Association of osteoporosis with physiological and biochemical variables of medical importance: a study from local population

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Abstract

Osteoporosis is the disease in which there is low bone density which leads to the low mechanical strength and the chances of the bone fracture increases. It usually begins to appear as acute back pain due to pathological vertebral compression or episodic groin or thigh pain due to hip fracture. This disease is becoming highly prevalent worldwide. It can be due to multiple causes either primary or secondary cause. Current study was carried to find the association of osteoporosis with physiological and biochemical variables of medical importance. The data was collected by non-sampling technique from the local clinical setup. 50 sample size was taken which included both genders of 18-60 age. By their consent, alkaline phosphatase, calcium, BMI, sono bone graph were measured. Bone graph was taken by SONO bone gadget. Other tests were done by taking their blood sample in lab. The result has shown that underweight and obese have more chances of osteoporosis. Increased calcium levels in body would increase the t-score leading to osteopenia. Alkaline phosphatase was increased among osteoporosis patients. Study concluded that there is association of alkaline phosphatase and calcium with osteoporosis. Still investigation is needed to find the association of secondary causes with osteoporosis.

Introduction

Osteoporosis is a disease in which there was low bone density, which ultimately led to low mechanical strength so there were increased chances of bone fracture(Glaser & Kaplan, 1997). Osteoporosis is a highly prevalent disorder with disrupted outcomes(Khadilkar & Mandlik, 2015). Bone mineral density could be quantified at the spine and hip with the help of dual-energy x-ray absorptiometry which assists in finding the osteoporosis victim(Hansen et al., 2019). It also helped to find the correct medical diagnosis. Dual-energy X-ray absorptiometry was useful and widely used because bone mineral density could be described according to the T-score definition of osteoporosis, treatment for anti fractures, and find the treatment prognosis(Blake & Fogelman, 2007).

Many causes played a role in developing osteoporosis(Ali, Lam, Bronze, & Humphrey, 2009). Secondary causes didn't need to be always present among diagnosed osteoporosis patients(Ahmadieh, Basho, Chehade, Al Mallah, & Dakour, 2018). Studies had shown 20-30% of females with postmenopausal age and above 50% of men suffering from osteoporosis may have secondary causes(Rosen, 2020). Secondary causes include side effects of drugs, endocrine problems, eating disorders, inactivity, bone marrow disruptions, GIT diseases, renal dis functioning, and cancer(Templeton, 2005). Additionally, organ transplants in patients were at increased risk for developing osteoporosis(Targownik et al., 2008). The adversity of osteoporosis could be declined with a better treatment regime(LeBoff et al., 2022). Several advancements had been done for giving a clear view of the mechanism and diagnosis of a bone condition(Fitzpatrick, 2002).

In past studies it was shown that lifestyle factors like exercise, calcium intake, and tobacco usage had affected the bone density(Keramat et al., 2008). But these factors still need to be addressed among elder population. For finding its effect, BMD being measured at lumbar spine and proximal femur among both genders(Wright et al., 2014). It revealed that BMD was higher among men than in women(Cheng & Green, 2008). Age-related decline in BMD at femoral neck in both genders and lumbar spine changes among women(Runolfsdottir, Sigurdsson, Franzson, & Indridason, 2015). Tobacco usage was also linked with the declining in BMD among both genders(Daly et al., 2013). No effect of calcium consumption. This concluded that lifestyle factors like using alcohol, calcium intake, and physical exertion altered the bone density in elders(Berg et al., 2008). Changing these factors reduced the osteoporosis-related fractures in both genders(Nguyen et al., 1994).

A study was conducted on Pakistani population in 2009. The study findings were done by ultrasonic findings. 40 million people of 45-70 years were victim of osteopenia patients and 10 million people had osteoporosis. Overall number of osteoporosis was 16% and 34% were osteopenia patients(Ejaz, Mahmood, Qureshi, & Ali, 2012). Past studies had showed that 78% of men were suffering from secondary osteoporosis and 22% had primary osteoporosis(Rinonapoli et al., 2021). Remaining may be suffering from idiopathic causes. 85% of them had back pain mainly and 65% of them were presented by chronic back pain and 35% of them had subacute pain presentation. Either patient having or not having chronic back pain have had vertebral fractures. Study had showed that

primary osteoporosis patients had less vitamin level and high calcium level(Sunyecz, 2008). It was not necessary for back pain patients that they were have vertebral fracture(Peris et al., 1995).

Reactive oxygen species and free radicals were needed for cell signal conversions and other body functions(Lushchak, 2014). However, even the excessive reactive oxygen species could bring the functional imbalance and be responsible for oxidative stress that results in several disorders(Nita & Grzybowski, 2016). Osteoclasts were being obtained from hematopoietic progenitors in bone and used in bone growth and remodeling, keeping the correct bone shape and for calcium metabolism during bone homeostasis(Bellido, Plotkin, & Bruzzaniti, 2019). ROS included superoxide ion, hydrogen peroxide for the correct functioning of osteoclasts(Wang et al., 2012). It may facilitate bone resorption. ROS was associated with osteoporosis development(Agidigbi & Kim, 2019).

