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Original Research Article

# THE STUDY OF CORRELATION BETWEEN VITAMIN D AND TUBERCULOSIS IN NEWLY DETECTED TUBERCULOSIS: PULMONARY AND EXTRA-PULMONARY PATIENTS ATTENDING A TERTIARY MEDICAL CENTER OF EASTERN UTTAR PRADESH

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## ABSTRACT

**Background:** Tuberculosis (TB) remains a major public health challenge in India. Nutritional deficiencies, particularly vitamin D deficiency, are increasingly recognized as important host-related factors influencing susceptibility and disease severity. Vitamin D plays a key role in immune modulation and macrophage-mediated defense against Mycobacterium tuberculosis. **Materials and Methods:** This hospital-based observational cross-sectional study was conducted during 2024–2025 at Maharshi Vashishtha Autonomous State Medical College. Ninety-five newly diagnosed tuberculosis patients aged 18–60 years were enrolled, including 67 pulmonary TB and 28 extra-pulmonary TB cases. Diagnosis was established using radiological findings, sputum AFB examination, GeneXpert testing, and FNAC with AFB/GeneXpert for extra-pulmonary cases. Serum 25-hydroxy vitamin D levels were estimated using chemiluminescence immunoassay. Statistical analysis was performed to assess associations between vitamin D levels, gender, and disease type. **Result:** Of the 95 patients, 53 were males and 42 were females, predominantly from low socioeconomic status. The mean serum vitamin D level was 22.82 ± 2.14 ng/mL. Vitamin D deficiency or insufficiency was observed in 86.3% of patients. Female patients had significantly lower mean vitamin D levels compared to males ($p < 0.01$). Low vitamin D levels were observed in both pulmonary and extra-pulmonary TB without a statistically significant difference between disease types ($p > 0.05$). **Conclusion:** Vitamin D deficiency is highly prevalent among newly diagnosed tuberculosis patients, with a significant association observed particularly among females. Routine screening and correction of vitamin D deficiency may be considered as an adjunctive strategy in the management of tuberculosis.

## INTRODUCTION

Tuberculosis (TB), caused by Mycobacterium tuberculosis, continues to be one of the most prevalent infectious diseases worldwide and remains a major public health concern in low- and middle-income countries. India accounts for a substantial proportion of the global TB burden. Despite availability of effective anti-tubercular therapy, TB persists due to its close association with malnutrition, poverty, overcrowding, and impaired host immunity.[1-3]

Vitamin D is a fat-soluble micronutrient traditionally associated with bone health and calcium metabolism. In recent years, its role in immune modulation has gained increasing attention. The biologically active form of vitamin D enhances innate immune responses by activating macrophages and inducing antimicrobial peptides such as cathelicidin and defensins, which are critical in controlling intracellular pathogens including Mycobacterium tuberculosis.[4-6]

In the pre-antibiotic era, vitamin D supplementation and sunlight exposure were commonly employed as supportive measures in tuberculosis management.

Although these practices declined following the introduction of effective chemotherapeutic agents, growing evidence suggests that vitamin D deficiency may predispose individuals to tuberculosis and influence disease severity and progression.[7-9]

Paradoxically, vitamin D deficiency is widespread in India despite abundant sunlight. Contributing factors include increased skin pigmentation, indoor lifestyle, inadequate dietary intake, and socioeconomic limitations. Women are particularly vulnerable due to nutritional neglect, reduced outdoor exposure, and sociocultural practices.[10-13]

In this context, the present study was designed to evaluate serum vitamin D levels in newly diagnosed pulmonary and extra-pulmonary tuberculosis patients attending Maharshi Vashishtha Autonomous State Medical College and to analyze the association between vitamin D deficiency, gender, and type of tuberculosis.[14,15]

## MATERIALS AND METHODS

**Study Design and Setting:** This was a hospital-based observational cross-sectional study conducted at Maharshi Vashishtha Autonomous State Medical College, Basti, UP during the period 2024–2025.

**Study Population:** A total of 95 newly diagnosed tuberculosis patients were enrolled in the study.

**Inclusion Criteria**

- Age between 18 and 60 years
- Newly diagnosed pulmonary or extra-pulmonary tuberculosis
- Diagnosis confirmed by microbiological, cytological, radiological, or molecular methods
- Patients willing to provide informed consent

**Exclusion Criteria**

- Patients on anti-tubercular therapy for more than one month
- History of previous tuberculosis
- Chronic kidney disease, chronic liver disease, malignancy
- Known metabolic bone disease
- Pregnant and lactating women
- Patients receiving vitamin D supplementation

**Diagnostic Criteria:** Pulmonary TB was diagnosed based on chest X-ray findings, sputum AFB positivity, and GeneXpert testing. Extra-pulmonary TB was diagnosed using FNAC, AFB staining, GeneXpert testing, and relevant radiological and clinical findings.

