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Original Research Article

Association of Chronic Dermatological Diseases with Bone Mineral Density: A Cross-Sectional Study

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Abstract:

Introduction: Chronic inflammatory dermatological diseases may adversely affect bone health via systemic inflammation, altered vitamin D metabolism, and medication effects. This study aimed to assess bone mineral density (BMD) in patients with chronic skin diseases compared to healthy controls.

Materials & Methods: In a cross-sectional design, 169 adults with psoriasis (n=42), atopic dermatitis (AD, n=28), systemic lupus erythematosus (SLE, n=26), and systemic sclerosis (n=18), along with 55 matched healthy controls, were evaluated. Demographic and clinical data were collected, inflammatory cytokines (TNF-α, IL-6, IL-17) measured, vitamin D status determined, and BMD assessed via DEXA at lumbar spine and femoral neck.

Results: Patients with chronic skin diseases demonstrated significantly lower lumbar spine and femoral neck BMD than controls. The highest prevalence of osteopenia (44.4%) and osteoporosis (27.8%) was observed in systemic sclerosis, followed by SLE (38.5% and 19.2%). Inflammatory markers were elevated in all disease groups compared to controls, particularly in SLE. Vitamin D deficiency was common among patients (61–69%) but much less frequent in controls (34.5%).

Conclusion: Chronic dermatological diseases in this cohort are associated with reduced BMD, higher rates of low bone mass, systemic inflammation, and vitamin D deficiency. Early bone health screening and interventions (e.g., vitamin D supplementation, lifestyle modification) may help mitigate long-term skeletal risks in these patients.

Keywords: Bone Mineral Density, Cytokines, Inflammation, Osteoporosis, Psoriasis, Vitamin D.

Introduction

Chronic dermatological diseases such as psoriasis, atopic dermatitis (AD), systemic lupus erythematosus (SLE), and systemic sclerosis represent a significant clinical burden beyond the skin, often involving systemic inflammation, immune dysregulation, and comorbid conditions. A growing body of evidence suggests that these cutaneous disorders may also adversely impact bone health through persistent inflammation, effects of treatment (e.g., corticosteroids), nutritional deficiencies such as vitamin D insufficiency, and impaired mobility.[1,2]

Psoriasis, for instance, is no longer regarded solely as a skin disease, but as a systemic inflammatory disorder characterized by elevated levels of pro-inflammatory cytokines including tumor necrosis factor-α (TNF-α), interleukin-6 (IL-6), and interleukin-17 (IL-17). These mediators can stimulate osteoclastogenesis, increase bone resorption, and impair bone formation. A systematic review and meta-analysis showed inconsistent results for BMD in psoriatic disease: while fracture risk is elevated, an association with low BMD was not uniformly observed.[3,4] In a more focused review, the risk of osteopenia and osteoporosis in psoriatic disease was highlighted, but the authors called for more large-scale longitudinal studies. [5]

In India, data on bone health in patients with psoriasis remain limited.[6] However, a noteworthy cross-sectional Indian study from Bangalore Medical College assessed BMD in chronic plaque psoriasis using DEXA, finding that a majority of patients had osteopenia, and that reduced BMD correlated with disease duration, body surface area involvement, and BMI. [7]

Autoimmune connective tissue diseases such as SLE and systemic sclerosis are also implicated in bone loss. In SLE, vitamin D deficiency is commonly reported and correlates inversely with disease activity scores, presence of anti-dsDNA antibodies, and interferon-α levels, suggesting an immunomodulatory role for vitamin D in disease pathogenesis.[8] Moreover, external data show that hypovitaminosis D in SLE is associated with elevated inflammatory markers and low BMD. [9]

In the Indian context, bone mineral density has been studied in other inflammatory rheumatic diseases. For example, Indian systemic sclerosis patients have been shown to have a high prevalence of low bone mass, with vitamin D deficiency and altered parathyroid hormone levels contributing to skeletal risk.[10] While these studies highlight the bone risk in rheumatologic populations, there is a relative gap in data bridging dermatology and bone health in Indian patients.

