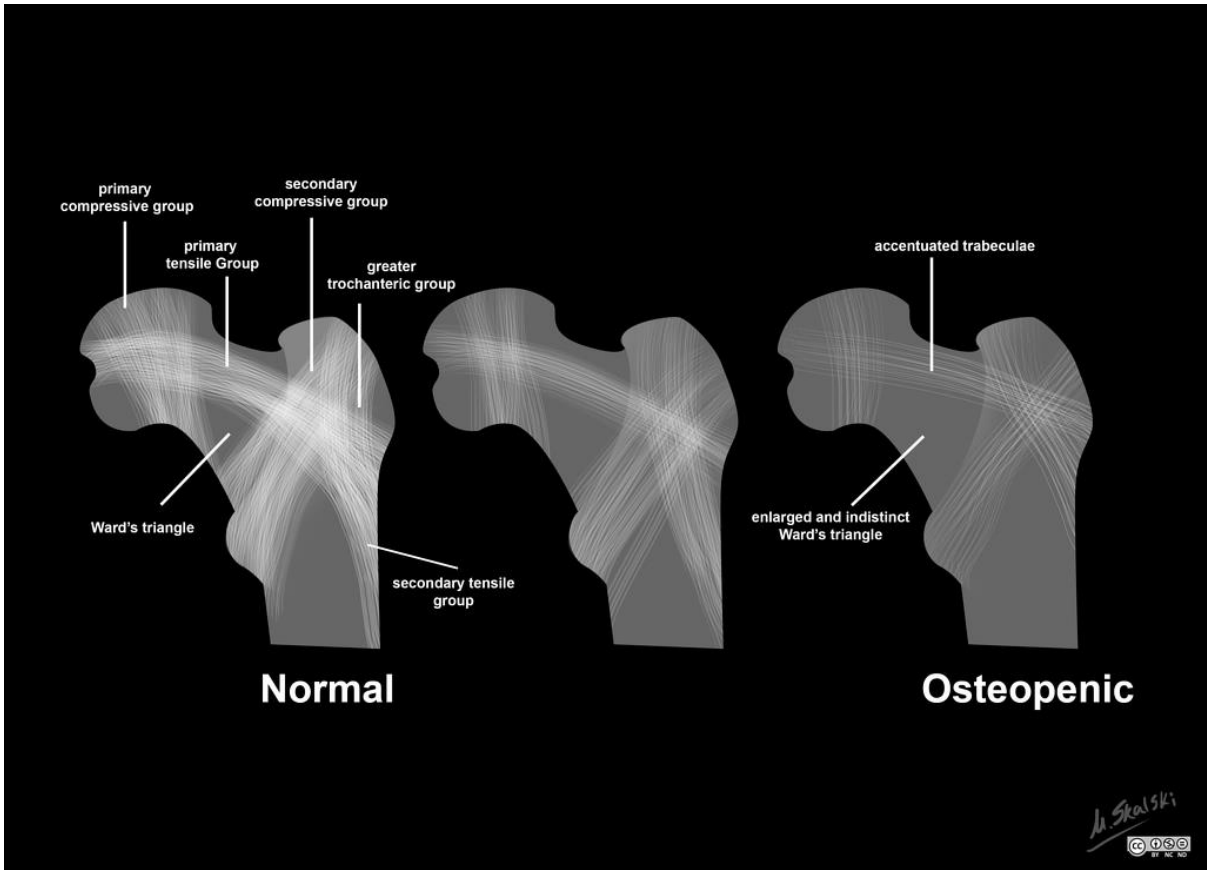


Figure 5: Trabecular pattern of proximal femur<sup>49</sup>

Screening recommendations

National Osteoporosis Foundation (NOF)	<p>The NOF recommends measurement of BMD (DXA of the hip and spine) in:</p> <ul style="list-style-type: none"> <li>▪ Women age 65 years and older and men age 70 years and older, regardless of clinical risk factors.</li> <li>▪ Younger postmenopausal women, women in the menopausal transition, and men age 50 to 69 years with clinical risk factors for fracture.</li> <li>▪ Adults who have a fracture after age 50 years.</li> <li>▪ Adults with a condition (eg, rheumatoid arthritis) or taking a medication (eg, glucocorticoids in a daily dose =5 mg prednisone or equivalent for =3 months) associated with low bone mass or bone loss.</li> </ul>
National Institutes of Health (NIH)	<p>The NIH recommends:</p> <ul style="list-style-type: none"> <li>▪ BMD measurements for individuals at high risk for osteoporosis. They do not recommend universal screening.</li> </ul>
UK National Osteoporosis Guideline Group (NOGG)	<p>The NOGG does not recommend population screening. They are in favor of performing BMD measurements using a case-finding strategy based upon age-specific fracture probability thresholds.</p>

Figure 6: Osteoporosis screening recommendations<sup>6</sup>

Various articles discussing the Vitamin D levels with bone mineral density

Study by Paul TV et al., (2008) to assess the occurrence of osteoporosis among the postmenopausal women. The frequency of osteoporosis in the lumbar spine is 48percent, 16.7percent in the femoral neck, and 50percentoverall. The average dietary calcium consumption was well below the usual level for above age group. BMI and BMD at lumbar spine and femur neck had a significant positive correlation ( $r = 0.4$ ;  $P = .0001$ ). Femoral neck bone density was substantially decreased in vitamin D inadequate research individuals compared with vitamin D adequate women ( $P = .03$ ). This semi urban people of postmenopausal females in India have increased prevalence of osteoporosis and vitamin D inadequate, which was serious health issue. Measures like proper calcium and vitamin D supplements may be advantageous in female of above age range.<sup>51</sup>

In a study by Jahnsen J et al., (2009) to correlate the vitamin D status, PTH and bone mineral density among the patients. Vitamin D inadequacy (25-hydroxyvitamin D3 30 nmol/l) seen in 27percent of Chrons Disease patients, 15percent of Ulcerative Colitis patients. Further, compared to UC patients, CD patients showed considerably decreased mean concentration of 25-hydroxyvitamin D3. Vitamin D level had no effect on Bone density at any of locations studied. Secondary hyperparathyroidism discovered in 10 out of 27 CD patient following small-bowel surgeries. There were no variations in Serum Osteocalcin or Urine Pyridinoline levels among CD and UC patients. Conclusions: In Chrons patient, hypovitaminosis D is frequent. Patients who have had CD or small-bowel resections are more likely to develop secondary hyperparathyroidism and poor BMD.<sup>52</sup>

Study done by Bandeira F et al., (2010) to assess the vitamin D deficiency with its effect on the bone density in postmenopausal women's. Age substantially increased the frequency of vitamin D insufficiency at 62.5nmol/L criterion. Patients with hypovitaminosis D were postmenopausal for longer period of time and had a decreased density of bone at the Femoral Neck. According to a study, postmenopausal women had a significant frequency of

hypovitaminosis D. Deficiency was linked to old age, years after menopause, and poor BMD in the Femur Neck.<sup>53</sup>

Study by Marwaha RK et al., (2011) to correlate vitamin D status among the good physical condition of Indian residents aged more than 50 years. Out of 643 male and 703 female, with an average age of 58.0 ± 9.5 years (ranging 50-84 years). Vitamin D deficiency [VDD, serum 25(OH)D levels less than 20 ng/ml] found in 1228 (91.2 percent), whereas Vitamin D insufficiency [VDI, serum 25(OH)D levels 20-30 ng/ml] was evident in 92 (6.8 percent). There was no statistically significant correlation in the prevalence of VDD or VDI among age groups or genders. Parathormone levels ( $r = -0.027$ ,  $p < 0.001$ ) and BMI were adversely linked with serum 25(OH)D levels ( $r = -0.027$ ,  $p < 0.001$ ). ( $r = -0.128$ ,  $p < 0.05$ ). Secondary hyperparathyroidism rose from 14.1 percent to 43.1 percent as VDI progressed to VDD. PTH began to rise when vitamin D levels reached 30 ng/ml. However, PTH levels were within the normal range in more than half of the individuals with severe VDD. Osteopenia is quite common (50.2 percent) and this group also had osteoporosis (31.2 percent). In north India, hypovitaminosis D is common beyond the age of 50. The absence of a PTH response was seen in more than 50 percent of VDD patients, the cause of which warrants additional investigation. Only 18.6 percent of research participants had normal bone mass.<sup>54</sup>

Study by Kadam NS et al., (2011) to assess the modifiable elements associated with less bone mineral content among the pre-menarchal Indian females. In comparison to Indian reference data, 15.6 percent of females having TBBMC for age Z-score less than -2, while 37.5 percent with Z-scores between -2 and -1. TBBMC Z-scores for total body bone area were less than -2 in one-fifth of the females, indicating demineralized bones. Study cohort had a less mean rate of rise in TBBMC with age and Tanner stage (11.6 percent and 20.7 percent) than the reference data (14.2 percent and 33.4 percent respectively). TBBMC were negatively influenced by less weight, 25OH-D, and protein, calcium, and zinc consumption ( $p < 0.05$ ). Many

disadvantaged pre-menarchal girls are at danger of developing poor skeletal mass. Steps to enhance underweight, 25OH-D, protein, calcium, and zinc diets may increase skeletal health.

55

Cross-sectional study by Agrawal T et al., (2013) to assess the osteoporosis among the women. Osteoporosis and osteopenia were found to be prevalent in 13.3percent 5.29percent and 48.1percent 7.79percent of the population, respectively. The statistical correlation between osteopenia and osteoporosis prevalence was shown to be notable with age group, gravida status, menopause status, weight, and physical status of the women. The statistical link is not significant correlation to their husband's occupation or eating pattern, but still, to be verified by undertaking bigger community trials in future. This study discovered a statistically significant link between age and frequency of osteopenia and osteoporosis. There was a negative correlation between age and BMD. Aside from age, gravida status and menopausal status had a false link with BMD whereas physically active lifestyle has a good correlation. These findings were non-significant in correlation to husband's rank level and food habits.<sup>56</sup>

In a study by Labronici PJ et al., (2013) to assess the relation of vitamin D level with Bone Mineral density among post-menopausal women. Between age groups, there was no obvious variation in vitamin D (ng/mL) levels. ( $p = 0.25$ ), fracture levels ( $p = 0.79$ ), or BMD levels ( $p = 0.76$ ). 82percent of the individuals had inadequate or insufficient vitamin D levels in their blood. After controlling for age, our findings revealed a substantial relationship among vitamin D levels and bone mineral density.<sup>57</sup>

In a study by Narula R et al., (2013) to assess vitamin D deficiency among women in menopause. Sr.vitamin D inadequacy discovered in two-thirds of the individuals. Body mass index and Bone mineral Density at the LS spine were shown to have a significant connection.

Monitoring and detecting hypovitaminosis D in postmenopausal women early is crucial to decrease the condition's prevalence.<sup>58</sup>

In a study by Shetty Shantaram et al., (2014) In order to investigate osteoporosis in healthy South Indian males and the impact of lifestyle factors on vitamin D level and bone mineral density, A total of 252 males with average age of 58, were included. At each given location, the prevalence of osteoporosis and osteopenia was 20percent (50/252) and 58percent, respectively. 53percent had vitamin D insufficiency (less than 20 ng/dL). Multiple logistic regression analyses revealed that BMI (OR 0.3; p-value = 0.04) and physical activity (OR 0.4; p-value 0.001) had a protective effect on BMD Twenty-five percent need medical attention. South Indian males had a disproportionately high rate of bone turnover and vitamin D insufficiency. Further research is required to investigate reductions in fractures in these people.

59

Cross-sectional study by Bachhel R et al., (2015) in order to evaluate the occurrence of vitamin D insufficiency in north western Punjab. The research participants had a high overall frequency of vitamin D deficiency (90percent). Between individuals with various occupations as well as between rural and urban subjects, there were significant differences in the distribution of vitamin D deficiency ( $P < 0.001$  and  $P < 0.05$ , respectively). A substantial gender difference was also observed at the 25 (OH) D cut-off level, with women having a greater frequency of deficiency than males ( $P < 0.05$ ). The Punjabi population suffers from a high frequency of vitamin D deficiency. Subjects with farmers and rural people had less prevalence<sup>60</sup>

In a cross-sectional retrospective study by Kaushal N et al., (2018) to analyse the prevalence of osteoporosis and osteopenia among the apparently healthy population. 524 participants (aged  $50.0 \pm 12.4$  years) were studied, with 41.2percent being female and 58.8percent being male. Osteoporosis was found in 6.9percent of the participants (11.1percent of the females and

4.2percentof the males) and osteopenia in 34percentof the subjects (40.3percentof the females and 29.9percentOf the males). Male patients had greater absolute BMD ( $P < 0.001$ ) than female subjects at all bone locations. In female patients, the prevalence of osteoporosis rise with age, not in males. Female individuals had osteoporosis rates of 3percent, 3.4percent, 14.3percent, 18.6percent, and 36.4percent at the lumbar spine in age ranges Of 30-39, 40-49, 50-59, 60-69, and 70 years, respectively, whereas male respondents had rates of 0percent, 4percent, 6.5percent, 4.3percent, and 5.6percent. Height ( $r = 0.234-0.358$ ), weight ( $r = 0.305-0.388$ ), BMI ( $r = 0.143-0.285$ ), and physical activity ( $r = 0.136-0.153$ ) were all positively related and alkaline phosphatase ( $r = 0.133$  to  $0.203$ ) were all inversely linked with BMD (all  $P < 0.01$ ). These indicators remained substantial relationships after adjusting for age and sex. At either site, there was no association between blood 25-hydroxyvitamin-D and calcium and BMD ( $P > 0.05$ ). This article includes further statistics on absolute BMD, T scores, and osteoporosis/osteopenia prevalence rates across numerous bone locations.<sup>61</sup>

In a study by Kadam NS et al., (2018) to assess the frequency of osteoporosis in apparently healthy adults in Pune city of India. The average age of the study population was  $53.3 \pm 8.4$  years. 44.3percentof the women in menopause, mean age at menopause Of  $49.2 \pm 3.5$  years. Postmenopausal women had a fast drop in BMD until the age Of 50, but men had a steady decline. In the women in menopause, it was not decreased positively with age ( $P > 0.1$ ). Males having positively lower T-scores at LS than premenopausal women ( $P < 0.05$ ). T-scores at the left femur was decreased in men than in premenopausal women ( $P < 0.05$ ),not in postmenopausal women ( $P > 0.1$ ). At LS, post-menopausal women were having more incidence than males but a greater frequency than premenopausal women. A low T-score in Indian males compared to females suggests an increased risk of osteoporosis. Menopause causes a fast reduction in BMD in females. As a result, both Indian men and postmenopausal women require proper osteoporosis prevention methods in their later years.<sup>62</sup>

A study done by Suryanarayana P et al., (2018) to evaluate the prevalence of vitamin D inadequacy and associated elements among elderly population of Hyderabad. The mean  $\pm$ SE plasma vitamin D level and VDD prevalence among the urban seniors were  $19.3 \pm 0.54$  (ng/ml) and 56.3percent, respectively. VDD was linked with health education, a high BMI, hypertension (HTN), and Diabetes. Multiple logistic regression analysis found that hypertension was a strong predictor of vitamin D deficiency, and the risk of VDD was two times higher in elderly patients with hypertension. It was found that VDD was significant in the urban elderly individuals in Hyderabad, India. High BMI, DM, HTN, are all important risk factors for VDD. <sup>63</sup>

In study by Binu AJ et al., (2019) to assess the bone density after 50 years in an ambulatory woman from rural south India. The mean standard deviation (SD) for this population's age was 60.7 (7.2) years, and its BMI was 26.2 (4.8) kg/m<sup>2</sup>. Osteoporosis was prevalent in 22percent of the Femur Neck and 39percent of the Lumbar Spine. At both locations, successive age groups showed a rise in the prevalence of osteoporosis. DCI was 420 (282) mg/24 hr on average (SD). Six percent had severe VDD (10 ng /ml), 54percent had vitamin D insufficiency (20 ng/ml). This large group of South Indian rural postmenopausal women in good health developed osteoporosis in either site as they aged. More than half of them had VDD, and the majority had a poor DCI. <sup>64</sup>

In a study by Kaur S et al., (2020) to evaluate the frequency of vitamin D deficiency among the urban elder population of Jammu. From January 2019 to December 2019, total of 150 elderly individuals, in which 70 men and 80 women over the age of sixty, had their vitamin D (25OH-D) status assessed. Out of this group, 28 (18.6percent) were having Vitamin D levels ranging 20 and 30 ng/ml, and 101 (67.3percent) had levels below 20 ng/ml. Of the elderly, only 21 (14percent) having readings more than 30 ng/ml. The older urban population of Jammu has

a very high rate of vitamin D insufficiency, which calls for intervention through public education, dietary fortification, proper sun exposure, and increased elderly mobility.<sup>65</sup>