Bone quality could be measured by bone density, bone turnover, trabecular bone connectivity, cortical porosity, and shape(Iolascon et al., 2014). 20% of bone was renewed by the metabolic and remodeling process. Bone turnover markers were being widely used in the clinical field and giving valid information about treatment plans, state of bone metabolism, and its prognosis as well as pointing out the bone loss. It concluded that bone turnover markers were potentially being used in osteoporosis. Any change in bone metabolic curve showed bone effect and was considered as a failure of therapy. Data was still not enough to show the bone turnover markers changes alone to figure out the fracture risk reduction(Bandeira et al., 2014).

Study had shown that estrogen played important role in pathophysiology of osteoporosis. Estrogen had both skeletal and exoskeletal role. Skeletal activities directly influence the estrogen receptors on osteoblast and osteoclast cells. And played indirect role on cells like stromal cells and immune cells hence upregulate the osteoprostaglandin. Decreased estrogen proceed the upregulation of RANKL gene which is determinant of increased bone resorption. Estrogen played role in osteoprostaglandin in osteoblast activity. Extra skeletal activities were basically regulated by increased calcium excretion and intestine calcium absorption. It may be due to increased PTH. Secondary hyperthyroid played role in calcium loss due to aging affect. Calcium absorption is also affected by decreased vitamin D**(Sipos, Pietschmann, Rauner, Kerschan-Schindl, & Patsch, 2009)**.

Materials and Methods

Place of work

Data was collected from local clinical setup in Lahore and lab tests were performed by the patient consent.

Study Design

In this study, we checked the association of physiological and biochemical markers with osteoporosis. This study was designed as correlational research a non-experimental study in which two variables are measured and check their statistical relationship.

Sampling Technique

Non probability sampling technique.

Sample Size

Sample size will be calculated using the formula for calculating mean.

$$n = \frac{\sigma^2 (Z_{1-\alpha} + Z_{1-\beta})^2}{(\mu_o - \mu_a)^2}$$

Where

σ^2 = variance

$Z_{1-\alpha}$ =confidence level

$Z_{1-\beta}$ =power of test

μ_o= population mean # 1

μ_a= population mean #2

Mean levels of calcium in premenopausal is 96.5 and postmenopausal is 8.73. Mean S.D will be 43.88 and variance will be 1925.4 .so sample size will be 4. But for better power of study, we will take 50 sample size.

Eligibility Criteria

Inclusion Criteria:

1. Age range of 20 to 60 added.
2. Both genders included
3. Patients taking glucocorticoids.
4. Postmenopausal females

Exclusion Criteria:

1. The patients of age below 20 or above 60 will not be included in the sample.
2. All the patients will be excluded who are/ were taking any steroid medicine except glucocorticoids.
3. Transgender will be excluded from the current study.

Results

In this study we will find the association of physiological and biochemical variables with osteoporosis. This study used the SPSS software to find the association.

Analytical Analysis

This is the normal bell shaped graph of osteoporosis this showed the normal distribution. There is more chances of osteopenia. It is characterized by the reduced amount of bone per unit volume relative to expected age and sex.it further leads to osteoporosis (figure 1).