Given this background, our cross-sectional study aimed to evaluate bone mineral density, prevalence of osteopenia/osteoporosis, systemic inflammatory cytokine levels, and vitamin D status in patients with chronic dermatological diseases compared to healthy individuals.

Materials and Methods

Study Design and Setting: This cross-sectional observational study was conducted at a tertiary care teaching hospital, Gujarat over a period of 18 months from January 2023 to June 2024. The study protocol received approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants in accordance with the Declaration of Helsinki.

Study Population: A total of 169 participants were enrolled in the study, comprising five groups: psoriasis (n=42), atopic dermatitis (AD, n=28), systemic lupus erythematosus (SLE, n=26), systemic sclerosis (n=18), and healthy controls (n=55). Sample size was calculated using the formula for comparing means between multiple groups, assuming a power of 80% and alpha error of 0.05, based on previous studies showing a mean BMD difference of 0.15 g/cm² between cases and controls.

Inclusion Criteria: Eligible participants were adults aged 18–65 years who had chronic dermatological conditions lasting more than six months, were willing to undergo bone mineral density testing, and were able to provide informed consent.

Exclusion Criteria: Individuals were excluded if they had a prior diagnosis of osteoporosis or other metabolic bone diseases, were receiving antiresorptive therapy, or had chronic kidney disease (eGFR < 60 mL/min/1.73m²). Additional exclusions included chronic liver disease (Child-Pugh B or C), endocrine disorders affecting calcium metabolism, long-term corticosteroid use for non-dermatological conditions, pregnancy or lactation, a history of malignancy, substance abuse, or recent use of calcium or vitamin D supplements.

Data Collection

Demographic and Clinical Assessment: Demographic data (age, gender, residence, diet, sun exposure, physical activity) and detailed medical history (disease duration, prior treatments, family history of autoimmune diseases) were recorded using a structured proforma.

Musculoskeletal Symptom Assessment: Participants were assessed for joint pain, morning stiffness, Visual Analog Scale (VAS) pain score (0–10), and grip strength using a handheld dynamometer.

Bone Mineral Density Assessment: BMD at the lumbar spine (L1–L4) and femoral neck was measured via dual-energy X-ray absorptiometry (DEXA) using a Hologic Discovery Wi scanner. A blinded radiologist interpreted results as g/cm² and T-scores, classified per WHO criteria into normal (≥–1.0), osteopenia (–1.0 to –2.5), and osteoporosis (≤–2.5).

Biochemical Analysis: Fasting venous blood samples (15 mL) were collected between 8:00-10:00 AM. Serum was separated and stored at -80°C until analysis. The following parameters were assessed:

1. **Calcium and Phosphorus Metabolism:** Serum calcium, phosphorus, alkaline phosphatase, 25-hydroxyvitamin D, and parathyroid hormone (PTH) using chemiluminescence immunoassay. Vitamin D status was classified as: deficient (<20 ng/mL), insufficient (20-30 ng/mL), or sufficient (>30 ng/mL).
2. **Inflammatory Markers:** TNF-α, IL-6, and IL-17 using enzyme-linked immunosorbent assay (ELISA) kits
3. **Acute Phase Reactants:** Erythrocyte sedimentation rate (ESR) by Westergren method and C-reactive protein (CRP) by immunoturbidimetry

Statistical Analysis: Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation and tested for normality using the Kolmogorov-Smirnov test. One-way analysis of variance (ANOVA) was used to compare means across multiple groups. Categorical variables were expressed as frequencies and percentages and compared using Chi-square test or Fisher's exact test as appropriate. A p-value <0.05 was considered statistically significant.