In a study by Ismail TS et al., (2020) to assess the correlation of vitamin D with the BMD by DEXA scan among adult population. 93 subjects (73.8percent) had adequate T-score of  $\geq -1$ , 33 individuals (26.2percent) presented with osteopenia (T-score  $-2.5$  to  $-1$ ) and none were having osteoporosis (T-score  $\leq -2.5$ ). Important positive association among serum 25(OH)D and Hip BMD ( $r = 0.234$ ,  $p = 0.009$ ) was pointed out, but no association was found between serum 25(OH)D and lumbar BMD. Otherwise, significant negative correlation between serum 25(OH)D and iPTH was pointed out ( $r = -0.324$ ,  $p < 0.001$ ). The healthy Malay individuals were showing highest rate of VDD, yet almost everyone were having acceptable bone strength. Despite this, Sr.25(OH)D were shown to be favourably linked with BMD and negatively correlated with iPTH. Data emphasize the role of vitamin D for one's nutrition.<sup>66</sup>

In a study by Gupta R et al., (2021) to assess the prevalence of vitamin D deficiency in north Indian athlete population. 258 (69.9percent) athletes were inadequate in Vitamin D, 51/369 (13.8percent) athletes were deficient in Vitamin D, and 60/369 (16.3percent) sport persons were sufficient in Vitamin D. Reduced blood Vitamin D levels were shown to be directly related to low BMD ( $r = 0.473$ ;  $P 0.05$ ). Overall, 114/369 (30percent) athletes showed low BMD, with 108 (95percent) of these 114 athletes lacking in Vitamin D. Vitamin D ( $r=-0.629$ ) and BMD ( $r=-0.267$ ) were shown to have negative relationship with Sr.PTH levels. Vitamin D insufficiency is common in North Indian sportsmen, and less Vitamin D (20 ng/ml) levels are correlation with low BMD and increased PTH levels.<sup>67</sup>

In an epidemiological study by Aggarwal A et al., (2021) to assess the bone density in adult healthy individuals in Chandigarh, India. According to BMD manufacturer statistics among the western people, 70percent of Indian subcontinent men's ( $> 50$  years) and 48percent of

postmenopausal Indian women had osteopenia, whereas 18 percent of men and 25 percent of women had osteoporosis. However, according to the present study's recalculated T-scores, only 56 percent of men and 7.2 percent of females presented osteopenia and osteoporosis, respectively. Parallel to the Western population, Indian men and women saw an age-related decline in bone mass. A reference database for BMD in a healthy Indian age group being established by the study, and which may have therapeutic implications for the screening and treatment of osteoporosis.<sup>68</sup>

## MATERIAL & METHOD

**Source of data:** Patients in the age group of 45years and above both male and female sex who were complaining of pain over lower back and hip pain who came to outpatient/in patient department of KLE Prabhakar Kore Hospital Belagavi.

**Study Design:** Observational study conducted at a hospital

**Study Period:** The study was conducted from January 1st 2021 to December 31st 2021

### Sample Size-

The prevalence rate-based calculation for the minimal sample size is

$$n = \frac{z_{\alpha}^2 P(1-P)}{d^2}$$

Where P is the percentage of prevalence and d is the percentage likely difference in the prevalence.  $z_{\alpha}$  is linked with the level of significance. For 5percent level of the significance  $z_{\alpha} = 1.96$ .

With P = 50.0percent and d = 25percent of P = 12.50percent, the sample size is 62.

**Sampling Method:** Universal Sampling

**Selection Criteria:**

**Inclusion Criteria:**

1. Patients in age group greater than 45
2. Patients who are willing for consent

**Exclusion Criteria:**

- 1) Patients suffering from significant liver diseases, deranged renal functions
- 2) H/o of any malignancies,
- 3) Patients who were using steroid therapy, anticonvulsants, anticoagulants
- 4) Patients age group greater than 80
- 5) Patients who were not willing for consent

**Procedure:**

- One year hospital based observational study was done in men and women aged 45 and above who were outpatient and inpatient in KLE hospital during a period of 1 year.
- After taking informed consent data was collected related to the risk factors Vitamin D levels were used and patient underwent DEXA scan for bone mineral density status.
- Following the WHO criteria, the T score was determined as osteoporosis and osteopenia were classified together with normal BMD.
- At three locations, including the lumbar spine, right hip, and left hip, BMD was calculated using DEXA.
- The DEXA aids in determining bone mineral density, which allows for the detection of individuals who may have osteoporosis and those who are at risk of getting it.
- Serum Vitamin D levels was estimated by using chemiluminescent assay and other biochemical parameters using spectrophotometric analysis.
- Exposure to sunlight: was considered adequate exposure of more than 2hr per day and inadequate if the sun exposure was less than 2hr per day.

## **DEXA scan evaluation technique**

An X-ray machine and a computer are used in a dual energy X-ray absorptiometry (DEXA) scan to assess bone density. Bone mineral density is the most crucial parameter for diagnosing osteoporosis. It enables for the precise, consistent, and accurate analysis of bone mineral density as well as the early detection of osteoporosis before fractures occur. The gold standard for calculating BMD is the DEXA Scan.

### **Procedure**

The treatment is quick and painless, lasting around 10 minutes. It entailed subjecting the body to a low amount of X-ray radiation. The patient was brought to the X-ray room and instructed to lie down on an X-ray table. The scanning equipment was operated by a radiographer.

The scan was performed at two locations: the lumbar spine and the hip joint. The patient's legs were flexed and put over a huge block for lumbar spine scanning. This was done to accomplish spine straightening. The patient was made to lie supine solely for the scanning of the hip joints. The scanning instrument was then passed over the patient's lumbar spine and hip joints, projecting an X-ray beam.

A detector measured how much radiation passes through the bones and sends the information to a computer. A printed report was then obtained stating the BMD, 'T' & 'Z' scores

### **Interpretation**

The Bone Mineral Density (BMD in g/cm<sup>2</sup>) and 'T' and 'Z' scores was determined. "Z" score compares the BMD result with individuals of the same age group size and gender, "T" score analyses the BMD outcome with that of a young adult with the same gender with a peak bone mass.

Following was the data analysis

- A normal BMD is one when T Score falls within one SD of the adult mean.
- T score for osteopenia is between -1.0 and 2.5.
- Osteoporosis: T score of 2.5 or below, with or without fragility fracture.

Using the BMD score as a base, data was gathered, documented, and a diagnosis was made.

Data on numerous risk variables that were gathered through the questionnaire and BMD data were correlated, and relationships were then deduced.

## **STATISTICAL ANALYSIS**

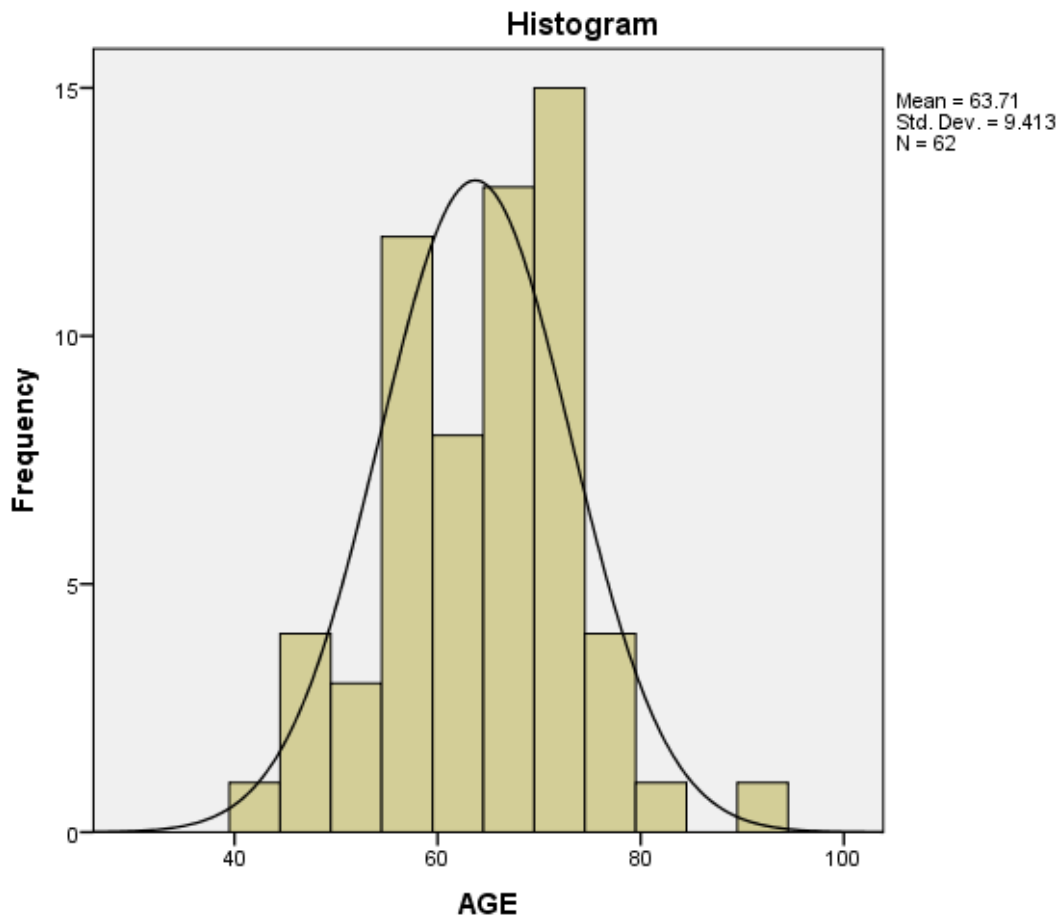
For the continuous quantitative variables mean and standard deviation was calculated. For the purpose of comparison if the data is divided into two groups with respect to certain qualitative characteristic, the continuous variables was compared using suitable tools of statistics like student's unpaired t test. The pre- and post-treatment measures was compared using student's paired t test Discrete variables was represented by median. The categorical data were expressed in terms of rates, ratios and percentages. The association between the outcome, clinical and demographic characteristics was tested using Chi-square test, test of proportion or Fisher's exact test. For discrete variables nonparametric tests was used. Apart from the above suitable tools like ANOVA, correlation, regression etc., was used according to the need. Suitable graphs were used to depict the comparison. For all the tests the value of p less than 5percent (0.05) was considered significant and analysis was performed using SPSS v21 operating on windows 10.

## RESULTS

Following informed consent, 62 patients who met the inclusion criteria have been included to the study. The mean age of patients was found to be  $63.71 \pm 9.41$  yrs. Among them 58.1% were female patients and 41.9% male patients with slight female preponderance in the study.

**Table 3: Showing the mean age of the patients**

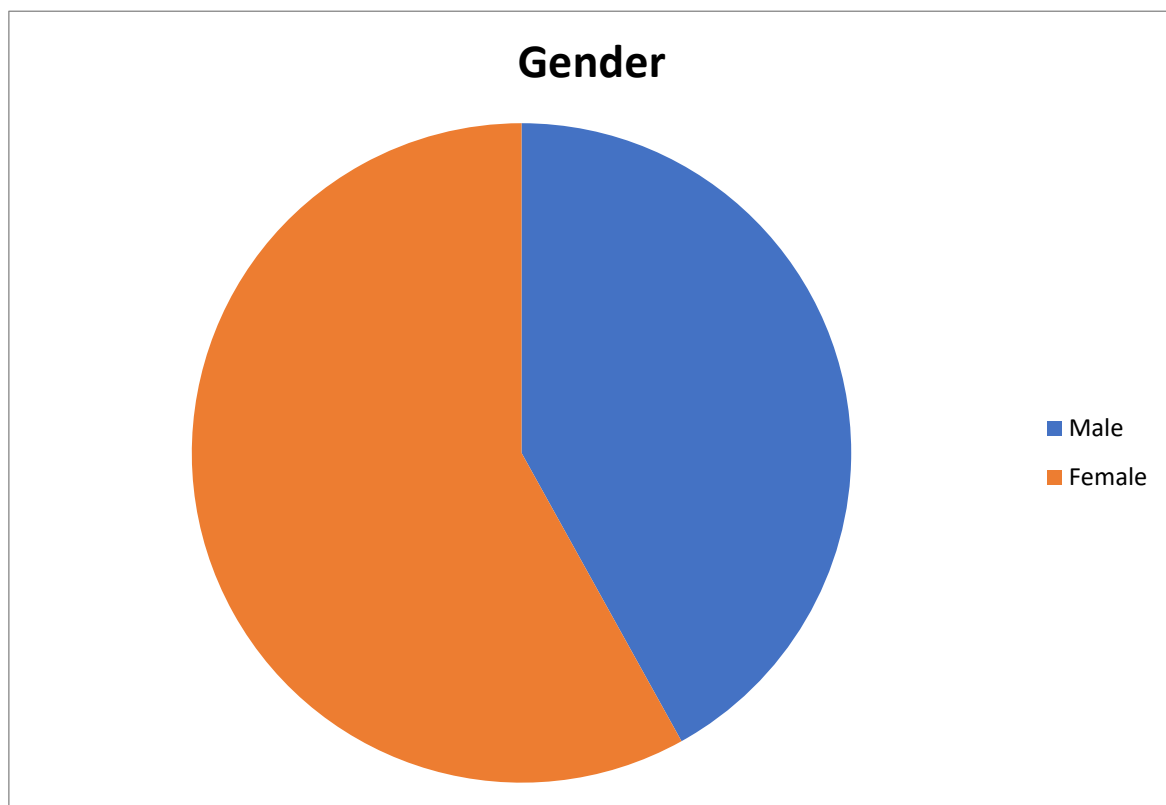
	N	Minimum	Maximum	Mean	SD
Age in year	62	45	90	63.71	9.413



**Figure 7 : Histogram showing the age distribution in the present study**

**Table 4: Showing the gender distribution among study participants**

		Frequency	Percent
Gender	Female	36	58.1
	Male	26	41.9
	Total	62	100.0

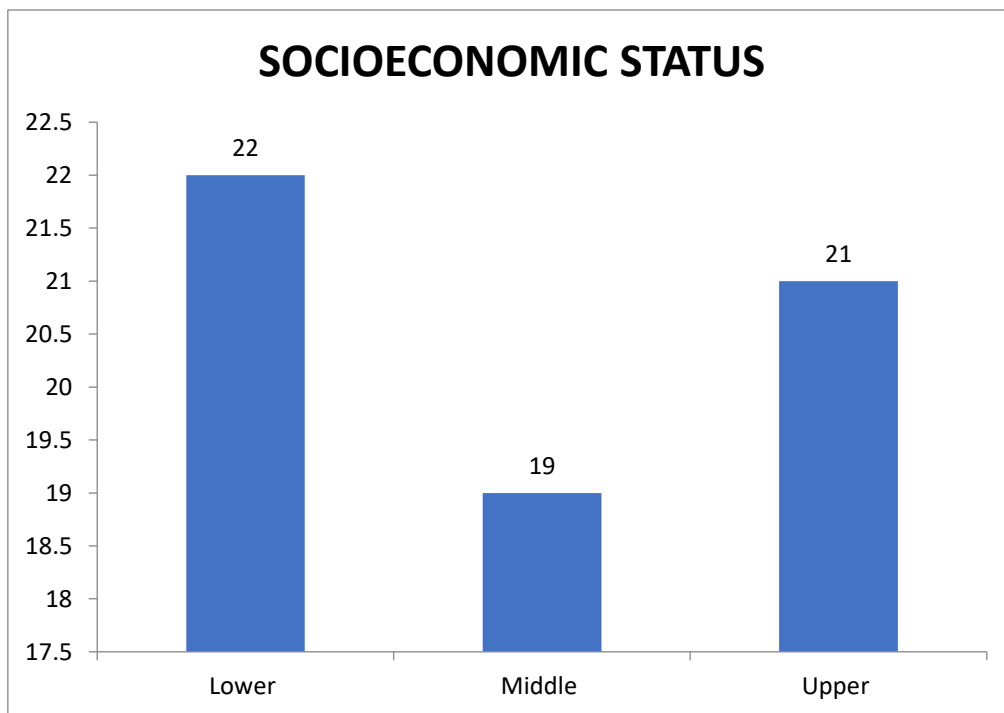


**Figure 8: Showing the gender distribution among study participants**

**Table 5: Showing socioeconomic status of the patients**

		Frequency	Percent
Socioeconomic Status	Lower	22	35.5
	Middle	19	30.6
	Upper	21	33.9
	Total	62	100.0

In present study, 35.5% belonged to lower SES, 33.9% in upper class and 30.6% in middle socioeconomic status.