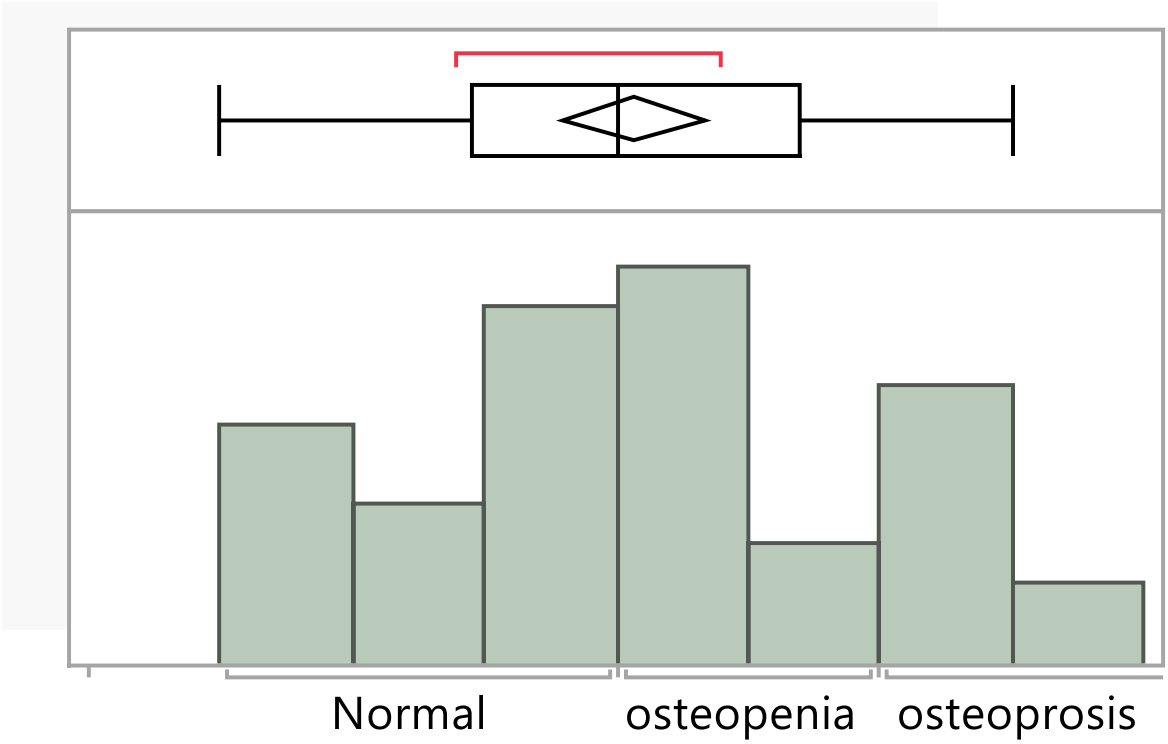

Figure 1: This graph has shown normal range, osteopenia and osteoporosis range. There is always more chances of osteopenoia this is shown in above figure.

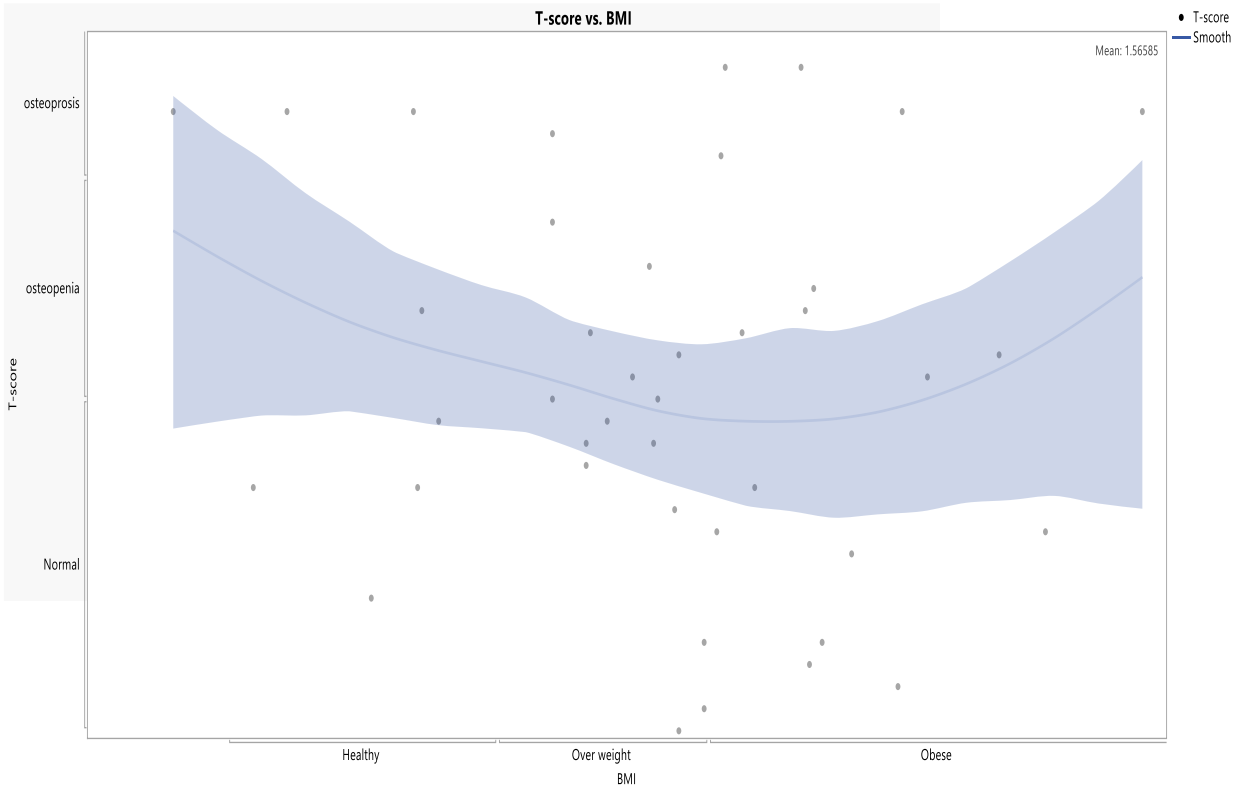

Figure 2: This graph showed the T-score vs BMI relationship.

Figure 2 shows that underweight people have a direct relation to BMI and t-score and increased chances of osteoporosis. Healthy people have fewer chances of osteoporosis. Being overweight showed the inverse relationship that causes less osteoporosis. And obese people have increased chances of osteoporosis shown by increased graph line.