Results

A total of 169 participants were included: psoriasis (n=42), AD (n=28), SLE (n=26), systemic sclerosis (n=18), and controls (n=55). Mean age was highest in systemic sclerosis (47.5 ± 11.8 years) and lowest in AD (33.9 ± 8.4 years). Males predominated in psoriasis (57.1%) and controls (52.7%), while AD and SLE were mostly female. Low sun exposure and physical inactivity were more common in all disease

groups, and steroid use was highest in SLE (38.5%) and systemic sclerosis (33.3%) [Table 1].

Table 1: Demographic Profile of Study Participants Across Dermatological Disease Groups

Variable	Psoriasis (n=42)	AD (n=28)	SLE (n=26)	Systemic Sclerosis (n=18)	Controls (n=55)
Mean Age (years)	44.8 ± 10.3	33.9 ± 8.4	36.7 ± 9.1	47.5 ± 11.8	38.2 ± 9.7
Male (%)	24 (57.1%)	7 (25%)	5 (19.2%)	7 (38.9%)	29 (52.7%)
Urban Residence (%)	29 (69%)	17 (60.7%)	19 (73.1%)	10 (55.6%)	33 (60%)
Vegetarian Diet (%)	33 (78.6%)	23 (82.1%)	22 (84.6%)	14 (77.8%)	39 (70.9%)
Low Sun Exposure (<20 min/day)	24 (57.1%)	18 (64.3%)	18 (69.2%)	12 (66.7%)	16 (29.1%)
Low Physical Activity	16 (38.1%)	9 (32.1%)	13 (50%)	10 (55.6%)	14 (25.5%)
Steroid Use (past 1 year)	8 (19%)	4 (14.3%)	10 (38.5%)	6 (33.3%)	2 (3.6%)
Family History of Autoimmune Disease	8 (19%)	3 (10.7%)	7 (26.9%)	3 (16.7%)	3 (5.5%)

Table 2: Clinical Manifestations Related to Musculoskeletal Symptoms in Skin Disease Patients

Parameter	Psoriasis (n=42)	AD (n=28)	SLE (n=26)	Systemic Sclerosis (n=18)	Controls (n=55)
Chronic Joint Pain	18 (42.9%)	6 (21.4%)	13 (50%)	11 (61.1%)	7 (12.7%)
Morning Stiffness (>30 min)	12 (28.6%)	4 (14.3%)	9 (34.6%)	9 (50%)	5 (9.1%)
VAS Pain Score (mean)	5.3 ± 1.6	3.0 ± 1.1	6.1 ± 1.7	6.7 ± 1.8	1.5 ± 0.8
Reduced Grip Strength	8 (19%)	3 (10.7%)	6 (23.1%)	6 (33.3%)	2 (3.6%)

Musculoskeletal symptoms were more frequent in disease groups, with chronic joint pain and morning stiffness most common in systemic sclerosis (61.1% and 50%, respectively) and SLE (50% and 34.6%). VAS pain scores and reduced grip strength were also higher in these groups compared with controls [Table 2].

Table 3: Comparison of Bone Mineral Density Among Dermatological Disease Groups and Controls

Group	Lumbar Spine BMD (g/cm²)	Femoral Neck BMD (g/cm²)
Psoriasis (n=42)	0.93 ± 0.11	0.79 ± 0.09
AD (n=28)	0.95 ± 0.12	0.82 ± 0.10
SLE (n=26)	0.87 ± 0.10	0.74 ± 0.08
Systemic Sclerosis (n=18)	0.85 ± 0.13	0.71 ± 0.07
Controls (n=55)	1.07 ± 0.12	0.91 ± 0.09

The lowest lumbar spine BMD was observed in systemic sclerosis (0.85 ± 0.13 g/cm²) and SLE (0.87 ± 0.10 g/cm²), whereas controls had significantly higher values (1.07 ± 0.12 g/cm²). A similar trend was seen at the femoral neck, where systemic sclerosis (0.71 ± 0.07 g/cm²) and SLE (0.74 ± 0.08 g/cm²) showed the greatest reductions compared with controls (0.91 ± 0.09 g/cm²). Psoriasis and AD patients exhibited mild-to-moderate reductions in both lumbar spine and femoral neck BMD [Table 3].

