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Correlation Between Alkaline Phosphatase and Vitamin D Among Female Students in The Faculty of Pharmacy at Arab International University

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Abstract:

Vitamin D status is commonly assessed by measuring serum levels of 25-hydroxyvitamin D (25OHD), a lipid-soluble vitamin with a long half-life. It comprises vitamin D2 (from plant sources) and vitamin D3 (from animal sources). Vitamin D is critical for overall health, as it interacts with vitamin D receptors (VDRs) in various tissues and influences over 200 genes. A deficiency in vitamin D can affect numerous body systems, leading to widespread health issues. Globally, over 1 billion people, including both children and adults, suffer from vitamin D deficiency or insufficiency, which manifests in symptoms such as muscle weakness, bone pain, and fatigue, and is linked to diseases like neuropathy, cardiovascular issues, and immune dysfunctions. Alkaline phosphatase (ALP) is an enzyme involved in bone formation, and elevated serum levels often indicate increased bone turnover. Conditions such as osteomalacia, a disease caused by vitamin D deficiency, are associated with raised ALP levels. This study evaluated ALP levels in 151 healthy female students aged 20-30 and assessed the relationship between 25OHD and ALP in 42 samples. Vitamin D deficiency (<20 ng/ml) was observed in 66.66% of participants, while 14.28% had insufficiency (20-30 ng/ml) and 19.05% had normal levels. All participants had normal ALP levels (72-112 u/L), and a weak correlation was found between 25OHD and ALP (p=0.24). Using an ALP cutoff of 75 u/L, vitamin D deficiency could be predicted with 85.3% sensitivity but low specificity (37.5%).

Keywords: Vitamin D Deficiency, 25-Hydroxyvitamin D (25OHD), Alkaline Phosphatase (ALP), Bone Health, Vitamin D Receptors (Vdrs).

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العلاقة بين الفسفاتاز القلوية وفيتامين د بين طالبات في كلية الصيدلة في الجامعة العربية الدولية

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الملخص:

يتم تقييم حالة الفيتامين د عن طريق قياس مستويات 25- هيدروكسي فيتامين د، وهو فيتامين منحل بالدسم ويملك نصف عمر طويل. وهو يشمل فيتامين د2 (من مصادر نباتية) وفيتامين د3 (من مصادر حيوانية). يعتبر الفيتامين د مهماً للصحة بصورة شاملة، حيث يتفاعل مع مستقبلات الفيتامين د في الأنسجة المختلفة ويؤثر على 200 مورثة. العوز بفيتامين د يمكن أن يؤثر على عدد كبير من أجهزة الجسم ويؤدي إلى مشاكل صحية واسعة.

أكثر من بليون شخص عالمياً، بمن فيهم الأطفال والبالغين، يعانون من عوز أو قصور الفيتامين د والذي يتجلى بأعراض مثل ضعف العضلات، ألم بالعظام، وتعب، ويرتبط بأمراض مثل الاعتلال العصبي، المشاكل القلبية الوعائية، وحالات الخلل المناعي.

الفوسفاتاز القلوية *ALP* هي أنزيم يشارك في تكوين العظام، ومستويات المصل المرتفعة منه تشير غالباً إلى زيادة في تحول العظم. ترتبط حالات مثل تلَيُن العظم، وهو مرض يحدث بسبب عوز فيتامين د، بزيادة مستويات الفسفاتاز القلوية *ALP* .

في هذه الدراسة تمَ قياس مستويات الفسفاتاز القلوية ل 151 من الطالبات الإناث الأصحاء، واللواتي تتراوح أعمارهن من 20-30 سنة، وتقييم العلاقة بين 25- هيدروكسي فيتامين د والفسفاتاز القلوية في 42 عينة. تمت ملاحظة عوزالفيتامين د (قيم أقل من 20 *ng/ml*) لدى 66.66% من المشاركات، و14.28% من المشاركات لديهم نقص بالفيتامين د (قيم بين 20 و 30 *ng/ml*)، و19.05% لديهم قيم طبيعية من فيتامين د. كل المشاركات أظهرن قيم طبيعية من الفسفاتاز القلوية(*72-112 u/l*) ، وأظهرت الدراسة علاقة ضعيفة بين الفسفاتاز القلوية و25- هيدروكسي فيتامين د (*p=0.24*). باستخدام قيمة الفسفاتاز القلوية 75 *u/L* كحد ، مما يمكن من التنبؤ بعوز الفيتامين د بحساسية عالية 85.3% و نوعية منخفضة 37.5%.