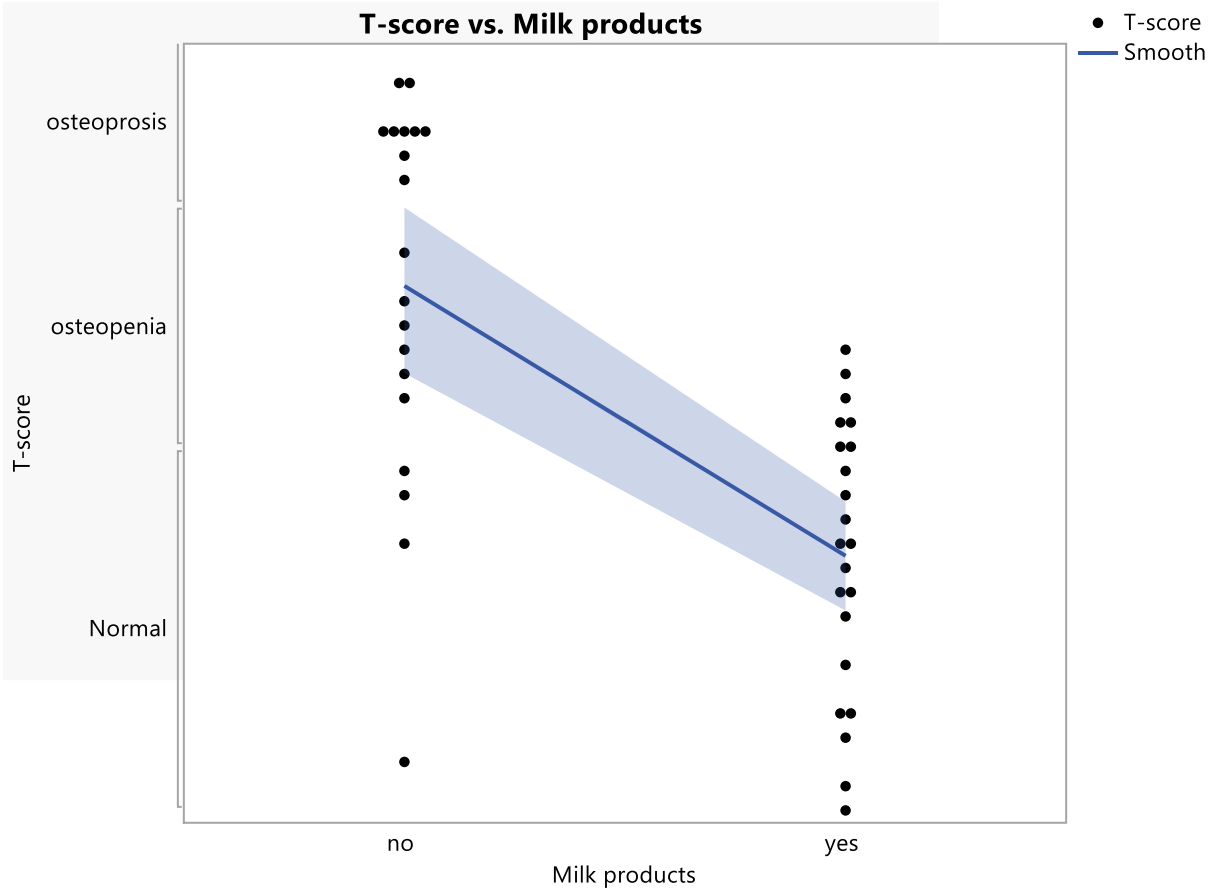

Figure 3: This graph showed that people using milk regularly have fewer chances of causing osteoporosis. And those people not having regular milk intake have more chances of causing osteoporosis.

Milk is needed for bone growth as it is direct source of calcium. People taking less or no milk or milk product are more inclined to deplete the calcium in bones. If calcium is lowered it activavtes the parathyroid hormone to makeup the deficiency of calcium in blood. parathyroid hormone absorbs more calcium from bones which leads to the bone weakening. Calcium is controlled by the vitamin D absorption. Absorption of calcium is lessened in intestine due to decrease in vitamin D. as above mentioned graph has shown the relationship of milk intake and osteoporosis (figure 3).