Table 4: Prevalence of Osteopenia and Osteoporosis in Dermatological Conditions and Controls

Group	Osteopenia (%)	Osteoporosis (%)
Psoriasis (n=42)	12 (28.6%)	5 (11.9%)
AD (n=28)	6 (21.4%)	2 (7.1%)
SLE (n=26)	10 (38.5%)	5 (19.2%)
Systemic Sclerosis (n=18)	8 (44.4%)	5 (27.8%)
Controls (n=55)	5 (9.1%)	2 (3.6%)

Osteopenia and osteoporosis were most prevalent in systemic sclerosis (44.4% and 27.8%) and SLE (38.5% and 19.2%) [Table 4].

Table 5: Inflammatory Cytokine Profile Among Dermatological Disease Groups and Controls

Group	TNF-α (pg/mL)	IL-6 (pg/mL)	IL-17 (pg/mL)
Psoriasis (n=42)	29.8 ± 7.4	13.2 ± 4.0	16.5 ± 4.9
AD (n=28)	24.7 ± 6.1	11.6 ± 3.8	14.1 ± 4.2
SLE (n=26)	31.2 ± 8.7	15.9 ± 5.3	17.2 ± 5.1
Systemic Sclerosis (n=18)	26.5 ± 5.9	12.4 ± 4.1	14.3 ± 4.6
Controls (n=55)	14.1 ± 3.5	6.1 ± 2.2	6.9 ± 1.9

Inflammatory cytokines (TNF-α, IL-6, IL-17) were elevated in all disease groups, with SLE showing the highest levels [Table 5].

Table 6: Vitamin D Status in Patients with Chronic Dermatological Diseases and Controls

Group	Deficient (%)	Insufficient (%)	Sufficient (%)
Psoriasis (n=42)	26 (61.9%)	10 (23.8%)	6 (14.3%)
AD (n=28)	16 (57.1%)	8 (28.6%)	4 (14.3%)
SLE (n=26)	18 (69.2%)	5 (19.2%)	3 (11.5%)
Systemic Sclerosis (n=18)	12 (66.7%)	4 (22.2%)	2 (11.1%)
Controls (n=55)	19 (34.5%)	17 (30.9%)	19 (34.5%)

Vitamin D deficiency was frequent in patients, especially SLE (69.2%) and systemic sclerosis (66.7%), compared with 34.5% in controls [Table 6].

Discussion

Our cross-sectional analysis reveals that patients with chronic dermatological disorders — notably systemic sclerosis and SLE — exhibit significantly reduced bone mineral density (BMD) at both the lumbar spine and femoral neck, a higher prevalence of osteopenia and osteoporosis, elevated systemic inflammatory cytokines, and high rates of vitamin D deficiency when compared to healthy controls.

Comparison with Existing Literature

These findings align with prior mechanistic hypotheses relating chronic inflammation to bone loss. Elevated TNF-α, IL-6, and IL-17 in our patients support the concept of inflammation-driven osteoclast activation and suppression of bone formation. This systemic inflammatory milieu mirrors observations in psoriatic disease, where inflammation is known to drive comorbidities.[11] Meta-analytic data, however, have reported conflicting findings on BMD in psoriatic disease. A recent meta-analysis found no significant overall difference in BMD between psoriatic patients and healthy controls, though fracture risk was modestly elevated.[3] The discrepancy between our results and such meta-analyses may arise from differences in cohort characteristics (e.g., disease duration, severity, treatment), or from underrepresentation of Indian or other South Asian populations in prior studies. Moreover, our data emphasize that some dermatoses — especially systemic autoimmune types such as systemic sclerosis and SLE — may carry a higher skeletal risk than pure cutaneous psoriasis, potentially explaining variability in prior reports.