الكلمات المفتاحية: عوز الفيتامين د، ٢٥ هيدروكسي فيتامين د، الفوسفاتاز القلوية، صحة العظام، مستقبلات فيتامين د

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I. Introduction:

Vitamin D status is primarily assessed by measuring the levels of 25-hydroxyvitamin D (25OHD), a lipid-soluble metabolite with a long half-life that reflects the overall vitamin D status in the body. Total 25OHD is the sum of two primary forms of vitamin D: the plant-based form, vitamin D2 (ergocalciferol), and the animal-derived form, vitamin D3 (cholecalciferol) [1]. Vitamin D is a crucial micronutrient for maintaining optimal health, largely due to its role in regulating a wide variety of physiological processes. It exerts its effects through highly specific receptors known as vitamin D receptors (VDRs), which are present in nearly all tissues and organs of the body. Furthermore, vitamin D plays an essential role in the transcriptional regulation of over 200 genes involved in processes ranging from bone metabolism to immune function. Consequently, a deficiency in vitamin D can have widespread effects, potentially impacting any tissue or body system [2].

The deficiency and insufficiency of Vitamin D represent a significant global health issue, affecting over 1 billion people worldwide, spanning both children and adults [3]. A deficiency in vitamin D is linked to a broad range of health problems, including fatigue, generalized tiredness, muscle weakness, bone pain, walking difficulties, and joint discomfort, among others [1]. Other symptoms associated with vitamin D deficiency include cold intolerance, numbness, tingling sensations, muscle spasms, hair loss, cognitive impairments such as mental fog and poor memory, as well as mood disorders like depression [2]. In addition to these clinical manifestations, vitamin D deficiency has been associated with a high prevalence in various diseases, including neurological disorders like neuropathy, certain types of malignancy, infertility, cardiovascular diseases, kidney dysfunction, disturbances in glucose metabolism, and immune system dysregulation [3].

Alkaline phosphatase (ALP) is a group of enzymes that are found throughout the body, with distinct forms derived from different tissues. These enzymes are encoded by four homologous genes, three of which produce tissue-specific alkaline phosphatases (such as those found in the bone, liver, and kidney), while the fourth is more widely distributed across various tissues. In healthy adults with normal liver function, serum ALP levels are typically balanced between the liver and bone sources. Although the precise function of alkaline phosphatase is not fully understood, it is believed to play a role in the synthesis and mineralization of bone tissue. As a product of osteoblast activity, elevated levels of ALP in the blood are indicative of increased bone turnover, and are therefore used as a marker for bone formation. High ALP levels can also signal disorders like osteomalacia, a condition associated with vitamin D deficiency that leads to impaired bone mineralization and softening of the bones. In children, vitamin D deficiency can result in rickets, a disease characterized by weakened, deformed bones [4].

In this study, we investigated the relationship between serum alkaline phosphatase (ALP) levels and vitamin D status in a cohort of 151 healthy female students, aged 20-30 years. Among the participants, 66.66% were found to have vitamin D deficiency (defined as serum 25(OH)D < 20 ng/mL), 14.28% had vitamin D insufficiency (defined as 25(OH)D between 20-30 ng/mL), and 19.05% maintained normal vitamin D levels (25(OH)D ≥ 30 ng/mL). Interestingly, despite these varying levels of vitamin D, all participants exhibited normal serum ALP levels (ranging from 72-112 U/L). A weak correlation was found between 25(OH)D and ALP levels ($p=0.24$), suggesting that while there is some relationship, it is not strong. When considering an ALP cutoff value of 75 U/L, the ability to predict vitamin D deficiency was 85.3% sensitive, but with only 37.5% specificity. This suggests that while elevated ALP may serve as a somewhat reliable

indicator of vitamin D deficiency in this population, it is not a definitive marker on its own, and further investigation would be needed to better understand the clinical utility of ALP in diagnosing vitamin D deficiency.