**Figure 9 : Showing socioeconomic status of the patients**

**Table 6: Showing the distribution of occupational status of patients**

		Frequency	Percent
Occupation	Manual labour	19	30.6
	Others	8	12.9
	Sedentary	35	56.5
	Total	62	100.0

In the study, 56.5% of the patients were having sedentary lifestyle at occupation, 30.6% were labours.

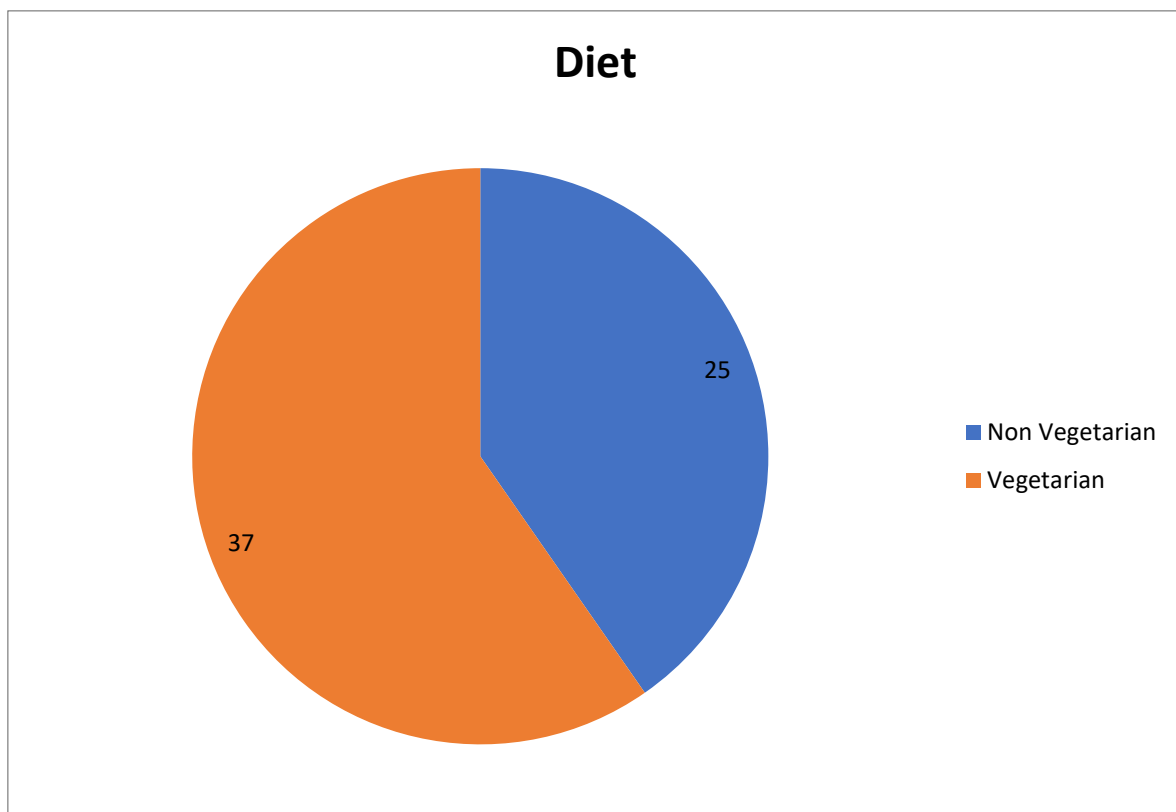


**Figure 10: Showing the distribution of occupational status of patients**

**Table 7: Showing the diet preference among study participants**

		Frequency	Percent
<b>Diet</b>	Non-Vegetarian	25	40.3
	Vegetarian	37	59.7
	Total	62	100.0

On assessment of diet, 59.7% were vegetarian and 40.3% were non-vegetarian.

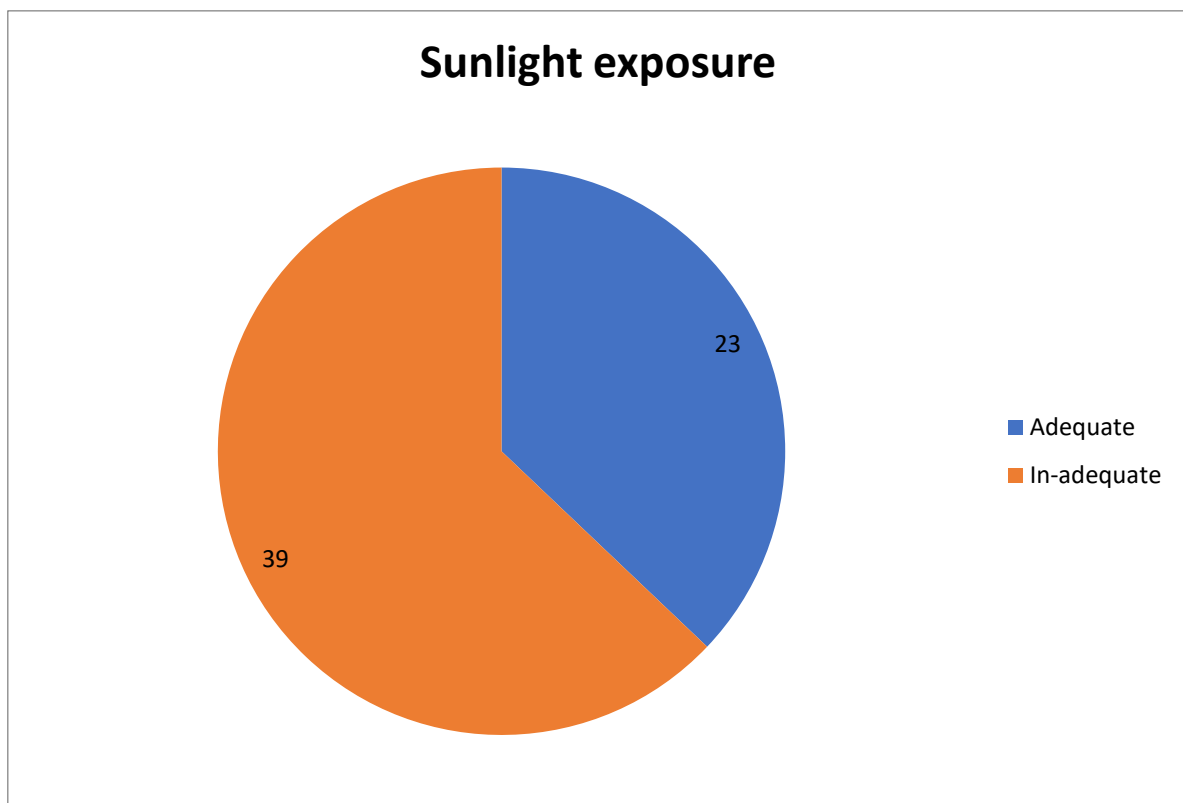


**Figure 11 Showing the diet preference among study participants**

**Table 8: Showing the adequate sunlight exposure among study participants**

		Frequency	Percent
<b>Sunlight</b>	Adequate	23	37.1
	In-adequate	39	62.9
	Total	62	100.0

On assessment of exposure to sunlight, 37.1% of the patients had the adequate and 62.9% with in-adequate exposure.

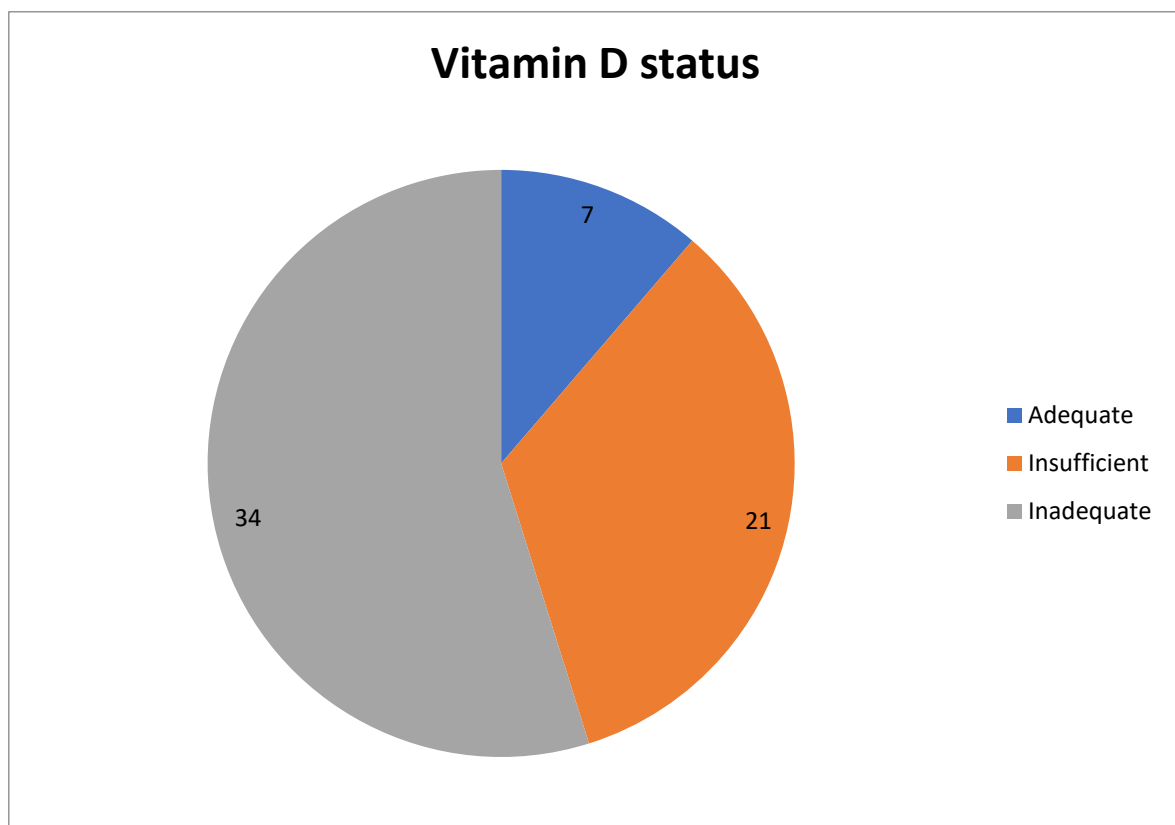


**Figure 12: Showing the adequate sunlight exposure among study participants**

**Table 9: Showing the presence of vitamin D deficiency among study participants**

		Frequency	Percent
<b>Vitamin D Status</b>	Adequate	7	11.3
	Insufficient	21	33.9
	Inadequate	34	54.8
	Total	62	100.0

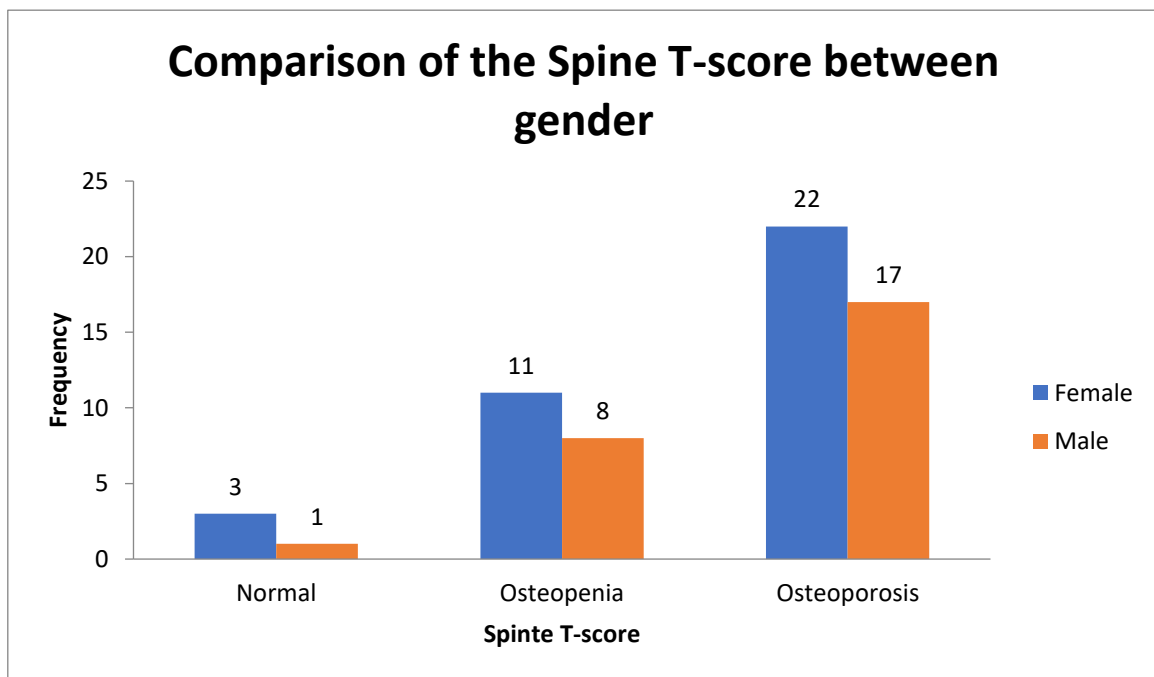
Once the vitamin D levels of the patients was analysed, 11.3% had adequate vitamin D, 33.9% had insufficient vitamin D, and 54.8% had inadequate vitamin D.



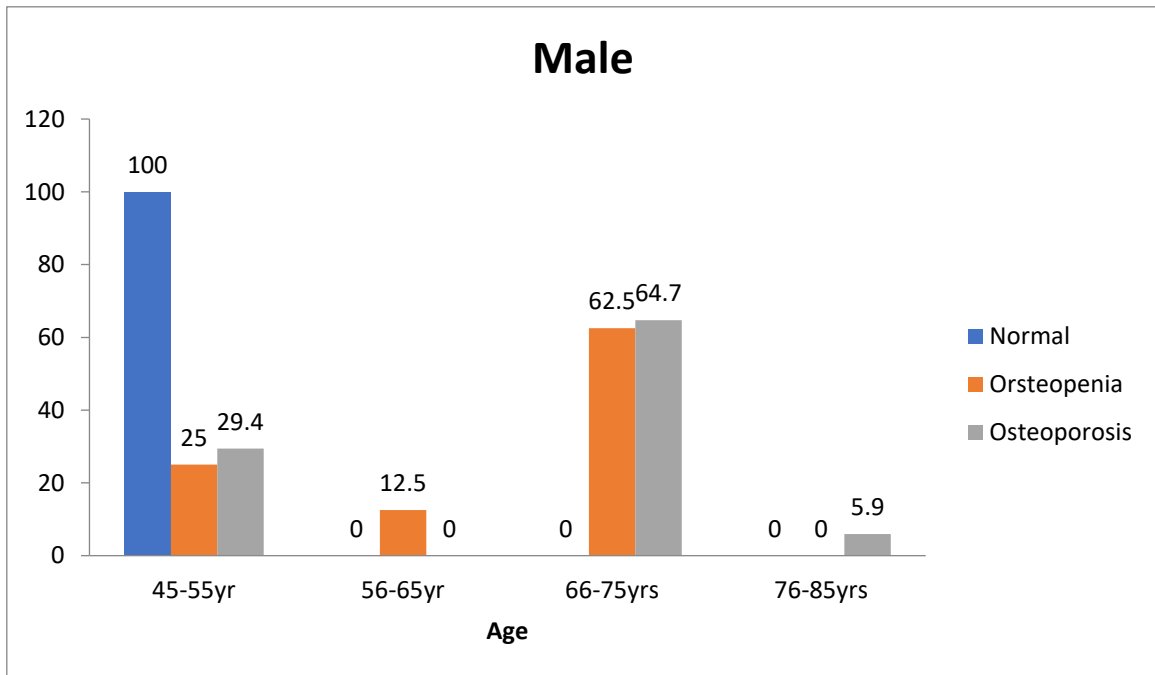
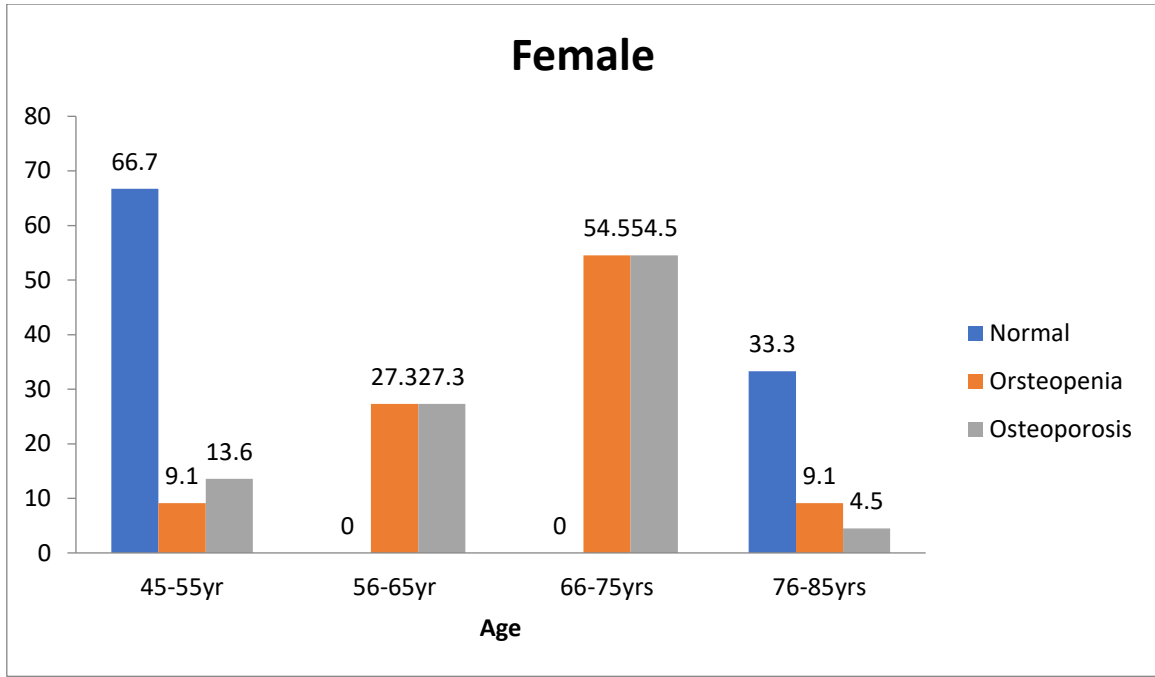
**Figure 13 : Showing the presence of vitamin D deficiency among study participants**