**Vitamin D Estimation:** Venous blood samples were collected and serum 25-hydroxy vitamin D levels were measured using chemiluminescence immunoassay. Vitamin D levels were interpreted as: - Deficient: <20 ng/mL - Insufficient: 20–30 ng/mL - Sufficient: >30 ng/mL

**Statistical Analysis:** Data were analyzed using standard statistical software. Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as percentages. Statistical significance was considered at $p < 0.05$.

## RESULTS

A total of 95 newly diagnosed tuberculosis patients were included in the study. Of these, 67 (70.5%) patients had pulmonary tuberculosis and 28 (29.5%) had extra-pulmonary tuberculosis.

**Table 1: Demographic profile of the study population**

| Variable | Number (n=95) | Percentage (%) |
|---|---|---|
| Age group (18–60 years) | 95 | 100 |
| Male | 53 | 55.8 |
| Female | 42 | 44.2 |
| Pulmonary TB | 67 | 70.5 |
| Extra-pulmonary TB | 28 | 29.5 |
| Low socioeconomic status | 95 | 100 |

The majority of patients belonged to the economically weaker section, highlighting the association of tuberculosis with poverty and undernutrition.

**Vitamin D status:** Serum 25-hydroxy vitamin D levels were assessed in all patients. The overall mean vitamin D level was found to be 22.82 ± 2.14 ng/mL, indicating widespread insufficiency among the study population.

**Table 2: Distribution of vitamin D levels among tuberculosis patients**

| Vitamin D status | Vitamin D level (ng/mL) | Number of patients | Percentage (%) |
|---|---|---|---|
| Deficient | <20 | 38 | 40.0 |
| Insufficient | 20–30 | 44 | 46.3 |
| Sufficient | >30 | 13 | 13.7 |

A significant proportion of patients had either deficient or insufficient vitamin D levels.

**Gender-wise comparison of vitamin D levels:** Female patients demonstrated comparatively lower vitamin D levels than male patients.


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**Table 3: Gender-wise comparison of mean vitamin D levels**

| Gender | Number | Mean vitamin D (ng/mL) ± SD | Statistical test | p-value |
|---|---|---|---|---|
| Male | 53 | 24.10 ± 2.36 | Unpaired t-test | <0.01 |
| Female | 42 | 21.10 ± 1.92 | | |

Vitamin D deficiency was significantly more pronounced among females compared to males ($p < 0.01$), which may be attributed to nutritional factors, reduced sun exposure, and sociocultural practices.

Both pulmonary and extra-pulmonary TB patients exhibited low vitamin D levels, suggesting that vitamin D deficiency is associated with tuberculosis irrespective of disease site.

## DISCUSSION

This study demonstrates a high prevalence of vitamin D deficiency and insufficiency among newly diagnosed pulmonary and extra-pulmonary tuberculosis patients. The findings align with accumulating evidence that inadequate vitamin D status is commonly observed in individuals with active tuberculosis and may play a contributory role in disease susceptibility.

Vitamin D is known to influence host defense mechanisms through modulation of innate and adaptive immune responses. It enhances macrophage-mediated phagocytosis and stimulates the expression of antimicrobial peptides such as cathelicidin, which inhibit the intracellular survival of Mycobacterium tuberculosis. Reduced vitamin D levels may weaken these immune pathways, thereby facilitating infection and dissemination of the disease.

A notable observation in the present study was the lower mean vitamin D levels among female patients compared to males. This gender disparity has been reported in previous Indian studies and can be attributed to factors such as inadequate nutritional intake, limited sun exposure, traditional clothing habits, and overall poorer socioeconomic conditions affecting women more disproportionately.

Both pulmonary and extra-pulmonary tuberculosis patients exhibited comparable degrees of vitamin D deficiency, suggesting that hypovitaminosis D impacts systemic immunity rather than being confined to pulmonary involvement alone. This observation supports the hypothesis that vitamin D deficiency may influence both disease occurrence and clinical phenotype.

The cross-sectional design of the study limits causal inference, and the absence of a healthy control group restricts comparative analysis. Additionally, treatment outcomes following vitamin D supplementation were not assessed. Despite these limitations, the study provides important regional data and underscores the relevance of nutritional assessment in tuberculosis care.

## CONCLUSION

Vitamin D deficiency is highly prevalent among newly diagnosed pulmonary and extra-pulmonary tuberculosis patients, particularly among females. The study demonstrates a significant association between low vitamin D levels and tuberculosis. Screening for vitamin D deficiency and appropriate supplementation may serve as a beneficial adjunct to standard anti-tubercular therapy.

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