Ii. Materials And Methods:

This study was a cross-sectional investigation conducted on 42 out of 151 (samples with ALP>71U/L) apparently healthy female students from the Faculty of Pharmacy, aged between 20 and 30 years. The primary aim was to explore the relationship between serum 25-hydroxyvitamin D (25(OH)D) levels and alkaline phosphatase (ALP) activity in this cohort.

A. Assessment of serum 25(OH)D levels

To determine the serum concentration of 25-hydroxyvitamin D (25(OH)D), we utilized the Cobas 6000 Roche analyzer, a highly precise and automated system used for the measurement of various biomarkers. The serum 25(OH)D levels were quantified using electrochemiluminescence immunoassay(ECL) technology. This method involves the binding of the analyte (in this case, 25(OH)D) to specific antibodies coated on a solid surface, followed by the generation of an electrochemiluminescent signal in response to the chemical reaction. The intensity of this signal was then used to calculate the exact concentration of 25(OH)D in the serum. This assay has been widely recognized for its accuracy and sensitivity in measuring vitamin D metabolites.

B. ALP measurement

Serum alkaline phosphatase (ALP) levels were measured using the Biolab ALT GPT (IFCC) kit, which is designed for the quantitative determination of ALP activity in human serum. The method employed in this kit is based on the International Federation of Clinical Chemistry (IFCC) standards, which ensures a high level of consistency and reliability in enzyme measurement. The assay utilizes a colorimetric reaction, where the enzyme activity leads to the production of a colored compound, the intensity of which is proportional to the amount of ALP present in the sample. This allows for accurate measurement of ALP levels, which serves as a marker of bone turnover, and in this context, provides insight into the potential effects of vitamin D status on bone metabolism.

C. Statistical Method

To examine the relationship between serum 25(OH)D levels and ALP activity, we employed several statistical tests to analyze the data. Correlation analysis was used to assess the strength and direction of the relationship between the two variables. This test evaluates how changes in 25(OH)D concentrations may correspond to variations in ALP levels, and provides a measure of the linear association between them.

In addition to correlation, we performed sensitivity and specificity tests to evaluate the diagnostic potential of ALP levels in predicting vitamin D deficiency. Sensitivity refers to the ability of a test to correctly identify those with low 25(OH)D levels (true positives), while specificity measures the ability of the test to correctly identify those without the condition (true negatives). These metrics are essential for understanding the diagnostic performance of ALP as an indicator of vitamin D status.

All statistical analyses were performed using Minitab Statistical Software, a powerful and widely used tool for statistical data analysis. Minitab was employed to calculate the necessary parameters, including correlation coefficients, sensitivity, specificity, and corresponding p-values. A p-value <0.05 was considered to be the threshold for statistical significance, meaning that any observed relationship between 25(OH)D and ALP levels would be deemed statistically meaningful if the probability of it occurring by chance was less than 5%.

III. Results:

Table 1 presents the serum levels of alkaline phosphatase (ALP) and 25-hydroxyvitamin D (25(OH)D) for 42 participants. Figure 1 illustrates the table values visually. ALP is measured in International Units per Liter (IU/L), and 25(OH)D is measured in nanograms per milliliter (ng/mL). The data provides an overview of the distribution of these two biomarkers within the cohort of healthy female students, aged 20-30 years, and offers insights into the potential relationship between vitamin D status and bone turnover. The table shows a wide range of values for both ALP and 25(OH)D. ALP values span from 72 IU/L to 112 IU/L, with measurements recorded at intervals of 1 to 2 IU/L. Similarly, the 25(OH)D concentrations vary significantly, ranging from as low as 10.50 ng/mL to as high as 58.67 ng/mL.