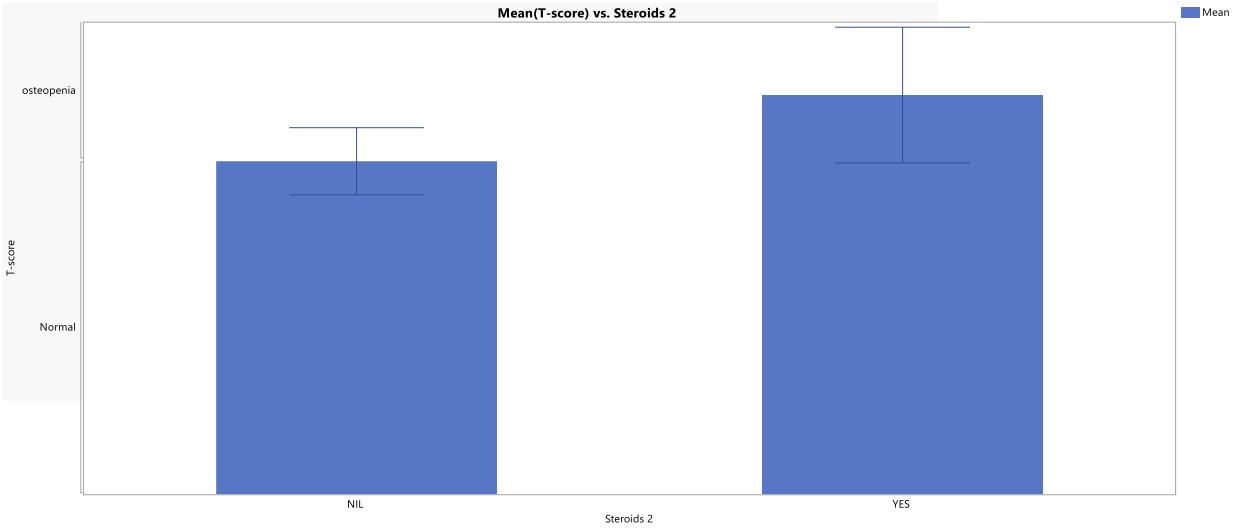

Figure 4: Patients using steroids have increased chances of osteopenia. Patients' not using steroids have less chances of causing osteopenia.

Glucocorticoids decrease the osteoblastic activity directly. And indirectly through the inhibition of insulin like growth factor 1 expression. Bone resorption stimulation is more responsible for initial bone loss after steroids. Corticosteroids increase the osteoporosis. But anabolic steroids increase the bone density. Steroids decrease the bone resorption and increase the bone breaking. As above mentioned graph has shown the relationship of steroids and osteoporosis (figure 4).