**Table 10: Comparison of the Spine T-score between gender**

		Female		Male		p-value
		N	N %	N	N %	
Spine T-score	Normal	3	8.3%	1	3.8%	0.773
	Osteopenia	11	30.6%	8	30.8%	
	Osteoporosis	22	61.1%	17	65.4%	







**Table 12: Comparison of the Spine T score and femur T score between gender**

		Male		Female		p-value
		Count	N %	Count	N %	
Spine T score	Normal	3	8.3%	1	3.8%	0.05*
	Osteopenia	11	30.6%	8	30.8%	
	Osteoporosis	22	61.1%	17	65.4%	
Femur T score	Normal	7	19.4%	2	7.7%	0.05*
	Osteopenia	12	33.3%	6	23.1%	
	Osteoporosis	17	47.2%	18	69.2%	

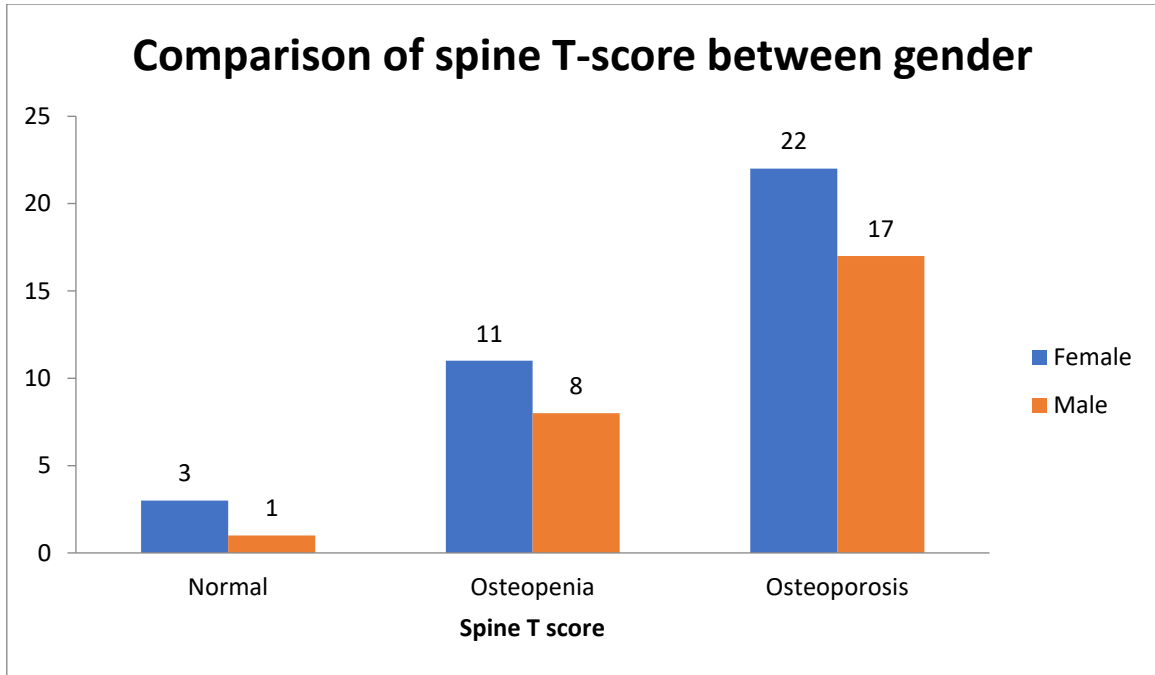


Figure 14 : Comparison of spine T-score between gender

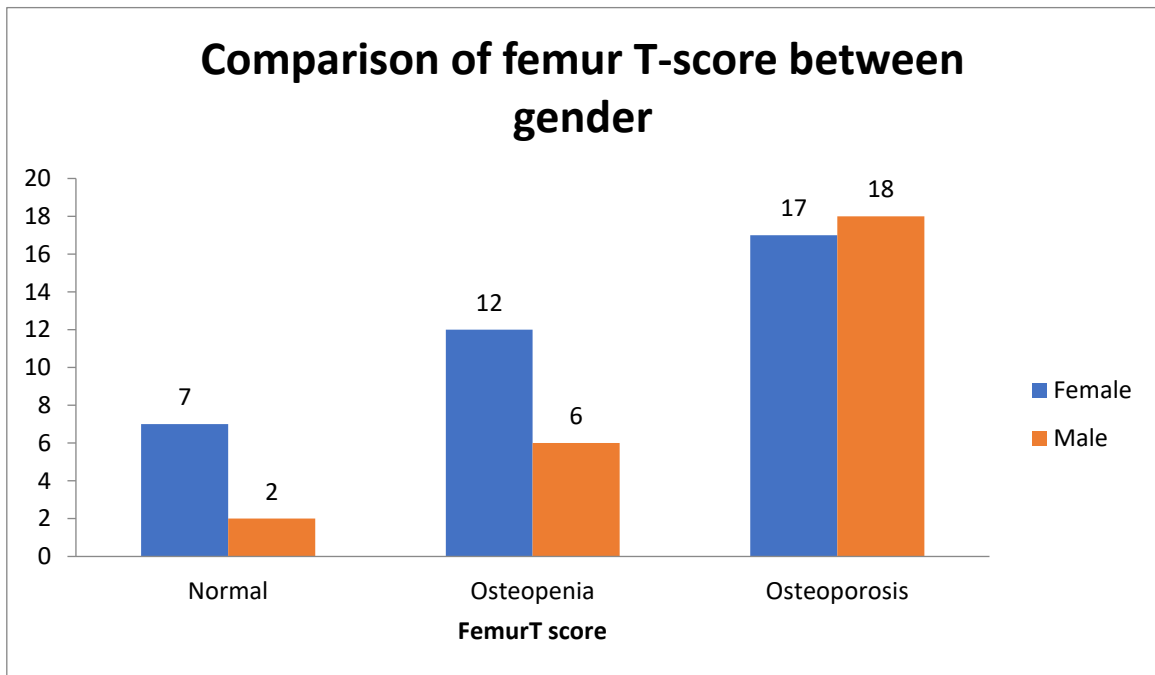
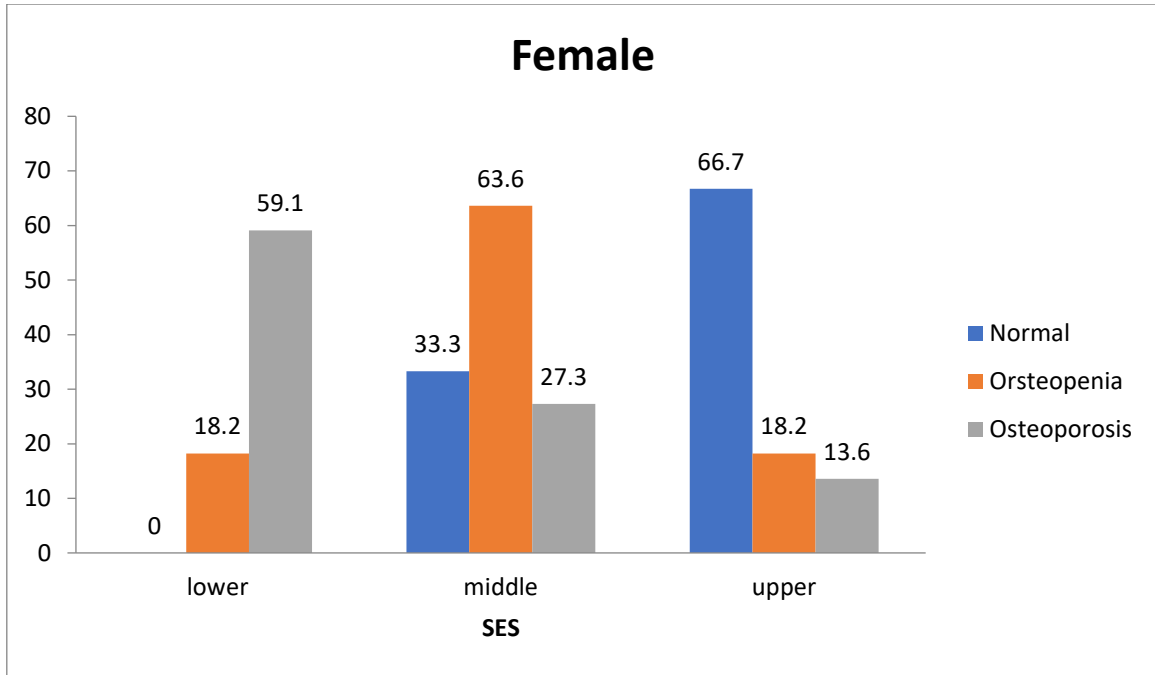


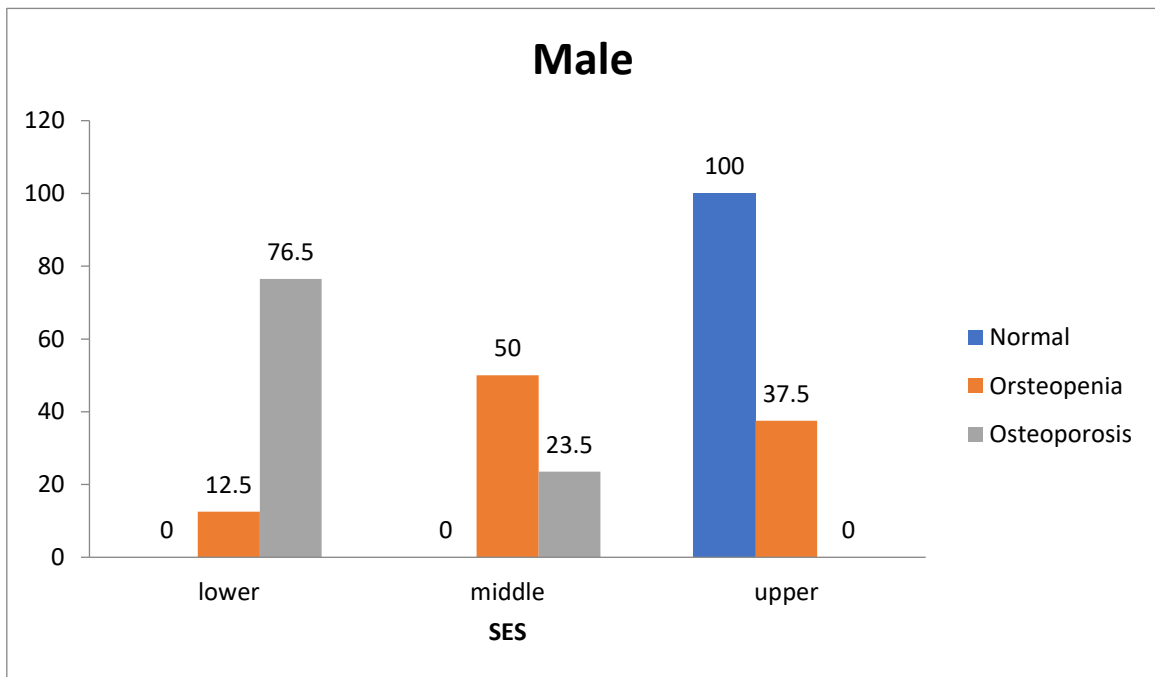
Figure 15 : Comparison of femur T-score between gender

**Table 13: Comparison of the socioeconomic status with the spine T-score result between gender**

		Spine T-score											
		Normal				Osteopenia				Osteoporosis			
		Female		Male		Female		Male		Female		Male	
		C ou nt	N %	C ou nt	N %	C ou nt	N %	C ou nt	N %	C ou nt	N %	C ou nt	N %
Socioe conomi c status	lo we r	0	0.0%	0	0.0%	2	18.2%	1	12.5%	13	59.1%	13	76.5%
	mi dd le	1	33.3%	0	0.0%	7	63.0%	4	50.0%	6	27.3%	4	23.5%
	up pe r	2	66.7%	1	10.0%	2	18.2%	3	37.5%	3	13.6%	0	0.0%



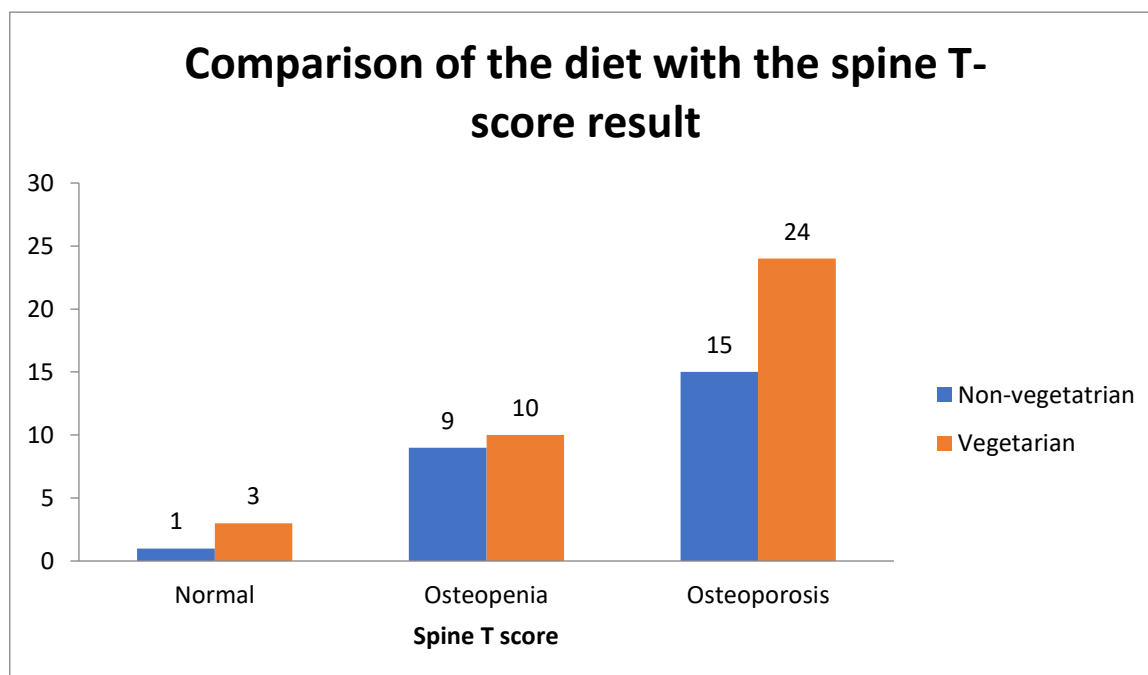
**Figure 16 : Comparison of the socioeconomic status with the spine T-score result among females**