Low Vitamin D Levels (25(OH)D < 20 ng/mL): Several ALP readings correlate with 25(OH)D levels below 20 ng/mL, such as the ALP values of 72, 73, 74, and 75 IU/L, which correspond to 25(OH)D levels ranging from 10.50 ng/mL to 18.78 ng/mL. These low vitamin D levels suggest a deficiency, which could potentially contribute to an increase in bone turnover, as reflected in elevated ALP levels. Moderate Vitamin D Levels (25(OH)D between 20-30 ng/mL): The range of 25(OH)D levels between 20 and 30 ng/mL corresponds to ALP values between 75 and 85 IU/L. For instance, at ALP values of 80 IU/L and 82 IU/L, the corresponding 25(OH)D levels are 36.06 ng/mL and 17.89 ng/mL, respectively. While these ALP levels are still within the higher end of normal, the vitamin D status of the participants varies, indicating that other factors may influence bone turnover. Higher Vitamin D Levels (25(OH)D > 30 ng/mL): Higher 25(OH)D values, such as 52.35 ng/mL, 57.43 ng/mL, and 58.67 ng/mL, are associated with ALP levels ranging from 74 IU/L to 96 IU/L. For example, when the ALP levels are 95 IU/L and 96 IU/L, the corresponding 25(OH)D concentrations are 14.16 ng/mL and 58.67 ng/mL, indicating variability in the relationship between ALP and vitamin D status, where higher vitamin D does not always correspond to lower ALP levels.

This dataset suggests a complex interplay between vitamin D and bone metabolism, as reflected in the variability in ALP levels across different ranges of 25(OH)D. Although higher ALP values may indicate increased bone turnover, it is not always directly associated with vitamin D deficiency. The relationship between ALP and 25(OH)D may be influenced by other factors, such as diet, calcium intake, or genetic predisposition, which were not controlled for in this study.

Table 1: values of ALP and 25(OH)D

ALP IU/L	72	72	72	73	74	74	74	75	75	76	76	77	77	77
25(OH)D ng/mL	18.3	14.52	14.21	18.78	52.35	57.43	57.60	19.79	30.04	26.8	12.19	13.8	24.47	18.15

ALP IU/L	78	79	80	80	80	80	81	82	82	83	83	83	84	85
25(OH)D ng/mL	25.24	12.24	10.50	40.01	21.21	36.06	14.79	17.89	12.58	36.60	12.33	12.26	12.97	15.37

ALP IU/L	85	86	88	89	90	90	91	93	95	96	103	103	110	112
25(OH)D ng/mL	18.08	12.64	17.24	29.8	14.44	13.35	14.59	13.20	14.16	58.67	21.42	16.21	19.82	12.50