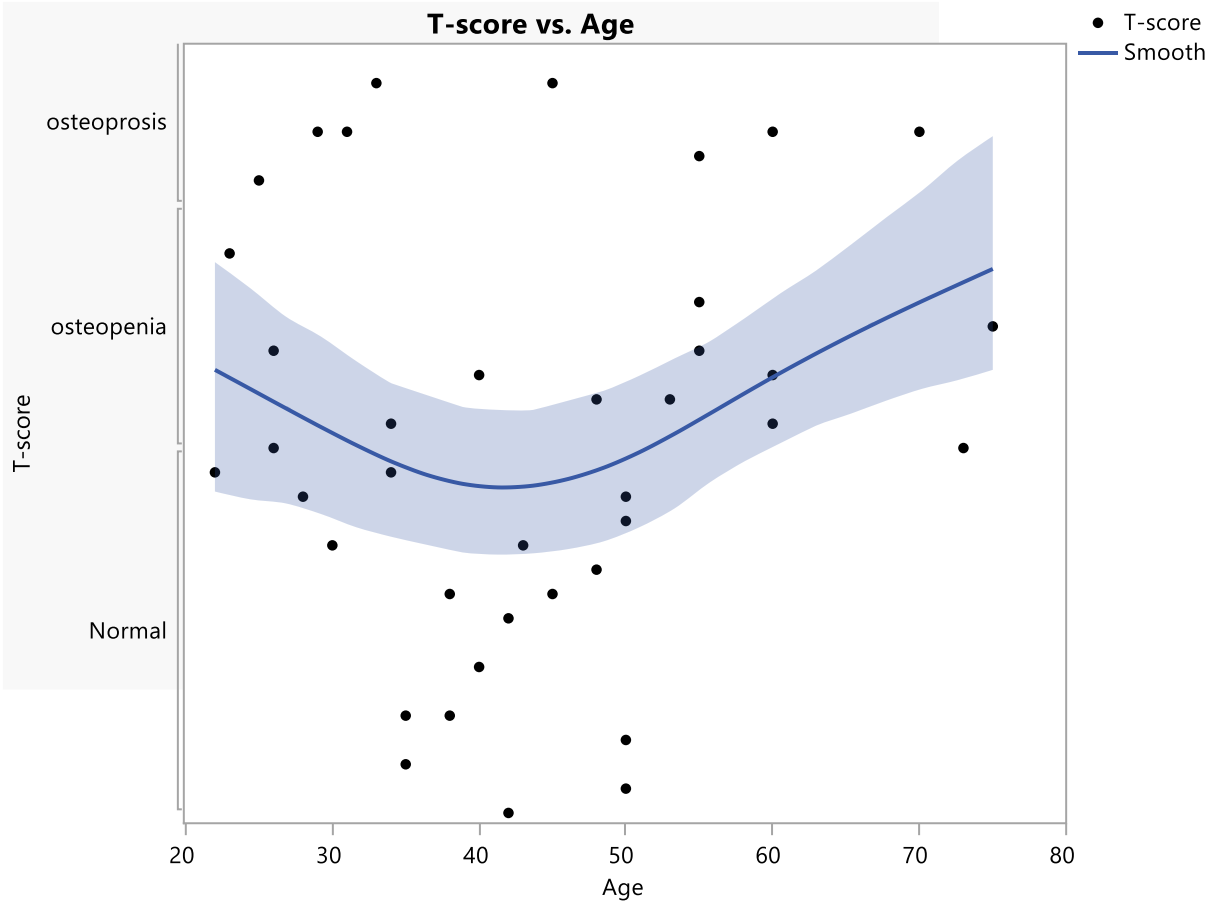

Figure 5: The following graph showed the relationship between T-score and age. This indicates the direct relationship between age and T-score. At early age ranging from 20 to 35 approximately there are fewer chances of osteopenia. From 45 to onwards there is a direct relationship showed between T-score vs age. So there are increased chances of osteopenia leading to osteoporosis.

Sex hormone controls the bone modeling in early age and remodeling in later age. Estrogen plays important role. With age calcium and vitamin D metabolism is altered. Decreased production of vitamin D and less absorption of calcium with age leads to bone weakening.with age bone cellularity is decreased. Above mentioned graph has shown the relationship of osteoporosis and age (figure 5).

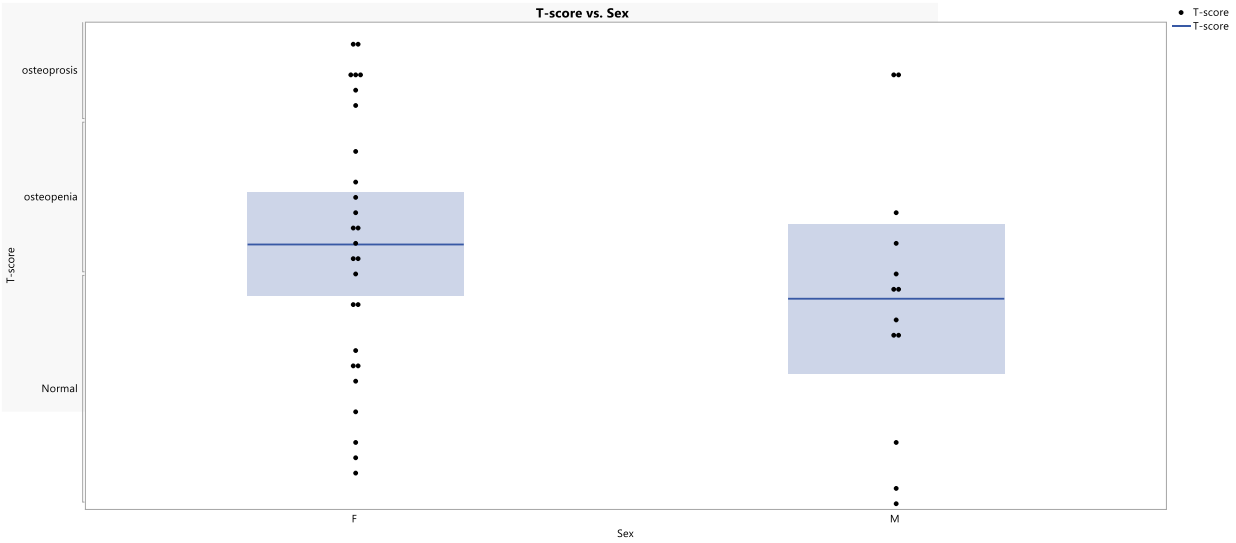

Figure: 6 The graph is plotted between t-score and sex. Graph indicated that the average of collected t-score data in females resulted in osteopenia. And the average of collected data in males resulted normal.

Females are more prone towards osteoporosis it is basically due to the estrogen factor. estrogen manages the bone homeostasis in skeletal and exoskeletal system. In skeletal system estrogen acts directly by acting estrogen receptors on osteoblast and osteoclast cells and indirectly by acting receptors on cells like stromal cells. In exoskeletal system this is based on increased renal calcium excretion and decreased calcium absorption in intestine. Above mentioned graph has shown the relationship of gender and osteoporosis (figure 6).