**Figure 17 : Comparison of the socioeconomic status with the spine T-score result among males**

**Table 14: Comparison of the diet with the spine T-score result**

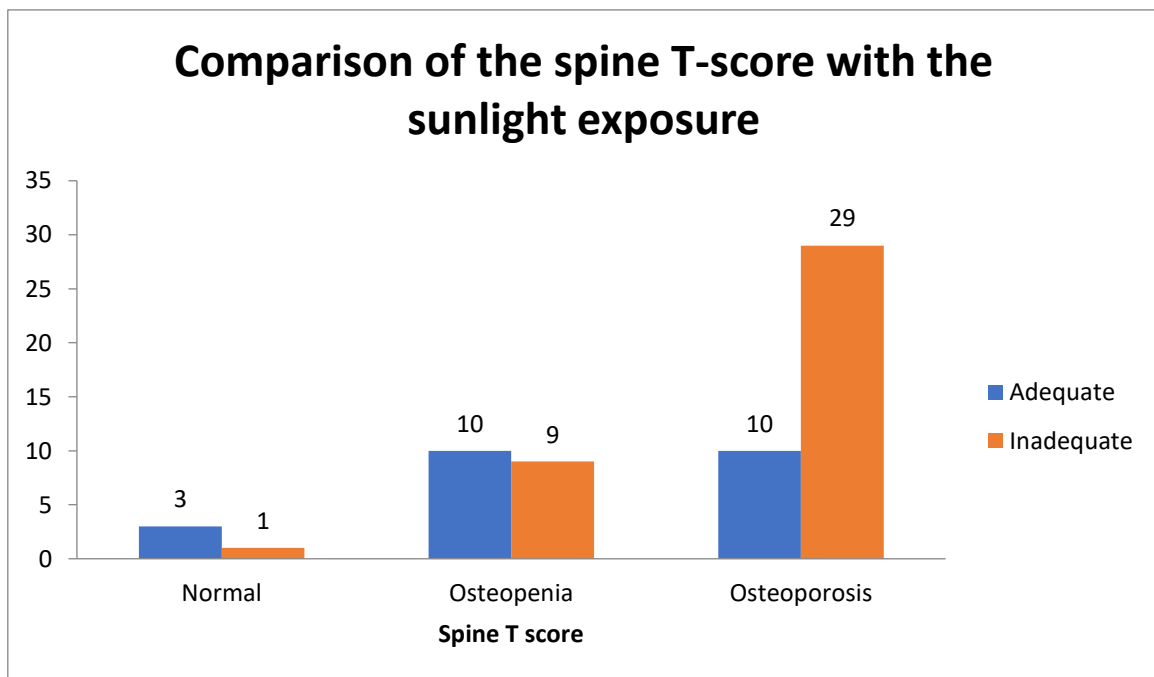
		DIET				p-value
		Non-Veg		Veg		
		Count	N %	Count	N %	
Spine T score	Normal	1	4.0%	3	8.1%	0.15
	Osteopenia	9	36.0%	10	27.0%	
	Osteoporosis	15	60.0%	24	64.9%	



**Figure 18 :Comparison of the diet with the spine T-score result**

**Table 15: Comparison of the spine T-score with the sunlight exposure.**

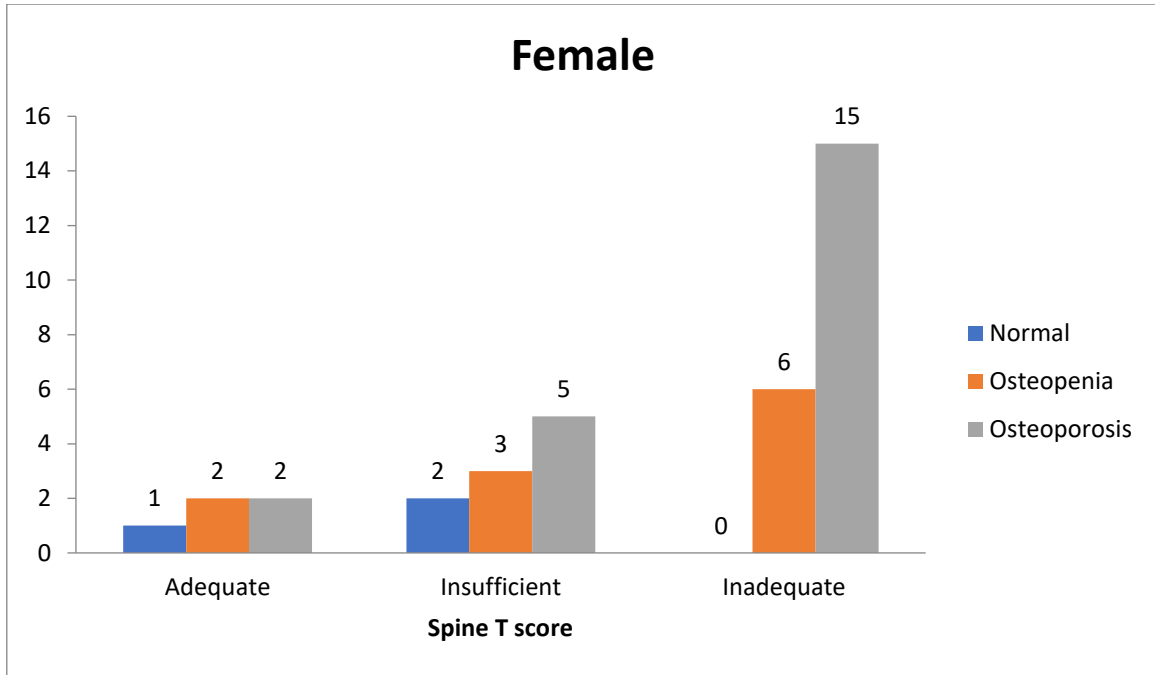
		Sunlight				p-value
		Adequate		Inadequate		
		Count	N %	Count	N %	
Spine T-score	Normal	3	13.0%	1	2.6%	0.03*
	Osteopenia	10	43.5%	9	23.1%	
	Osteoporosis	10	43.5%	29	74.4%	



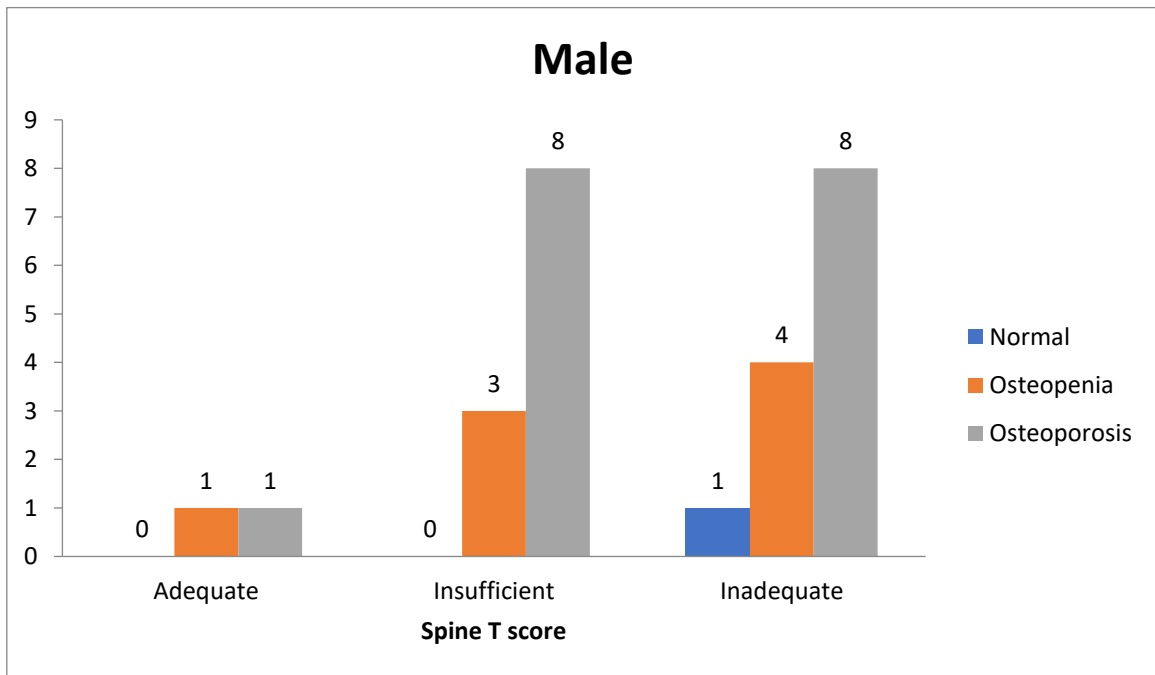
**Figure 19: Comparison of the spine T-score with the sunlight exposure**

**Table 16: Comparison of the spine T-score with vitamin D status between the gender**

			Spine T score						p-value
			Normal		Osteopenia		Osteoporosis		
			Cou nt	N %	Cou nt	N %	Cou nt	N %	
Vitam in D Status	Adequate	FEMALE	1	100.0 %	2	66.7 %	2	66.7 %	0.792
		MALE	0	0.0%	1	33.3 %	1	33.3 %	
	Insufficien t	FEMALE	2	100.0 %	3	50.0 %	5	38.5 %	0.266
		MALE	0	0.0%	3	50.0 %	8	61.5 %	
	Inadequate	FEMALE	0	0.0%	6	60.0 %	15	65.2 %	0.05*
		MALE	1	100.0 %	4	40.0 %	8	34.8 %	



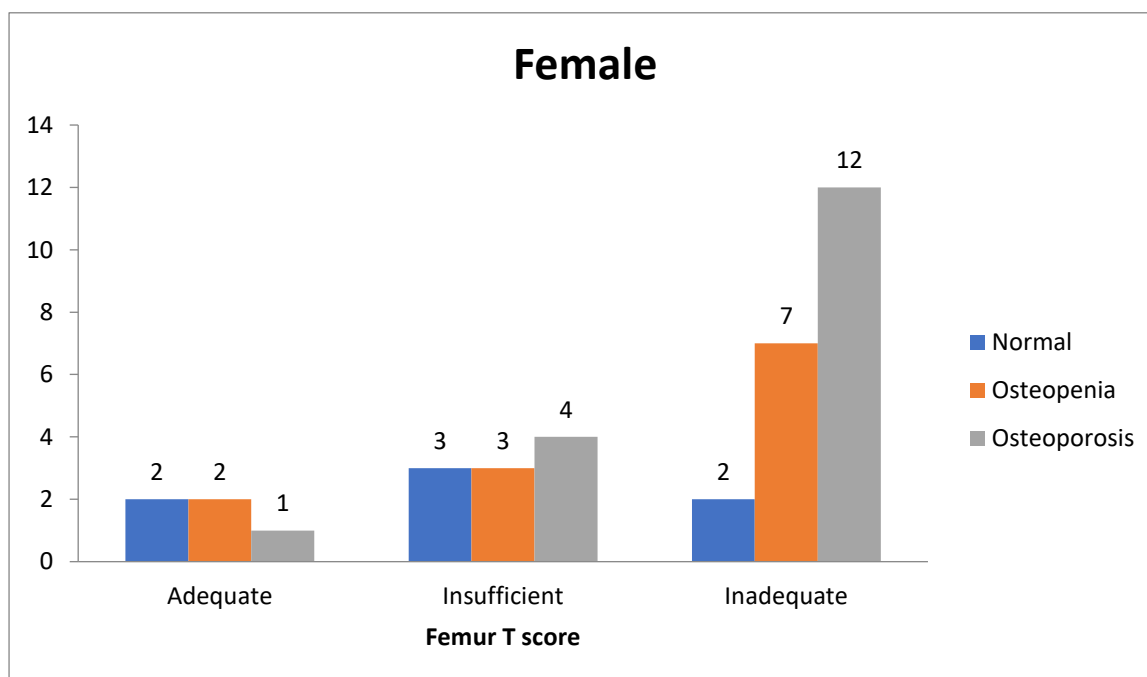
**Figure 20: Comparison of the spine T-score with vitamin D status among females**



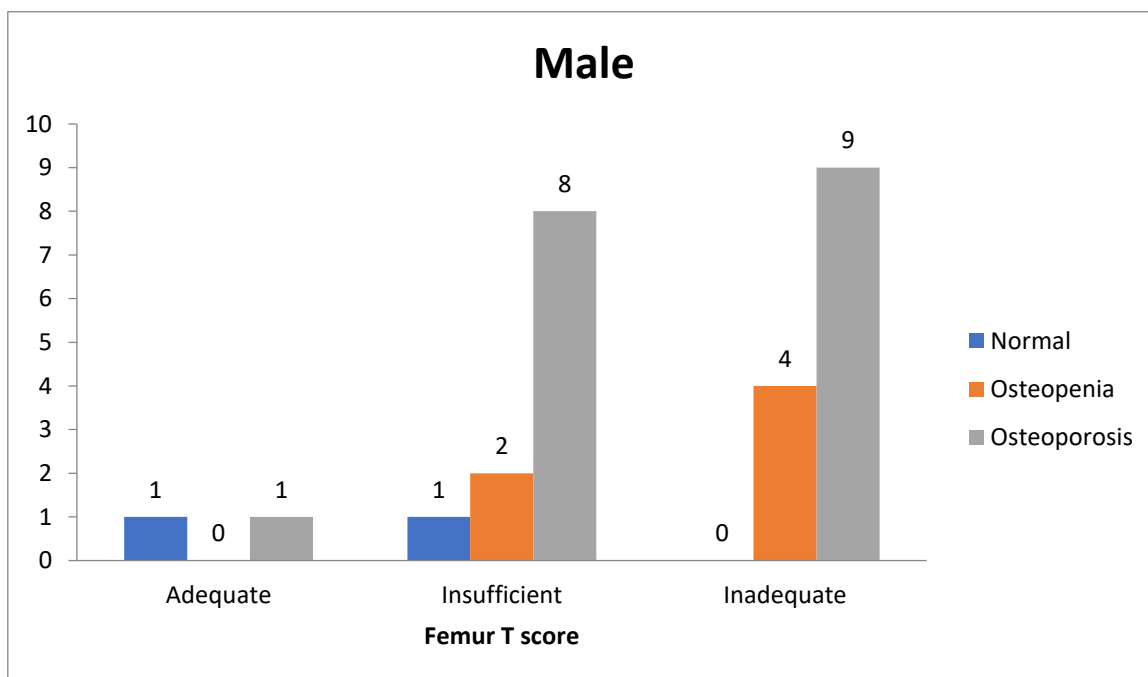
**Figure 21: Comparison of the spine T-score with vitamin D status among males**

**Table 17: Comparison of the femur T-score with vitamin D level between the genders**

			Femur T score						p-value
			Normal		Osteopenia		Osteoporosis		
			Count	N %	Count	N %	Count	N %	
Vitamin D Status	Adequate	Female	2	66.7%	2	100.0%	1	50.0%	0.526
		Male	1	33.3%	0	0.0%	1	50.0%	
	Insufficient	Female	3	75.0%	3	60.0%	4	33.3%	0.288
		Male	1	25.0%	2	40.0%	8	66.7%	
	Inadequate	Female	2	100.0%	7	63.6%	12	57.1%	0.05*
		Male	0	0.0%	4	36.4%	9	42.9%	



**Figure 22: Comparison of the femur T-score with vitamin D level among females**

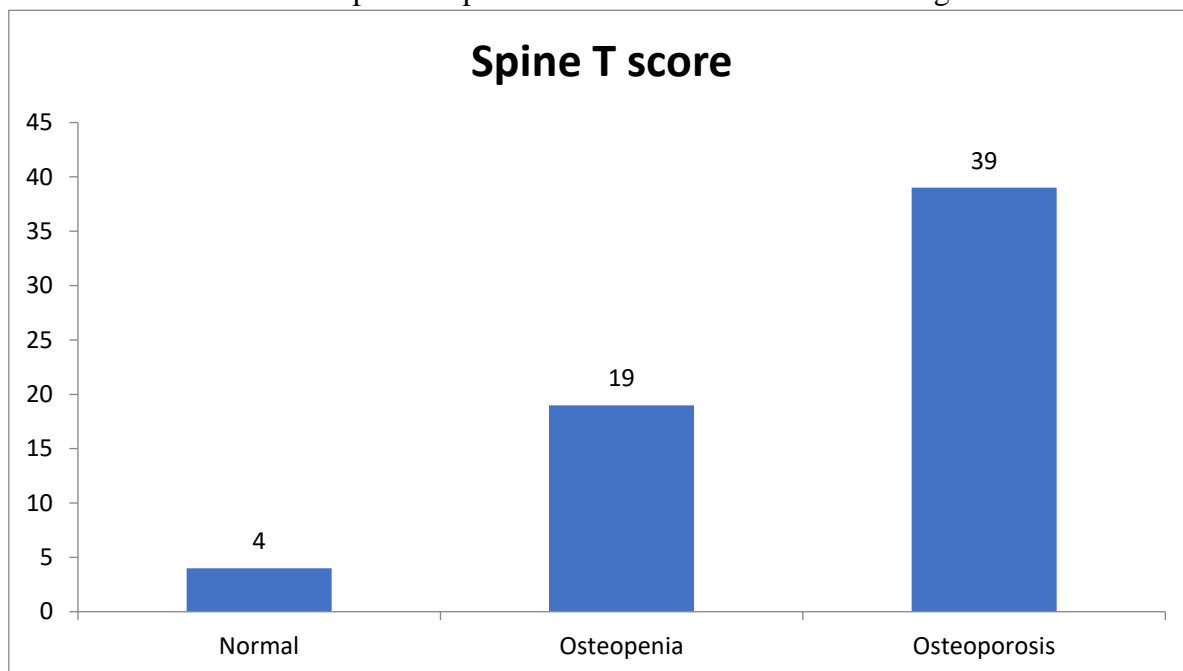


**Figure 23: Comparison of the femur T-score with vitamin D level among males**

**Table 18: Showing the presence of osteoporosis and Osteopenia among study participants with spine T score**

		Frequency	Percent
Spine T score	Normal	4	6.5
	Osteopenia	19	30.6
	Osteoporosis	39	62.9
	Total	62	100.0