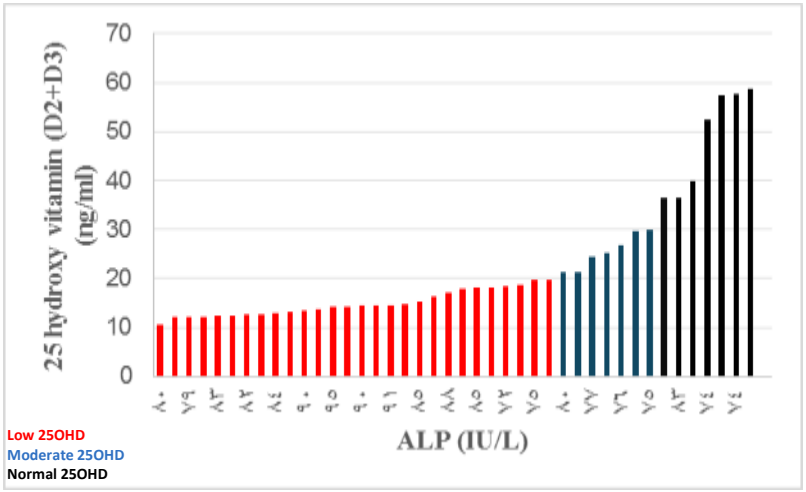

Figure 1: values of ALP and 25 (OH)D

Groups of Patients According to 25(OH)D Values
Table 2 categorizes the 42 participants into three groups based on their serum 25-hydroxyvitamin D (25(OH)D) levels and presents the corresponding ranges of alkaline phosphatase (ALP) levels, along with the Pearson correlation coefficient for each group. This table provides valuable insight into the relationship between vitamin D status and bone turnover in the study population.
In the first group, with 25(OH)D levels ranging from 10–20 ng/mL (vitamin D deficiency), 28 participants (66.66% of the cohort) had serum ALP levels between 72 and 112 IU/L. The Pearson correlation coefficient of 0.913 indicates a strong positive correlation between 25(OH)D levels and ALP. This suggests that individuals with lower vitamin D levels tend to have higher ALP levels, which may reflect increased bone turnover. The strong correlation supports the hypothesis that vitamin D deficiency is associated with higher bone resorption activity. The second group, consisting of 6 participants (14.28% of the cohort) with 25(OH)D levels between 20–30 ng/mL (vitamin D insufficiency), had ALP levels ranging from 76 to 103 IU/L. The Pearson correlation coefficient in this group was 0.648, which indicates a moderate positive correlation between 25(OH)D and ALP. While the relationship remains significant, the weaker correlation compared to the deficiency group suggests that the effect of vitamin D insufficiency on bone turnover is less pronounced. In the third group, with 25(OH)D levels ranging from 30–100 ng/mL (normal to high vitamin D levels), 8 participants (19.05% of the cohort) had ALP levels between 74 and 96 IU/L. The Pearson correlation coefficient of 0.760 reflects a moderate to strong positive correlation between 25(OH)D and ALP. This suggests that even in participants with sufficient or elevated vitamin D levels, there is a moderate association with bone turnover, although the relationship is weaker than in the deficiency group.

Table 2: groups of patients according to 25(OH)D values

25 hydroxy vitamin (D2+D3) ng/ml	Number of samples	Percentage of samples %	Range of ALP (IU/L)	Pearson Correlation p-value
10 – 20	28	66.66	72 – 112	0.913
20 – 30	6	14.28	76 – 103	0.648
30 – 100	8	19.05	74 – 96	0.760

Statistical analysis:

Table 3 presents the descriptive statistics for both ALP and 25(OH)D levels across all participants. For ALP, the mean value is 83.69 IU/L, with a standard deviation of 10.03 IU/L and a variance of 100.66 IU/L². These values suggest moderate variation in ALP levels within the cohort. The coefficient of variation (CoefVar) for ALP is 11.99%, indicating relatively low variability in bone turnover among the participants. ALP levels ranged from 72.00 IU/L to 112.00 IU/L, with the higher levels likely reflecting increased bone turnover in some participants.

For 25(OH)D, the mean level is 22.27 ng/mL, indicating that the average vitamin D status of the cohort is in the insufficient range. The standard deviation of 13.35 ng/mL and variance of 178.17 ng/mL² point to considerable variability in vitamin D levels. The coefficient of variation for 25(OH)D is 59.95%, highlighting the broad range of vitamin D status among the participants. The 25(OH)D levels varied from 10.50 ng/mL (vitamin D deficiency) to 58.67 ng/mL (within the normal range), further emphasizing the variability in vitamin D levels within the study population.

These descriptive statistics confirm the presence of significant variability in both ALP and 25(OH)D levels, which is expected given the diverse factors influencing vitamin D status and bone metabolism. The data suggests that while most participants had insufficient vitamin D, there was a broad range of bone turnover activity, which may be influenced by factors beyond vitamin D levels, such as diet, lifestyle, and other underlying health conditions.

Table 3: Descriptive Statistics for ALP and 25(OH)D

Variable	Mean	StDev	Variance	CoefVar	Minimum	Maximum
ALP	83.69	10.03	100.66	11.99	72.00	112.00
25(OH)D	22.27	13.35	178.17	59.95	10.50	58.67