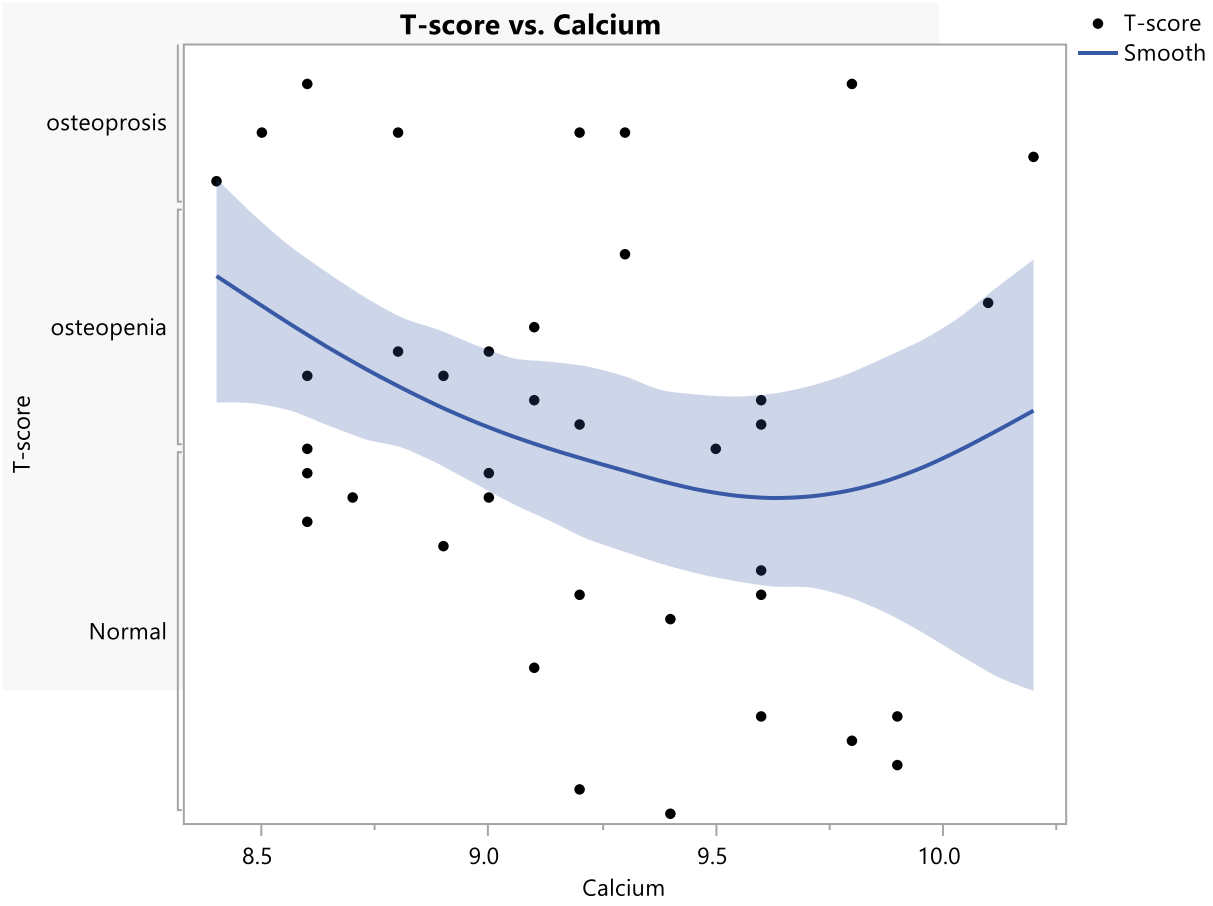

Figure 7: The graph is built between the t-score and calcium. A lower value of calcium resulted in a higher t-score (osteopenia). An increase in calcium decreased the t-score until 9.75 calcium value. Then increase in calcium value gradually increased the t-score resulting in osteopenia.

Calcium plays important role in bone management. It regulates the skeletal strength and structure. If calcium is decreased it declines the bone density. Increase the chances of bone loss and fractures. calcium is controlled by the 3 hormones i.e parathyroid, calcitonin, vitamin D. calcium resorption and distribution is mediated by bone cells like osteoblast and osteoclast. Above mentioned graph has shown the relationship of calcium and osteoporosis (figure 7).