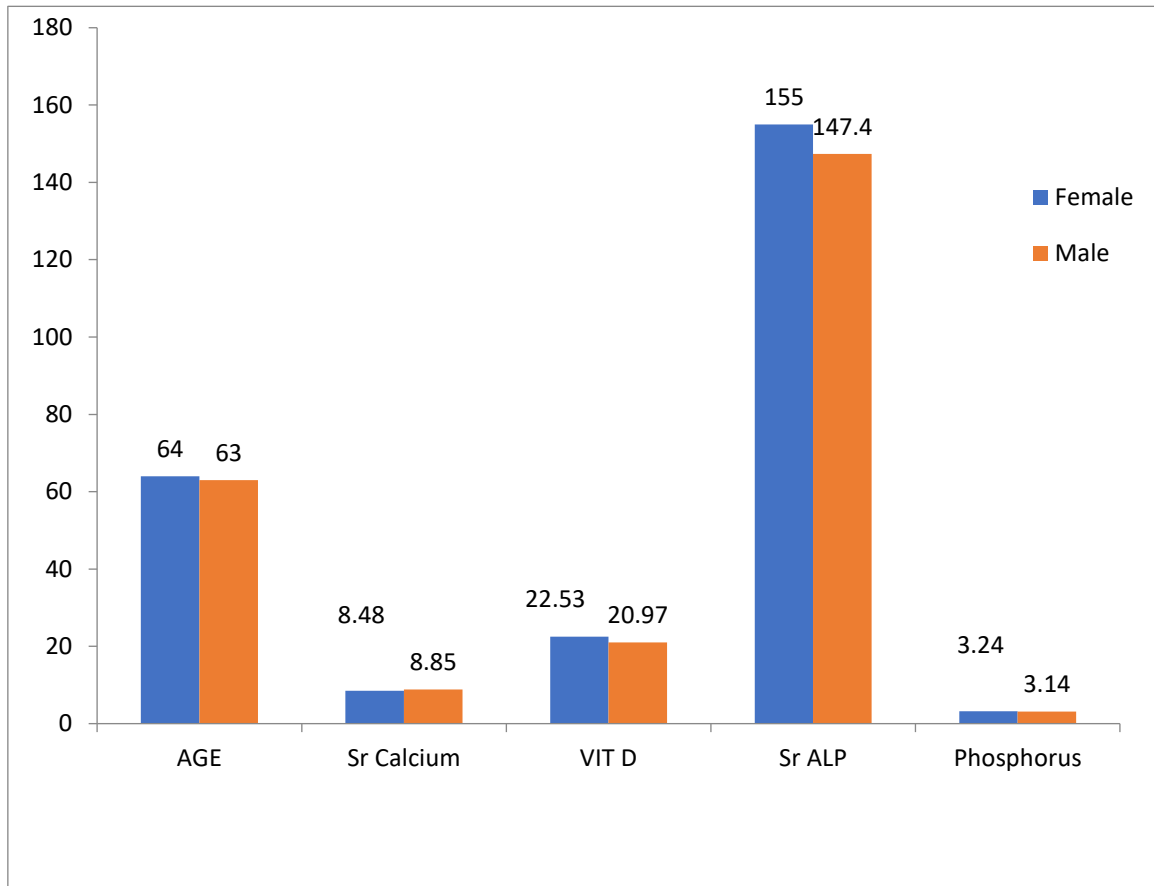
In present study, on assessment of spine T score, 62.9% had the osteoporosis and 30.6% had the Osteopenia in patients. 6.5% showed normal findings.



**Figure 24 : Showing the presence of osteoporosis and Osteopenia among study participants with spine T score**  
**Table19: Comparison of mean level of parameters between the gender**

	Female		Male		p-value
	Mean	SD	Mean	SD	
AGE	64	9	63	10	0.508
Sr Calcium	8.48	0.95	8.85	0.52	0.076
VIT D	22.53	8.40	20.97	6.03	0.302
Sr ALP	155	54.1	147.4	46.2	0.515
Phosphorus	3.24	0.95	3.14	0.89	0.674
*p-value <0.05 is considered statistically significant.					

The study observed no statistically significant variations in the mean age, serum calcium, vitamin D, serum ALP, or phosphorus between the sexes. ( $p > 0.05$ )



**Figure 25 : Comparison of mean level of parameters between the gender**

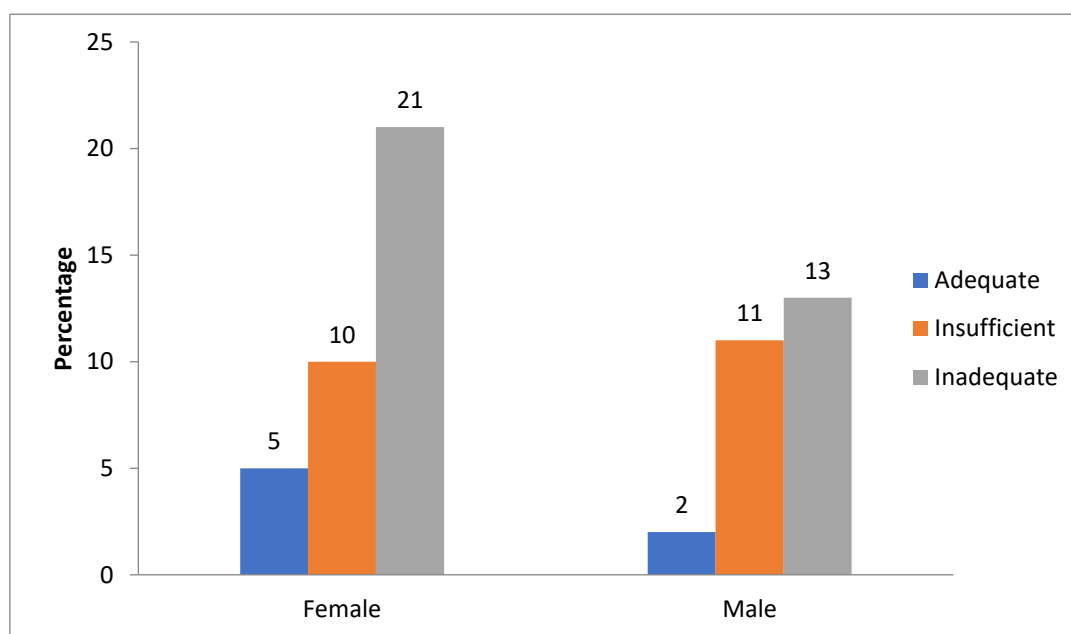
**Table 20: Showing the presence of vitamin D deficiency between gender**

		Female		Male		Chi-square
		Count	N %	Count	N %	
Vitamin D Status	Adequate	5	13.9	2	7.7	1.646 (0.415)
	Insufficient	10	27.8	11	42.3	

	Inadequate	21	58.3	13	50.0	
*p-value <0.05 is considered statistically significant.						

We noticed no statistically significant difference in the distribution of vitamin D deficiency between male and female in the current study's assessment of vitamin D status by gender.

However, female patients had a greater rate of deficit than male ones.



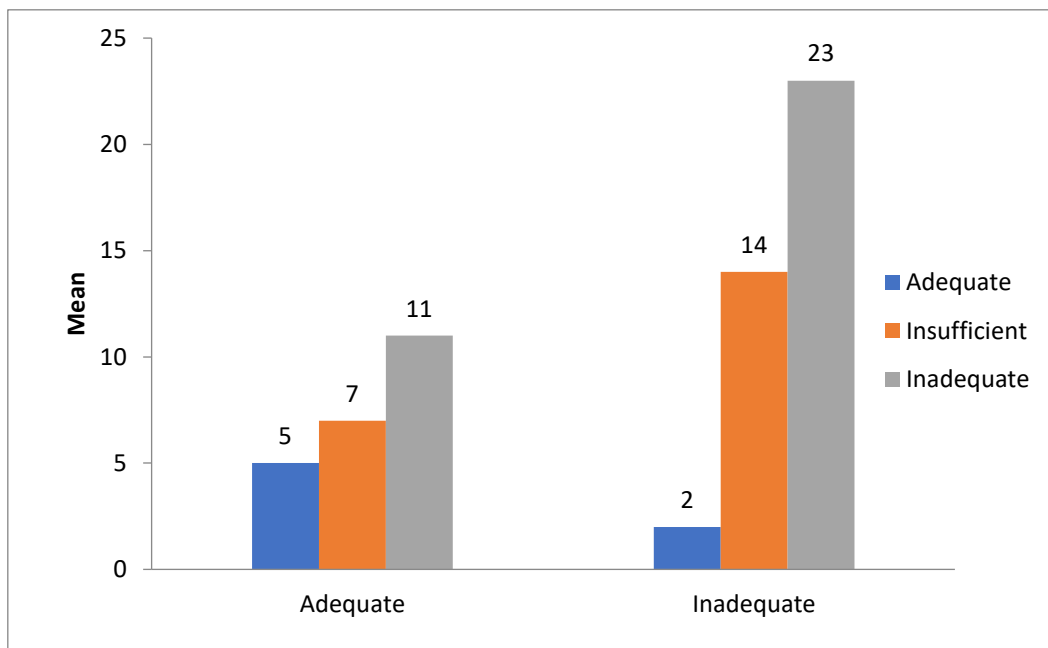
**Figure 26 : Showing the presence of vitamin D deficiency between gender**

**Table 21: Comparison of vitamin D deficiency with sunlight exposure among study participants**

		Vitamin D Status						Chi-square test
		Adequate		Insufficient		Inadequate		
		Count	N %	Count	N %	Count	N%	
Sunlight	Adequate	5	71.4	7	33.3	11	32.4	4.133 (0.042)
	Inadequate	2	28.6	14	66.7	23	67.6	

								*
*p-value <0.05 is considered statistically significant.								

Based on patients' exposure to sunlight, there is a significant variation in the existence of deficient vitamin D among them. There is significant higher incidence of the presence of vitamin D inadequate among the patients with inadequate sunlight exposure (62.9%) compared to the patients with adequate sunlight exposure (37.1%). (p<0.05)



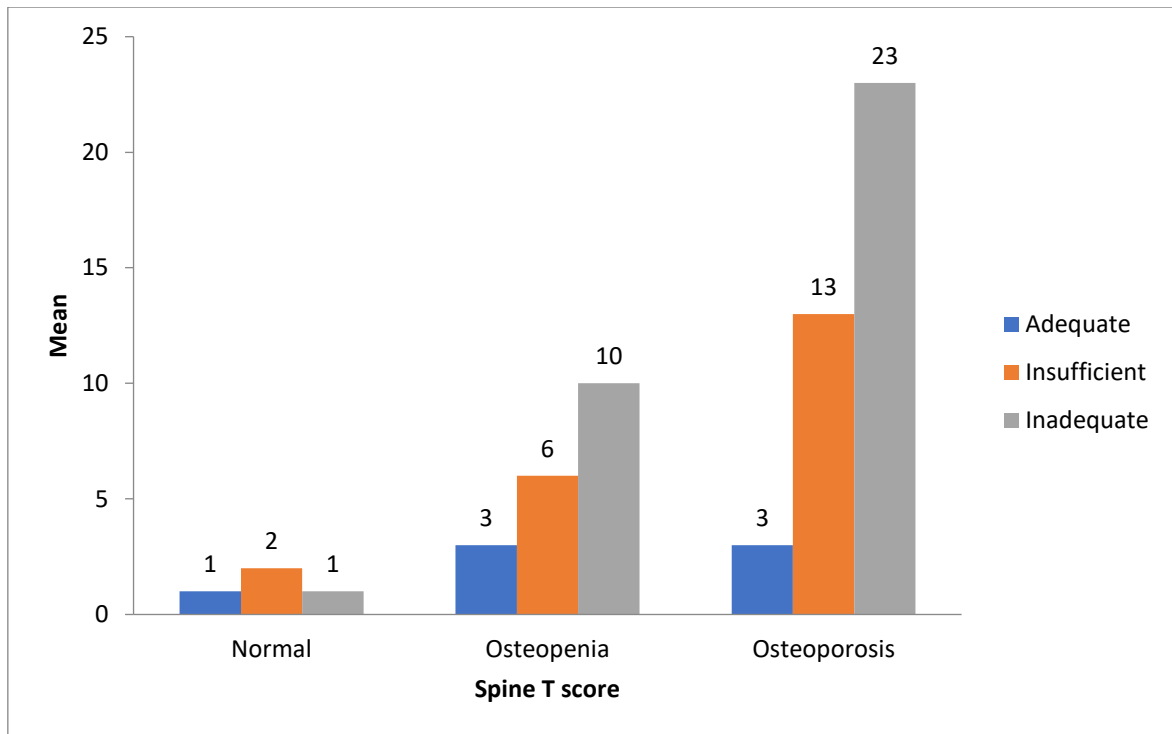
**Figure 27: Comparison of vitamin D deficiency with sunlight exposure among study participants**

**Table 22: Comparison of vitamin D deficiency with spine and femur T score among study participants**

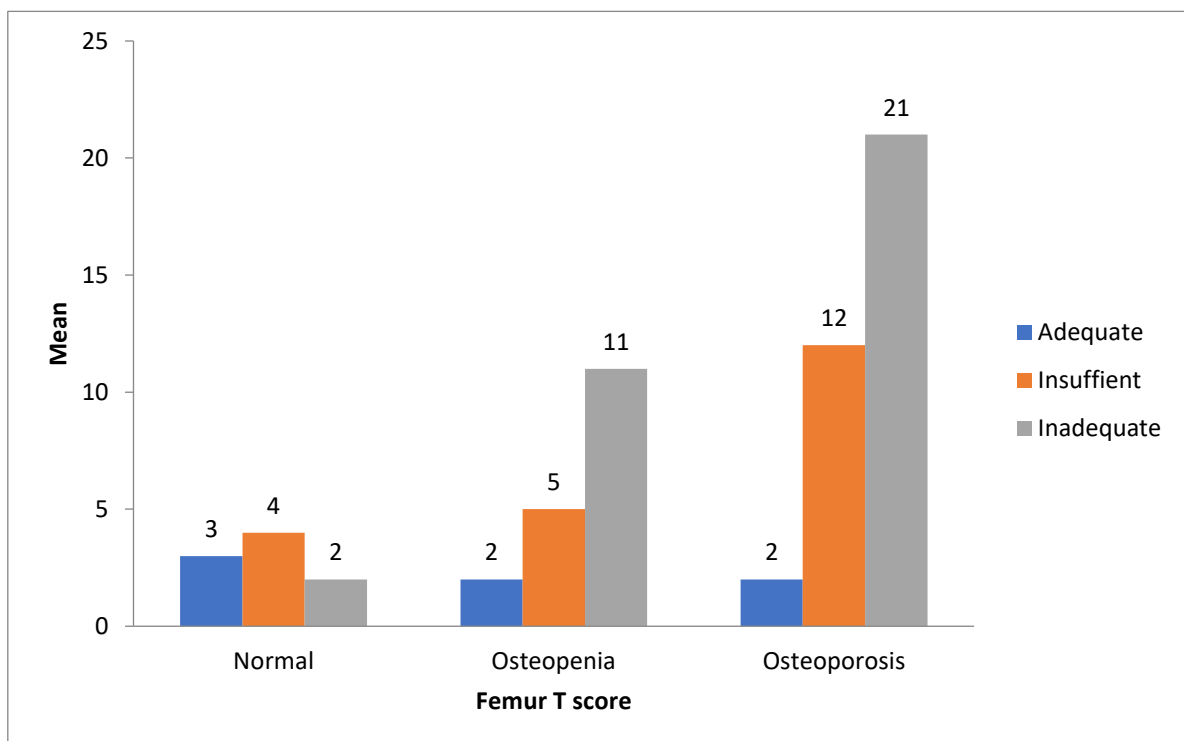
	Vitamin D Status			Chi-square
	Adequate	Insufficient	Inadequate	

		Count	N %	Count	N %	Count	N %	test
Spine T score	Normal	1	14.3	2	9.5	1	2.9	6.821 (0.03) *
	Osteopenia	3	42.9	6	28.6	10	29.4	
	Osteoporosis	3	42.9	13	61.9	23	67.6	
Femur T score	Normal	3	42.9	4	19	2	5.9	7.036 (0.03) *
	Osteopenia	2	28.6	5	23.8	11	32.4	
	Osteoporosis	2	28.6	12	57.1	21	61.8	
*p-value <0.05 is considered statistically significant.								