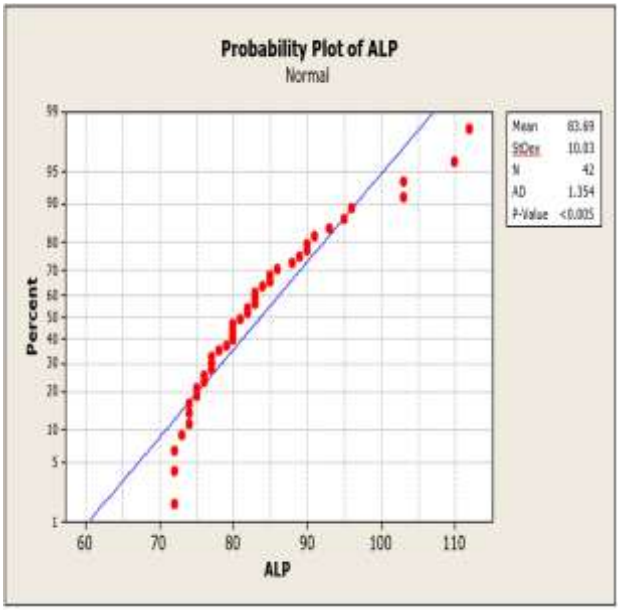

Figure 2: Normality test for ALP

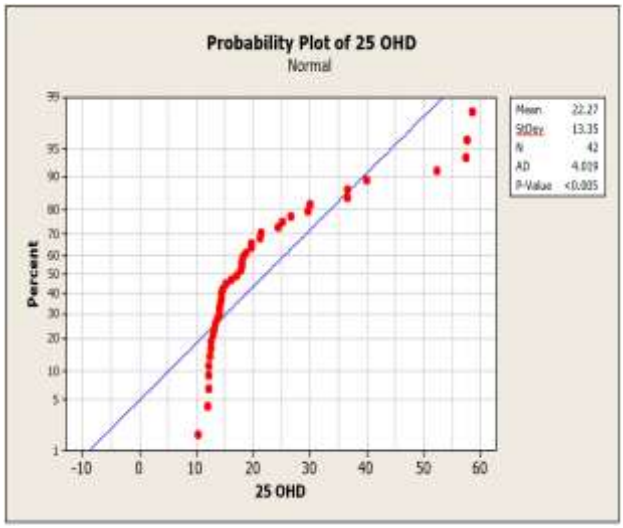

Figure 3: Normality test for 25(OH)D

The statistical analysis of alkaline phosphatase (ALP) and 25-hydroxyvitamin D (25(OH)D) levels provides important insights into the relationship between these two variables and their predictive value for vitamin D deficiency. Below is a detailed explanation of the findings from the statistical tests performed.

Distribution of ALP and 25(OH)D Levels

The p-value of <0.005 indicates that both ALP and 25(OH)D levels follow a normal distribution in the study sample. This suggests that, for both variables, the data are symmetrically distributed around the mean, with values spread evenly on both sides. This normal distribution assumption is crucial for performing correlation and regression analysis, as many parametric statistical tests, including Pearson's correlation, rely on this assumption for validity.

Correlation Between ALP and 25(OH)D

The Pearson correlation coefficient between ALP and 25(OH)D was calculated to be -0.186, which represents a weak negative correlation. This means that while there is a slight inverse relationship between the two variables, the strength of this relationship is weak. A Pearson correlation of -0.186 indicates that changes in 25(OH)D levels are not strongly associated with changes in ALP levels.

The p-value for this correlation was 0.240, which is greater than the conventional threshold of 0.05. This suggests that the correlation is not statistically significant. In other words, there is insufficient evidence to conclude that 25(OH)D and ALP levels are meaningfully related in this study population. Therefore, the weak correlation observed may be due to random variation or the influence of other factors that were not captured in the analysis.

Sensitivity and Specificity Test

To further investigate the utility of ALP as a predictor of vitamin D deficiency, a sensitivity and specificity test was performed, using an ALP cutoff value of 75 IU/L to differentiate between individuals with and without vitamin D deficiency. Sensitivity is a measure of the test's ability to correctly identify individuals who actually have the condition (in this case, vitamin D deficiency). In this study, the sensitivity was calculated as:

$$\textbf{sensitivity} = \frac{29}{29+5} = 85.3\%$$

This means that the test correctly identified 85.3% of the individuals who had vitamin D deficiency. In other words, if an individual has vitamin D deficiency, there is an 85.3% chance that their ALP level will be above the 75 IU/L cutoff, making ALP a relatively accurate marker for detecting deficiency.