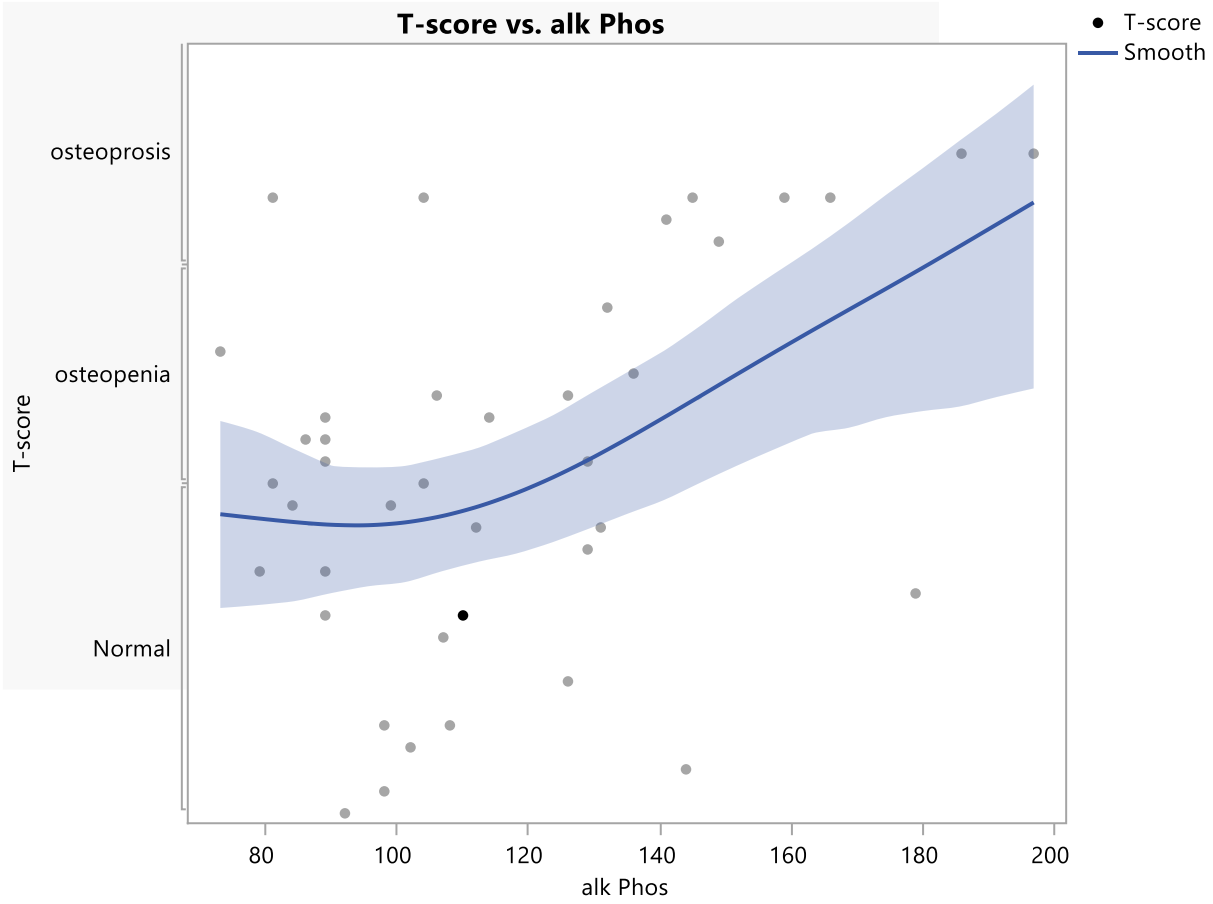

Figure 8: This graph is plotted between t-score and alkaline phosphatase. This shows the inverse relationship with ALP. As alkaline phosphatase is raised among people the t-score is decreasing and leads to osteoporosis.

Alkaline phosphatase plays important role in bone chemistery. It is used to form the hard tissue. It increases the local concentration of inorganic phosphate. It decrease the concentration of extracellular pyrophosphate and it is used in many therapeutic opportunities. Above mentioned figure has shown the relationship between alkaline phosphatase and osteoporosis (figure 8).

Discussion

Interstitial fluid through pores of bone is a mechanical osteocyte activator. Local bone gain, loss, and remodeling occurs as a result of fatigue damage. Remodeling occurred because of osteocytes sensing the canalicular flow pattern around different zones during loading so plays a role in finding the bone structure (Klein-Nulend, Nijweide, & Burger, 2003). There was an association between vascular calcification and osteoporosis. Vascular calcification had the same causes as bone formation. This study concluded that in osteoporosis victims there was a higher serum level of alkaline phosphatase with abdominal aortic calcification than in those having no calcification. There was less difference in urine levels of type 1 collagen cross-linked N telopeptides or the level of osteocalcin. For osteoblast differentiation, bone-specific alkaline phosphatase was a significant marker. Moreover serum level of its activity showed the activity of calcification of the aorta in osteoporosis victims (Iba, Takada, & Yamashita, 2004).

Hypophosphatemia is a less commonly occurring disease characterized by rickets and a low amount of total alkaline phosphatase with a mutation in ALPL. A study was conducted to find the prevalence and clinical importance of less serum total alkaline phosphatase level in young victims of osteoporosis but the research work conducted by me has clearly shown the increased level of alkaline phosphatase in osteoporosis patients(Alonso et al., 2020). Another study had shown the link between bone formation marker osteocalcin and alkaline phosphatase and age in postmenopausal women. It concluded with increased bone formation markers in postmenopausal women may be due to enhanced bone turn over which caused osteoporosis. Research work done by me has enlightened the relationship of physiological and biochemical variables with osteoporotic victims and concluded that age and ALP are involved in osteoporosis most commonly among 40 plus aged females(Lumachi, Ermani, Camozzi, Tombolan, & Luisetto, 2009).

Survey conducted on normal healthy children and patients to find the changes of metabolic bone disorders and abnormal renal working on the serum level of osteocalcin, the bone protein. Serum osteocalcin also indicates changes in bone metabolism but study conducted by me has emphasized on the clinical importance of alkaline phosphatase

among osteoporosis patients. Osteocalcin and ALP both are involved in osteoporosis (Cole, Carpenter, & Gundberg, 1985).

Conclusion

We concluded that biochemical and physiological markers are associated with osteoporosis. Further study is required to find the secondary risk factor association with osteoporosis. Age and gender are more frequent risk factors for osteoporosis.

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