There is a significant difference in the distribution of osteoporosis and vitamin D deficiency in the current investigation. The patients with vitamin D inadequate and insufficient had the higher incidence of the osteoporosis and presence of Osteopenia compared to the patients with adequate vitamin D.(p<0.05)



**Figure 28 Comparison of vitamin D deficiency with spine T score among study participants**



**Figure 29: Comparison of vitamin D deficiency with femur T score among study participants**

**Table 23: Pearson’s correlation between the variables - Vitamin D, Age, BMI, bone mineral density spine and femur.**

		BMI	VIT D
SPINE T-score	R	.512**	.324*
	p-value	.000	.010
FEMUR T-score	R	.676**	.391**
	p-value	.000	.002

In the current study's evaluation of Pearson's correlation, the correlation between vitamin D levels and BMI, spine T-scores, and femur T-scores was determined to be significantly positive. (p<0.05)

## DISCUSSION

As it is one of the fat-soluble vitamins, which is available in naturally contain like fatty fish liver, and major natural source is the dermal amalgam of the vitamin. Before it can become into active form it should undergo enzymatic alterations to its structure. The vitamin D which is from food or skin is physiologically inert.

The concentration of 25-hydroxyvitamin D that suppresses serum parathyroid hormone to the greatest extent is considered to be the optimal serum concentration, which only takes bone health into account.<sup>18</sup> Many of them define vitamin D deficiency as calcidiol level of <20 ng/mL and whereas level between 21–29 ng/mL is insufficiency. And Vitamin D sufficient if it is more than 30 ng/mL, and vitamin D intoxicated is considered if >150 ng/ml. Regardless of the fact that India is a country with plenty of sunshine, People of all ages have shown to be deficient in vitamin D. Some of the factors of hypovitaminosis D include avoiding sunlight exposure for socio cultural reasons, inadequate calcium consumption, environmental pollution, and a greater 25(OH)-d-24-hydroxylase enzyme among Indians.<sup>10,11</sup>

After receiving informed consent, a total of 62 patients who meet the inclusion criteria are included in the current research. Among this mean age was found to be 63.71±9.41 yrs. Among them 58.1% were female patients and 41.9% male patients with slight female preponderance in the study. In present study, 35.5% belonged to lower SES, 33.9% in upper class and 30.6% in middle socioeconomic status. 56.5% Of the patients were having sedentary lifestyle at occupation, 30.6% were labours. 59.7% were vegetarian and 40.3% were non-vegetarian. Exposure to sunlight, 37.1% of the patients had the adequate and 62.9% with in-adequate exposure.

In study by Kadam NS et al., documented the average age of the study population was 53.3 ±8.4 years. 44.3percent of the female were postmenopausal, with average age at menopause of 49.2 ±3.5 years. <sup>62</sup> In study by Kaushal N et al., 524 participants (aged 50.0 ±12.4 years) were studied, with 41.2percent being female and 58.8percent being male. <sup>61</sup>

In present study 11.3percent had the adequate vitamin D, 33.9percent with insufficient and 54.8percent with inadequate of vitamin D out of 62 patients more than 45yrs. There is a higher incidence of deficiency among female compared to male patients. Based on diet, there is a large variation in the proportion of vitamin D shortage among the patients. However, there is higher incidence of the patients with inadequate among the vegetarian compared (64.7percent) to non-vegetarian patients (35.3percent).(p<0.05) Based on sun exposure, there were noticeable differences in the prevalence of inadequate vitamin D amongst populations.

In study by Kaur S et al., documented a very high incidence of vitamin D deficiency in the urban aged population of Jammu, necessitating intervention through public awareness, food fortification, appropriate exposure to sunlight, and greater mobility of the elderly. <sup>65</sup> in study by Suryanarayana P et al., on multiple logistic regression analysis found that hypertension was a strong predictor of vitamin D deficiency, and the risk of VDD was twice as high in the elderly with hypertension. The prevalence of VDD was significant among the urban elderly population in Hyderabad, India. High BMI, MS, HTN are all important risk factors for VDD. <sup>63</sup>

In similar present study Bachhel R et al., The research participants had a very high overall occurrence of vitamin D deficiency (90percent). Between individuals with various occupations and also among rural and urban subjects, there had been significant variations in the prevalence of vitamin D deficiencies (P 0.05 and P 0.001, respectively). At the 25 (OH) D cut-off threshold, a substantial gender disparity was also seen. with women having a greater frequency of deficiency than males (P <0.05). Also stated that subjects who are more exposed to sunlight

such as rural residents, agriculturalist , and home-makers, have lower prevalence.<sup>60</sup>

In study by Marwaha RK et al., documented Vitamin D deficiencies [levels 20 ng/ml] found in 1228 (91.2percent), whereas Vitamin D insufficiencies [level 20-30 ng/ml] was evident in 92 (6.8percent). Comparing age categories or sexes, there wasn't a statistically significant distinction in the prevalence of VDD or VDI.<sup>54</sup> Bandeira F et al., According to a study, postmenopausal women had a large percentage of hypovitaminosis D. Deficiency was attributed to elderly age, years following menopause, and weak BMD in the FN.<sup>53</sup>

In present study, on assessment of spine T score, 62.9percent had the osteoporosis and 30.6percent had the Osteopenia in patients. 6.5percent showed normal findings. On assessment of femur T score, 56.5percent had the osteoporosis and 29.0percent had the Osteopenia in patients. 14.5percent showed normal findings.

In study by Aggarwal A et al., found that BMD in 70percentof Indian males (> 50 years) and 48percentof postmenopausal Indian women had osteopenia, whereas 18percentof men and 25percentoffemales presented with osteoporosis. In Accordance to the study's recalculated T-scores, only 56percentof men and 7.2percentoffemales having osteopenia and osteoporosis, respectively.<sup>68</sup> In study by Kadam NS et al., a low T-score in Indian males compared to women suggests an increased risk of osteoporosis. Menopause causes a fast reduction in BMD in women. As a result, both Indian men and postmenopausal women require proper osteoporosis prevention methods in their later years.<sup>62</sup>

In study by Kaushal N et al., documented Osteoporosis was found in 6.9percentof the participants (11.1percentof the females and 4.2percentof the males) and osteopenia in 34percentof the subjects (40.3percentof the females and 29.9percentof the males). Male patients had greater absolute BMD ( $P < 0.001$ ) than female subjects at all bone locations. In female patients, the prevalence of osteoporosis rise with age, but not in male subjects.<sup>61</sup> In

study by Paul TV et al., documented the occurrence of osteoporosis at LS spine was 48percent, 16.7percent in the femoral neck, and 50percent overall. <sup>51</sup>

In present study, there is a significant difference in the mean level spine T-score of genders with socioeconomic status, there is increased incidence of the Osteoporosis and Osteopenia among the patients belonging to lower SES compared to other, with no significant difference between the gender. Also documented presence of the osteoporosis on spine t-score among the patients with inadequate vitamin D, this was profound among the female patients compared to male patients. (p<0.05)

In study by LabronicI PJ et al., different age groups, there isn't any evidence of a substantial variation in vitamin D (ng/mL) levels. (p =0.25), fracture levels (p = 0.79), or BMD levels (p = 0.76). 82percentof individuals had inadequate levels in their blood. We found significant correlation between levels of vitamin D and bone density after age adjustment.<sup>57</sup> Kadam NS et al., documented in comparison to the Indian reference database, 15.6percentof females had TBBMC for age Z-scores less than -2, while 37.5% obtained Z-scores that ranged from -2 to -1. One-fifth of the females reported TBBMC Z-score for complete body bone area that were below -2, suggesting demineralized bones. When compared to the reference Database (14.2percent and 33.4percentrespectively), our analysis cohort's TBBMC's average growth rate decreased with age and Tanner stage. (11.6 percent and 20.7 percent, respectively) Low weight, 25OH-D, and protein, minerals intake had a deleterious impact on TBBMC.(p<0.05).<sup>55</sup>

In present study on assessment of Pearson's correlation, study found significant positive strength of association of vitamin D level with BMI, Spine T-score and femur T-score of patients. (p<0.05)

In similar to present study, Ismail TS et al., documented mean serum 25(OH)D was 38.91±

14.07 nmol/L. Out of 126 study subjects, 104 subjects (82.5percent) had insufficient level of vitamin D (< 50 nmol/L). According to T-score, 93 subjects (73.8 percent) had normal T-score of  $\geq -1$ , 33 subjects (26.2percent) had osteopenia (T-score -2.5 to -1) and none had osteoporosis (T-score  $\leq -2.5$ ). Significant positive correlation between serum 25(OH)D and hip BMD ( $r = 0.234$ ,  $p = 0.009$ ) was observed.<sup>66</sup>

Paul TV et al., documented BMI and BMD at LS spine and Femur Neck had significant positive correlation ( $r = 0.4$ ;  $P = .0001$ ). BMD at neck was substantially less in vitamin D-deficiencies research individuals compared with vitamin D-sufficient women ( $P = .03$ ).<sup>51</sup> In a study by Kaushal N et al., on correlation of Height ( $r = 0.235-0.358$ ), weight ( $r = 0.305-0.388$ ), BMI ( $r = 0.143-0.285$ ), and physical activeness ( $r = 0.136-0.153$ ) were all positively related and ALP ( $r = 0.133$  to  $0.203$ ) were all inversely linked with BMD (all  $P < 0.01$ ). At either site, there was no association between blood 25-hydroxyvitamin-D and calcium and BMD ( $P > 0.05$ ).<sup>61</sup>

## SUMMARY

Present hospital based observational study included the patients who are 45 years of age and older of male and female sex who were complaining of pain over lower back and hip pain who come to outpatient/in patient department of KLE Prabhakar Kore Hospital Belagavi were included in the study.

The goal of the current research was to evaluate the correlation between bone mineral density and the prevalence of vitamin D deficiency in adults older than 45.

Total of 62 patients fulfilling inclusion criteria are included in present study after obtaining the informed consent.

- The average patient age was found to be  $63.71 \pm 9.41$  yrs.
- Among them 58.1 percent were female patients and 41.9% male patients with slight female preponderance in the study.
- In present study, 35.5% belonged to lower SES, 33.9% in upper class and 30.6% in middle socioeconomic status.
- In the study, 56.5% of the patients were having sedentary lifestyle at occupation, 30.6% were labors.
- On assessment of diet, 59.7% were vegetarian and 40.3% were non-vegetarian.
- On assessment of exposure to sunlight, 37.1% of the patients had the adequate and 62.9% with in-adequate exposure.
- On assessment of the vitamin D status among the patients, 11.3% had the adequate vitamin D, 33.9% with insufficient and 54.8% with inadequate of vitamin D
- In present study, on assessment of spine T score, 62.9% had the osteoporosis and 30.6% had the osteopenia in patients. 6.5% showed normal findings.

- In present study, on assessment of femur T score, 56.5% had the osteoporosis and 29.0% had the osteopenia in patients. 14.5% showed normal findings.
- In present study on assessment of vitamin D status between the gender, we found no obvious difference in distribution of deficiency of vitamin D between male and female.
- However, there was higher incidence of inadequate among female compared to male patients.
- However, there is higher incidence of the patients with deficiency among the vegetarian compared (64.7%) to non-vegetarian patients (35.3%). ( $p<0.05$ )
- There is a significant difference in the presence of vitamin D inadequate among the patients based on sunlight exposure.
- There is significant higher incidence of the presence of vitamin D inadequate among the patients with inadequate sunlight exposure (62.9%) compared to the patients with adequate sunlight exposure (37.1%). ( $p<0.05$ )
- There is a major differential in the distribution of osteoporosis and vitamin D deficiency in the existing research.
- When compared to individuals with adequate vitamin-D levels, patients with vitamin D deficiency showed a greater incidence of osteoporosis and the existence of osteopenia. ( $p<0.05$ )
- In the current study's analysis of Pearson's correlation, it was discovered that there is a strong correlation between patients' BMI and vitamin D status. ( $p<0.05$ )
- On comparison of the spine t-score between the gender, there is higher incidence of the osteoporosis and Osteopenia among the female compared to males.
- On comparison of the Age wise distribution of patients and the spine t-score between the gender, there is higher incidence of the osteoporosis and Osteopenia among the patients in age 56-75yrs in males and females.

- The comparison of the femur t-score between the gender, there is significant higher incidence of the Osteopenia and osteoporosis among the females compared to males.
- On comparison of the spine t-score of genders with socioeconomic status, there was higher incidence of the osteoporosis and Osteopenia among the patients belonging to lower SES compared to other, with no significant difference between the gender.
- Study documented the presence of the osteoporosis on spine t-score among the patients with inadequate vitamin D, this was profound among the female patients compared to male patients.
- Study documented the presence of the osteoporosis on femur t-score among the patients with inadequate vitamin D, this was profound among the female patients compared to male patients.
- In the current study's evaluation of Pearson's correlation, the connection between vitamin D levels and patients' BMI, spine T-scores, and femur T-scores was determined to be significantly favorable. ( $p < 0.05$ )

## **CONCLUSION**

The prevalence of vitamin D deficiency was found to be 54.8% in participants aged more than 45 years. The vitamin D levels significantly correlated positively with the BMI of participants and the T-score at spine and femur. There is significant higher incidence of osteoporosis noted among female compared to males, with 65.4% in female at spine and 69.2% at femur and in males it was 61.1% at spine and 47.2% at femur. Also, strong correlation between osteoporosis and vitamin D deficiency, as well as with low sun exposure, patients BMIs, diets, and socioeconomic status.

## **LIMITATIONS OF THE STUDY**

Limitations of our study was a small sample size, single Centre experience with study population not reflective of the general population at large and lack of randomization in the recruitment of the patients as most of our subjects were hospital based. However, we feel that our single Centre experience would give a way for a longitudinal multi centric study involving large number of patients to confirm or negate our observations. There is also a need for large community based studied so that high risk population can be picked up and early intervention like adequate calcium intake, vitamin D supplementations and other life style changes can be planned.

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# ANNEXURE 1

## INFORMED CONSENT

**TITLE OF THE STUDY:**“CORRELATION OF VITAMIN D LEVELS WITH BONE MINERAL DENSITY IN PATIENTS OF AGE 45 AND ABOVE- A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY”

**PRINCIPAL INVESTIGATOR:** REG NO. BL0120003

Why am I being asked to take part in this study?

All male and female patients who were having Lower back pain and hip pain attending Ortho OPD and IPD aged 45 years and above are eligible to participate in this study. As you fall under this age group you are eligible to participate. Other patients of same age group are participating in this study. The decision to participation is entirely your own. The study is being done to find out prevalence of vitamin D level deficiency in age 45 years and above and its correlation with Bone Mineral Density. BL0120003 is the principal investigator.

**INTRODUCTION:** Osteoporosis is a skeletal disorder characterized by compromised bone strength with a consequent increased risk of fracture. Prediction of fracture risk is a key element in fracture prevention. Vitamin D plays a crucial role in the bone mineralization. Vitamin D from diet or from the skin is physiologically inert and must undergo enzymatic modifications to become an active metabolite. Main circulating form of vitamin D is 25-hydroxyvitamin D, is created in hepatic system and is subsequently converted in kidney in the form of 2,25-dihydroxyvitamin D. vitamin D in this form is active.

### **PROCEDURE:**

If you consent to be in this study, the relevant data is collected as per the proforma provided to you. Patients will be selected based on inclusion and exclusion criteria. Study will be conducted over a period of 1 year. Patients will be screened according to the inclusion criteria as described for the will then be subjected to Central DEXA scan of make GE Wipro and 2008 Lunar model [Bone Mineral Density] for confirmation of osteoporosis. Which is painless and can be performed within 10 mins and their vitamin D3 levels will be recorded and correlated.

### **RISKS:**

There are no potential risks associated with this study.

### **BENEFITS:**

To the patient in the study.

1. It will act as a diagnostic tool for the patient in the study by providing information regarding the presence of the disease.

2. Will help to initiate therapy for osteoporosis once the diagnosis is confirmed.
3. As a prognostic tool it will help to determine future probability of osteoporosis.

To the community at large.

1. The data obtained from the study will help to provide information on the epidemiology of the osteoporosis which will be then basis for initiation for various programs for osteoporosis prevention.
2. It will help create awareness regarding osteoporosis.