Specificity measures the ability of the test to correctly identify individuals who do not have the condition (i.e., those without vitamin D deficiency). In this study, the specificity was calculated as:

$$\textbf{specificity} = \frac{3}{3+5} = 37.5\%$$

This means that the test correctly identified 37.5% of individuals who did not have vitamin D deficiency. While the sensitivity is relatively high, the low

specificity indicates that ALP levels above 75 IU/L may not reliably indicate the absence of vitamin D deficiency, and there may be a relatively high rate of false positives. In other words, individuals who do not have vitamin D deficiency may still show elevated ALP levels, leading to incorrect conclusions that they are vitamin D deficient.

Iv. Discussion:

Our study on apparently 42 healthy female students, where 66.66% of participants had vitamin D deficiency (<20 ng/ml), 14.28% had vitamin D insufficiency (20-30 ng/ml), and 19.05% had normal vitamin D levels and all of participants had normal levels of ALP (72-112 u/l), shows there is weak correlation (p-value=0.24) between 25(OH)D deficiency and ALP levels. However, the results show that vitamin D deficiency could be predicted with 85.3% sensitivity and 37.5% specificity at ALP cutoff value (75 u/l).

Our result is compatible with previous studies which have shown that there is no difference in ALP levels between those with and without 25(OH)D deficiency among a Pakistan population [5]. Similarly, results among Australians showed that there were no differences in ALP levels among different vitamin D concentration classifications[6]. Further, there was no difference in ALP levels between the vitamin D supplement group and the placebo group [6]. Another study shows that there is a negative correlation between serum alkaline phosphate and serum vitamin D3 in malnourished children [7]. A study with 110 samples in Karachi Pakistan suggests that alkaline phosphatase may not be used as a screening test to rule out vitamin D deficiency [8]. No correlation between serum ALP and vitamin D levels was observed ($r = 0.05$, $p = 0.2$) on 460 patients from Saudi [9]. And Among 81 subjects, 73.91% had Vitamin D deficiency, Serum Vitamin D was not significantly correlated with serum phosphorus, serum alkaline phosphatase [10].

On the other hand, another previous study has shown that low serum 25(OH)D levels were inversely associated with high levels of ALP, a study among 24229 US adults provides epidemiological evidence that vitamin D deficiency is associated with liver ALP levels in humans [11]. Another study on 96 samples showed that serum Vitamin D3 levels correlated well with increased serum ALP levels but the level at which the ALP surge occurs was on the lower side [4]. The study of Nasir and his friends had shown that raised serum alkaline phosphatase (ALP) activity is a sensitive marker, which could be used as a screening test to detect rickets or osteomalacia [12]. The results had shown that the lower the 25(OH)D, the higher the PTH and ALP levels. When 25(OH)D was below 10 ng/mL, PTH was increased in 65% of the samples and ALP was elevated in 21% of the samples in Rajab study [1].

There are several limitations to our study, first because of the cross-sectional nature of the present study, we could not determine whether 25(OH)D levels affect ALP concentrations or vice versa. Second, the sample size was small because ALP values for 152 students were normal, and 110 samples were less than 72 u/l.

V. Conclusion:

The study found a weak correlation between 25-hydroxyvitamin D (25(OH)D) deficiency and alkaline phosphatase (ALP) levels, with a Pearson correlation coefficient of -0.186 and a p-value of 0.240, indicating that the relationship between these two markers is not strong or statistically significant. While there is some association, other factors likely influence the ALP levels, and the correlation is not robust enough to draw definitive conclusions about the direct link between low vitamin D and increased bone turnover. Despite this weak correlation, the study shows that ALP levels can still serve as a useful screening tool for predicting vitamin D deficiency. Using an ALP cutoff of 75 IU/L, the test demonstrated an 85.3% sensitivity, meaning it

correctly identified the majority of vitamin D-deficient individuals. However, the specificity was relatively low at 37.5%, suggesting a high rate of false positives, where individuals without deficiency may still have elevated ALP levels.

These findings highlight that while ALP could be a useful marker for detecting vitamin D deficiency, it should not be used in isolation due to its moderate diagnostic accuracy. The weak correlation between 25(OH)D and ALP indicates that other factors may influence ALP levels, and further studies with larger sample sizes are needed to validate these results. Larger-scale studies would help better understand the relationship between vitamin D status and bone turnover markers and refine the predictive value of ALP for vitamin D deficiency. Additionally, confirmatory testing for vitamin D status, such as direct measurement of serum 25(OH)D levels, should be considered to ensure accurate diagnosis.