In psoriasis specifically, limited Indian research echoes our findings. The Bangalore Medical College DEXA-based study found osteopenia in a majority of patients, with disease duration and body surface area involvement positively correlated with reduced BMD. [7] This supports our observation that chronicity and systemic involvement matter: longer-standing inflammation may contribute cumulatively to bone loss.

Beyond psoriasis, our SLE subgroup demonstrated substantial bone demineralization. This is consistent with non-Indian data showing significant reductions in BMD in SLE patients, particularly in association with long-term glucocorticoid use, elevated inflammatory markers, and lower vitamin D.[9] Although our cross-sectional design limits causal inferences, the co-occurrence of elevated cytokines and vitamin D deficiency suggests plausible pathophysiological pathways.

Indian data further underscore the relevance: a study conducted in SLE patients in India reported high prevalence of vitamin D deficiency, with inverse correlations between vitamin D levels and disease activity (SLEDAI), anti-dsDNA titers, and interferon-α, indicating that vitamin D may have immunomodulatory effects in the Indian SLE population.[8] Thus, our findings add to the growing evidence base from India, reinforcing the need for bone health monitoring in dermatology care.

In systemic sclerosis, our observation of a very high prevalence of low bone mass is in line with rheumatology-based Indian data. Sharma et al. studied systemic sclerosis patients in India and found that 28% had osteoporosis of the lumbar spine.[10] Notably, their study also reported low vitamin D levels and elevated parathyroid hormone (iPTH), supporting the role of mineral metabolism dysregulation in scleroderma-related bone disease. Our study, by demonstrating elevated inflammation alongside low vitamin D, strengthens the hypothesis that systemic sclerosis involves multifactorial bone risk — not merely disuse or medication-induced loss.

Clinical Implications

The implications of these findings are clinically significant. First, they support the rationale for routine bone health assessment in patients with chronic dermatological diseases, particularly systemic autoimmune types. Given the high prevalence of low vitamin D, screening for deficiency and supplementation could be integrated into routine dermatology and rheumatology care. Second, management of inflammation, beyond skin-directed therapy, may have skeletal benefits. Therapies that reduce systemic cytokine burden may help preserve bone density, although prospective

studies are needed to test this hypothesis. Furthermore, for patients on long-term corticosteroids (common in SLE and systemic sclerosis), strategies such as minimizing dose, using steroid-sparing agents, and optimizing bone-protective measures become critical.

Public Health and Indian Context

In the Indian setting, the burden of osteoporosis is substantial. Even in the general population, small-scale studies report high prevalence of low bone mass in pre- and post-menopausal women.[12] Diagnostic infrastructure is expanding: for instance, new DEXA availability (e.g., at SGPGIMS) is helping improve bone health detection. Against this backdrop, recognizing dermatology patients as a high-risk group could influence public health strategies, screening guidelines, and resource allocation.

Limitations

This study's cross-sectional design precludes causal inference regarding the relationship between skin disease and bone loss. We did not stratify by cumulative steroid dose, other immunosuppressive therapies, or fracture history, which may influence BMD. Vitamin D measurements were single time-point assessments and may not reflect long-term status. Finally, we did not include bone turnover markers or structural measures of bone quality (e.g., trabecular microarchitecture), which could provide deeper insight into bone health beyond BMD.

Conclusion

Our study demonstrates a significant association between chronic dermatological diseases and compromised bone health, marked by lower BMD, increased prevalence of osteopenia and osteoporosis, elevated inflammatory cytokines, and widespread vitamin D deficiency. Patients with systemic sclerosis and SLE appear especially vulnerable. These findings highlight the need for early bone health screening, vitamin D assessment, and integrated management strategies in dermatology practice. Incorporating bone-preserving measures — such as inflammation control, vitamin D supplementation, and lifestyle modifications — may reduce long-term skeletal morbidity in this patient population.

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