### **ALTERNATIVES:**

If you decline to participate decision it will not change the present or future health care or other services that you will receive. The treatment given out to you will be the standard treatment for your condition.

### **FINANCIAL INCENTIVES FOR PARTICIPATION:**

No additional costs shall be incurred upon you for the purpose of the study. It is purely done with the idea of research and all the cost of study will be done by the investigator.

### **VOLUNTARY PARTICIPATION/ WITHDRAWL:**

Taking part in this study is voluntary. You may choose not to take part in this study, or if you decide to take part, you can later change your mind and withdraw from the study. The investigator or the sponsor may stop your participation in this study if you are not fulfilling the inclusion criteria.

### **COMPENSATION:**

As the subject voluntarily consents to be a part of the study, no compensation will be given.

### **CONFIDENTIALITY:**

All information collected about the subject during the course of the study will be kept confidential to the extent permitted by the law. The code numbers will identify the subject in this research record. Information from this study may be presented but the subjects' identity will be confidential in any publication.

### **QUESTION:**

If any enquiries in the future or in case of study related injury or illness, you may contact principal investigator.

**PRINCIPAL INVESTIGATOR:**

REG NO : BL0120003

PG.RESIDENT,

DEPARTMENT OF

ORTHOPAEDICS,KAHER,

JAWAHARLAL NEHRU MEDICAL COLLEGE,

NEHRU NAGAR,

BELAGAVI-590010

**GUIDE:**

PROFESSOR,

DEPT.OF ORTHOPAEDICS,

KAHER J. N. MEDICAL COLLEGE,

BELAGAVI-590010.

IF YOU STILL HAVE ANY QUERIES

PLEASE CONTACT: CHAIRPERSON,

DR. HARSHA HEGDE

INSTITUTIONAL ETHICS

COMMITTEE FOR HUMAN

SUBJECTS RESEARCH,

JAWAHARLAL NEHRU MEDICAL

COLLEGE, BELAGAVI -59001

### STATEMENT OF CONSENT:

The details of the research study in which I am expected to participate, for which I have to undergo DEXA Scan and serum Vitamin D levels have been explained to me. I willingly, under no pressure from the researcher agree to take part in this study, and agree to participate in all investigations. I may withdraw at any time. I am not giving up any of my legal rights by signing this form.

My signature below indicates that I have read this entire consent form or it has been read to me, and had all my questions answered. I will be given a copy of this consent form.

Signature of the participant or legally authorized representative

Participants Name : Signature :

Name of the legally authorized representative : Signature :

Witness's name : Signature :

Investigators Name : Signature :

Date:

Place:

## **ANNEXURE 2**

### **CASE PROFORMA**

#### **“CORRELATION OF VITAMIN D LEVELS WITH BONE MINERAL DENSITY IN PATIENTS OF AGE 45 AND ABOVE- A ONE YEAR HOSPITAL BASED OBSERVATIONAL STUDY”**

IP / OP No:

Name :

Age :

Gender :

Address :

Contact number:

- Chief complaints:
  
- General physical examination:

BP -

PR -

RR-

Temp -

Pallor:

Icterus:

Cyanosis:

Clubbing:

Lymphadenopathy:

Systemic examination:

- Cardiovascular system: Central nervous system:
- Respiratory system: Per Abdomen:

Kind of work on daily basis:

- Household :
- Manual labor :
- Office work :
- Other :

Do you have any of the complaints as following:

- Backache :
- Easy fatiguability :
- Fracture after trivial fall :
- Others :

On any medications like anticonvulsants, steroid therapy, anticoagulants:

- Yes
- No

Existing diagnosed co-morbid conditions:

- Chronic liver disease :
- Chronic kidney disease :
- Diabetes mellitus :
- Rheumatoid arthritis :
- Chronic skin disease :
- Hypertension :

Alcohol consumption:

- Yes
- No

Cigarettes smoking:

- Yes
- No

Milk consumption daily:

- Yes
- No

On any vitamin D or calcium supplements:

- Yes
- No

Diet:

- Vegetarian
- Non-vegetarian

Time since Menopause:

Parents with history of osteoporosis:

- Yes
- No

Determination of body mass index

- Height
- Weight
- BMI

Exposure to sunlight;

- Adequate [ $>2$ hr/day]
- Inadequate [ $1\frac{1}{2}$ - 2 hr./day]

Socioeconomic status:

- Upper class
- Middle class
- Lower class

SERUM CALCIUM LEVELS [mg/dl]:

SERUM VITAMIN D LEVELS [ng/ml]:

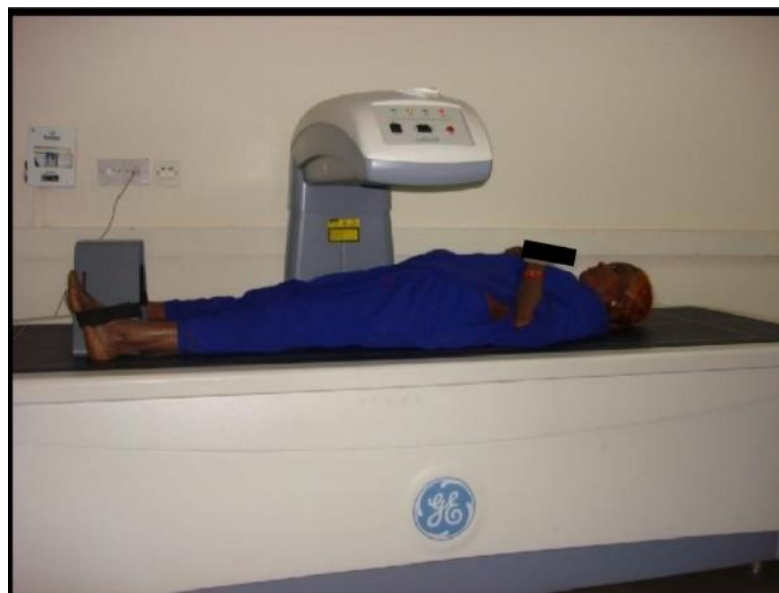
SERUM ALKALINE PHOSPHATASE:

SERUM PHOSPHORUS:

T-SCORE AT SPINE:

T SCORE AT FEMUR:

**ANNEXURE 3**



PHOTOGRAPH -1 AND 2: DEXA SCAN IN FEMALE



PHOTOGRAPH -3 AND 4: DEXA SCAN IN MALE

**ANNEXURE 4**

**MASTERCHART**

Patients Sr. No	AGE In Years	SEX	Sr. Calcium	Sr. VIT D	PHOSPHORUS	SPINE T-SCORE	SR..ALP	FEMUR T-SCORE	TIME SINCE	Socioeconomic	OCCUPATION	BMI	DIET	SUNLIGHT EXPOSURE
1	48 YEARS	FEMALE	9.4	34.71	2.8	-0.8	59	1.2		Upper	M. Labour	28	VEG	ADEQUATE
2	58 YEARS	FEMALE	8.88	18.6	3.4	-1.5	88	-0.2	7	Upper	M. Labour	27	NON	ADEQUATE
3	70 YEARS	FEMALE	9.1	18.93	4	-2.4	90	-2.6	22	Lower	Sedentary	18.5	VEG	INADEQUATE
4	70 YEARS	FEMALE	8.97	21.2	3.8	-2.6	168	-3	21	Middle	Sedentary	16.8	VEG	INADEQUATE
5	72 YEARS	FEMALE	8.8	16.7	2.1	-3.9	200	-3.2	23	Lower	Sedentary	16.4	VEG	INADEQUATE
6	66 YEARS	FEMALE	10	18.7	3.5	-3.1	201	-0.9	14	Middle	Labour	22.1	NON	INADEQUATE
7	58 YEARS	FEMALE	9.4	28.7	3.4	-1.5	169	-2	12	Middle	Labour	22.4	NON	ADEQUATE
8	73 YEARS	FEMALE	8.7	24.1	3.8	-3.2	188	-3.1	24	Lower	Sedentary	17.5	VEG	INADEQUATE
9	68 YEARS	MALE	9.14	20.1	3.4	-1.8	182	-0.3	.	Upper	Sedentary	21.5	VEG	INADEQUATE
10	74 YEARS	MALE	8.8	16.4	3.2	-3.1	212	-2.9		Lower	Sedentary	17.1	VEG	INADEQUATE

11	70 YEARS	MA LE	8.78	19.85	2.2	-2.2	143	-2.6		Mid dle	Sede ntary	1 8 . 2	V E G	INAD EQUA TE
12	57 YEARS	FE MA LE	9	11.6	3.4	-1.5	168	-2.9	7	Lo wer	Sede ntary	2 2 . 2	N O N	ADEQ UATE
13	58 YEARS	FE MA LE	9.1	42.2	3.6	-2.6	159	-0.4	8	Mid dle	M. Labo ur	2 5 . 4	N O N	INAD EQUA TE
14	42 YEARS	MA LE	8.75	19.7	1.9	-4.1	187	-2.8	.	Lo wer	M. Labo ur	2 6 . 1	N O N	ADEQ UATE
15	65 YEARS	MA LE	9.2	20.7	3.9	-2.7	183	-2.9	.	Lo wer	M. Labo ur	1 9 . 5	N O N	INAD EQUA TE
16	65 YEARS	MA LE	9.77	40.8	2.9	-1.2	154	-0.8		Upp er	M. Labo ur	2 0 . 4	V E G	ADEQ UATE
17	62 YEARS	FE MA LE	7.4	19.78	2.1	-1.8	207	- 1.2 3	13	Upp er	M. Labo ur	2 0 . 8	N O N	INAD EQUA TE
18	70 YEARS	FE MA LE	8.9	46.7	3.7	-2.1	167	-1.8	22	Mid dle	sede ntary	2 0 . 1	V E G	ADEQ UATE
19	75 YEARS	FE MA LE	8.7	19.1	2.7	-4	201	-3.3	24	Lo wer	sede ntary	1 6 . 1	V E G	INAD EQUA TE
20	70 YEARS	FE MA LE	7.1	14.5	1.9	-4.4	216	-4.8	18	Lo wer	sede ntary	1 7 . 2	V E G	INAD EQUA TE
21	72 YEARS	FE MA LE	7.68	18.1	2.1	-2.8	154	-2.1	24	Mid dle	M. Labo ur	2 1 . 1	N O N	ADEQ UATE
22	70 YEARS	FE MA LE	8.48	18.6	2.3	-3.3	148	-3	22	Lo wer	sede ntary	1 7 . 1	V E G	INAD EQUA TE
23	76 YEARS	FE MA LE	9.1	33.4	3.8	-1.3	182	-3.5	28	Mid dle	sede ntary	1 8	V E	INAD EQUA

	RS	LE										.2	G	TE
24	65 YEARS	FEMALE	8.5	42.6	2.1	-2.9	184	-0.8	18	Upper	M. Labour	20.2	NON	ADEQUATE
25	60 YEARS	FEMALE	7.7	14.58	1.3	-5.4	215	-2.9	13	Middle	sedentary	15.3	VEG	INADEQUATE
26	60 YEARS	FEMALE	8.36	18.4	4.1	-2.8	222	-1.5	11	Upper	M. Labour	23.1	NON	INADEQUATE
27	62 YEARS	MALE	9	16.5	3.4	-2.5	154	-2.9		Lower	M. Labour	18.2	VEG	INADEQUATE
28	60YEARS	FEMALE	7.8	18.7	2.3	-3.6	254	-2.8	43	Middle	sedentary	16.3	VEG	INADEQUATE
29	55 YEARS	FEMALE	6.9	16.8	2	-4	249	-2.7	5	Lower	sedentary	18.3	VEG	INADEQUATE
30	60 YEARS	FEMALE	9.1	16.8	3.1	-2.9	155	-3.5	11	Lower	sedentary	17.6	VEG	INADEQUATE
31	71 YEARS	MALE	8.3	12.7	4.01	-2.7	132	-2.7		Lower	sedentary	23.4	VEG	ADEQUATE
32	45 YEARS	MALE	7.1	16.35	3.4	-0.87	186	-1.2		Upper	M. Labour	22.9	VEG	INADEQUATE
33	73 YEARS	FEMALE	5.6	18.81	2.5	-3.3	213	-2.1	25	Lower	sedentary	18.2	VEG	INADEQUATE
34	50 YEARS	FEMALE	8.1	19.1	4.2	-1.3	88	-1.1	3	Middle	M. Labour	23.8	NON	ADEQUATE
35	58 YEARS	FEMALE	9.9	27.13	5	-3.7	94	-3.2	7	Lower	sedentary	16.8	VEG	INADEQUATE

36	58 YEARS	FE MA LE	9.1	20.2	3.7	-2.8	88	-0.9	7	Upper	M. Labour	28 .9	N O N	ADEQ UATE
37	52 YEARS	FE MA LE	6.7	13.4	1.9	-3.7	189	-3.1	1	Lower	sedentary	17 .6	N O N	INAD EQUATE
38	64 YEARS	FE MA LE	9.5	15.5	3.5	-3	67	-2.5	14	Lower	sedentary	18 .2	V E G	INAD EQUATE
39	65 YEARS	MA LE	8.4	20.6	2	-3.3	103	-2.8		Lower	sedentary	18 .3	V E G	INAD EQUATE
40	72 YEARS	MA LE	9.1	20.1	2.3	-1.8	110	-1.6		Middle	M. Labour	29 .7	N O N	ADEQ UATE
41	75 YEARS	MA LE	8.2	20.8	4.3	-2.9	159	-1.9 9		Middle	sedentary	25 .8	N O N	INAD EQUATE
42	46YE ARS	MA LE	9.1	18.25	3.6	-2.55	173	-2.4 8		Lower	others	17 .2	V E G	ADEQ UATE
43	55 YEARS	MA LE	8.5	26.4	3.1	-2.69	208	-2.7 5		Lower	others	21 .1	N O N	INAD EQUATE
44	70 YEARS	MA LE	8.5	24.2	2.4	-3.2	167	-3.5		Lower	sedentary	18 .1	V E G	INAD EQUATE
45	69 YEARS	MA LE	9	22.12	2.2	-2.8	69	-2.5 6		Lower	others	19 .4	V E G	INAD EQUATE
46	66 YEARS	FE MA LE	8.3	17.6	3.5	-2.9	158	-3.2		Lower	others	20 .3	V E G	ADEQ UATE
47	66 YEARS	MA LE	9.3	33.4	2.9	-2.78	79	-2.7 2		Lower	others	20 .1	N O N	ADEQ UATE
48	73 YEA	MA LE	9	22.6	2.4	-2.9	167	-3.1		Lower	sedentary	17	V E	INAD EQUA

	RS											.1	G	TE
49	60 YEARS	MALE	9.3	21.5	3.7	-2.15	55	-2.69		Middle	sedentary	18.3	NON	ADEQUATE
50	55 YEARS	MALE	9.2	16.87	4.8	-1.99	201	-2.68		Middle	others	19.4	VEG	ADEQUATE
51	55 YEARS	FEMALE	8.6	25.7	5.5	0.9	88	0.7	3	Middle	others	28.9	NON	ADEQUATE
52	64 YEARS	FEMALE	8.9	19.7	4.3	-1.99	124	-2.1	11	Middle	M. Labor	26.4	VEG	INADEQUATE
53	65 YEARS	MALE	9.4	28.6	4.3	-2.63	83	-2.9		Middle	sedentary	22.5	NON	INADEQUATE
54	55 YEARS	MALE	8.8	18.4	5.1	-1.78	128	-1.22		Upper	others	22.8	NON	ADEQUATE
55	52 YEARS	MALE	8.8	19.1	2.3	-3.3	129	-3.5		Lower	sedentary	16.4	VEG	INADEQUATE
56	80 YEARS	MALE	8.6	16.9	3.1	-2.8	164	-2.36		Middle	sedentary	22.4	NON	INADEQUATE
57	46 YEARS	MALE	9.4	19.7	2.4	-2.87	88	-3.12		Lower	sedentary	16.7	VEG	ADEQUATE
58	66 YEARS	MALE	8.6	12.6	2.3	-3.1	203	-3.3		Middle	sedentary	17.6	NON	INADEQUATE
59	77 YEARS	FEMALE	7.5	29.1	4.1	0.8	149	-1.8	28	Upper	sedentary	21.9	VEG	ADEQUATE
60	66 YEARS	FEMALE	8.7	28.4	3.4	-2.4	94	-0.9	16	Middle	sedentary	24.5	NON	INADEQUATE

61	65 YEARS	FEMALE	9.4	22.9	3.5	-2.5	109	-2.98	20	Middle	sedentary	28.7	VEG	INADEQUATE
62	55 YEARS	FEMALE	7.8	20.1	4.1	-2.9	90	-1.6	5	Lower	M. Labour	23.6	VEG	ADEQUATE