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References:

1. Rajab HA. The Effect of Vitamin D Level on Parathyroid Hormone and Alkaline Phosphatase. Diagnostics (Basel). 2022 Nov 17;12(11):2828. doi: 10.3390/diagnostics12112828. PMID: 36428888; PMCID: PMC9689845.
2. Raza A, Syed JG, Muhammad Ali F, Danish Khan M, Ali Khan M, Haleem F, Naeem R. Incidence of Vitamin D Deficiency in Different Seasons in the Adult Karachi Population Presenting in the Medical Outpatient Department with Generalized Body Ache. Cureus. 2019 Jul 18;11(7):e5167. doi: 10.7759/cureus.5167. PMID: 31528517; PMCID: PMC6743659.
3. Bellastella G, Scappaticcio L, Longo M, Carotenuto R, Carbone C, Caruso P, Maio A, Paglionico VA, Vietri MT, Maiorino MI, Esposito K. New insights into vitamin D regulation: is there a role for alkaline phosphatase? J Endocrinol Invest. 2021 Sep;44(9):1891-1896. doi: 10.1007/s40618-021-01503-w. Epub 2021 Jan 25. PMID: 33492600; PMCID: PMC8357672.
4. Gutch, Manish; Mandal, Uday Kumar1; Kumar, Sukriti2. Prediction of Rise in Alkaline Phosphatase at Different Vitamin D Levels. CHRISMED Journal of Health and Research 10(1):p 55-59, Jan–Mar 2023. | DOI: 10.4103/cjhr.cjhr_3_22
5. Nadeem Saqib MA, Rafique I, Hayder I et al. (2018) Comparison of vitamin D levels with bone density, calcium, phosphate and alkaline phosphatase – an insight from major cities of Pakistan. J Pak Med Assoc 68, 543–547.
6. Naderpoor N, Mousa A, de Courten M et al. (2018) The relationship between 25- hydroxyvitamin D concentration and liver enzymes in overweight or obese adults: cross- sectional and interventional outcomes. J Steroid Biochem 177, 193–199.
7. Srivastava T, Mehra N, Rathaur V K, Ahmad N. Correlation between Serum Alkaline Phosphatase and Vitamin D3 Levels among 1-14 Years Old Malnourished Children: A Descriptive Observational Study. CJP 2022; 8 (2) :711-716
8. Shaheen, Shehla & Noor, Shahid & Barakzai, Qamaruddin. (2012). Serum Alkaline Phosphatase Screening for Vitamin D Deficiency States. Journal of the College of Physicians and Surgeons--Pakistan: JCPSP. 22. 424-7.
9. Alsharif Et Al. "Lack of correlation between vitamin D and alkaline phosphatase levels among Saudi population," MEDICAL SCIENCE, vol.25, no.107, pp.16-25, 2021
10. Kiran B., Prema A., Thilagavathi R., Jamuna Rani R. Serum 25- Hydroxy Vitamin D, Calcium,Phosphorus and Alkaline Phosphatase Levels In Healthy Adults Above the age of 20 Living in Potheri Village of Kancheepuram District, Tamilnadu. J App Pharm Sci, 2014; 4 (12): 030-034.
11. He X, Xu C, Lu Z-H, Fang X-Z, Tan J, Song Y. Low serum 25-hydroxyvitamin D levels are associated with liver injury markers in the US adult population. Public Health Nutrition.
12. Nasir A. M. Al-Jurayyan, Abdullah N. A. Al Jurayyan, Hanan I.O. Al Omran, Rushaid N. A. Al Jurayyan, Abdulaziz N. A. Al Jurayyan, Amir M.I. Babiker. Alkaline phosphatase (ALP) activity as a marker for vitamin D deficiency. American Journal of Research Communication, 2015, 3(5): 1-9} www.usa-journals.com, ISSN: 2325-4076.
    2020;23(16):2915-2922. doi:10.1017/S1368980020000348