



VITAMIN D DEFICIENCY IN PATIENTS WITH ALOPECIA AREATA: A CROSS-SECTIONAL STUDY FROM A TERTIARY CARE CENTER

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ABSTRACT

Objectives:

To determine the prevalence of vitamin D insufficiency among patients with alopecia areata (AA) and to assess its association with disease severity and autoimmune comorbidities in a Pakistani tertiary care setting.

Study Design and Setting: A descriptive cross-sectional study was conducted from 17 January 2025 to 17 July 2025 in the Department of Dermatology at Khyber Teaching Hospital, and CMH Peshawar.

Methodology: Using successive sampling, 262 patients aged 5–50 years with clinically diagnosed alopecia areata were enrolled. Patients with conditions affecting vitamin D metabolism, systemic illnesses, or recent vitamin D supplementation were excluded. Disease severity was assessed using the Severity of Alopecia Tool (SALT) score. Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using liquid chromatography–tandem mass spectrometry and categorized according to Endocrine Society guidelines. Data were analyzed using SPSS version 22.0. Associations were assessed using chi-square and independent t-tests, with $p < 0.05$ considered statistically significant.

Results: The mean age of participants was 24.6 ± 8.9 years, with a male predominance (64.9%). Vitamin D deficiency was observed in 142 patients (54.2%), insufficiency in 61 (23.3%), and adequate levels in 59 (22.5%). Vitamin D deficiency was significantly associated with moderate-to-severe AA compared to mild disease (62.8% vs. 44.8%; $p = 0.004$; OR 2.08, 95% CI 1.27–3.41). A strong association was also found between vitamin D deficiency and the presence of autoimmune comorbidities (70.4% vs. 49.1%; $p = 0.01$; OR 2.47, 95% CI 1.30–4.69). No significant associations were observed with age, sex, or diabetes status.

Conclusions: Vitamin D insufficiency is highly prevalent among patients with alopecia areata and is significantly associated with increased disease severity and autoimmune comorbidities. These findings support routine screening for vitamin D deficiency in AA patients and highlight the need for interventional studies to evaluate the role of vitamin D supplementation as an adjunctive therapy.

Keywords: Alopecia Areata; Vitamin D Deficiency; Autoimmune Diseases; Disease Severity.

INTRODUCTION

Alopecia areata (AA) is a chronic, immune-mediated, non-scarring hair loss disorder that is characterized by the sudden appearance of sharply demarcated patches of alopecia, which can progress to alopecia totalis or alopecia universalis in severe forms.¹ It is one of the most common autoimmune conditions in the world, affecting almost 2% of the general population throughout their lifespan.² Recent U.S. claims-based epidemiological studies estimated point prevalence at 0.20–0.22% and incidence rates of 90–93 per 100,000 person-years, highlighting the disorder's significant burden.³ In addition to visible hair loss, AA causes significant psychosocial impairment, including social stigma, depression, and anxiety, which together lower quality of life and increase healthcare utilization. Anagen hair follicles' immunological privilege is compromised in the immunopathogenesis of AA, allowing autoreactive cytotoxic T cells and natural killer cells to target the hair bulb. This process, which is becoming more widely acknowledged as multifactorial, involves interactions between immunological dysregulation, genetic predisposition, and environmental stimuli. In light of this, vitamin D has drawn interest as a biologically likely contributor to the onset and severity of disease.⁵ Traditionally associated with skeletal health and calcium homeostasis, vitamin D also has significant immunomodulatory effects. Vitamin D influences antigen presentation, cytokine release, and the balance of T-helper (Th1, Th2, Th17) and regulatory T-cell populations through the vitamin D receptor (VDR), which is expressed in multiple immune cell subsets. Experimental studies show that VDR expression in follicular keratinocytes is crucial for hair follicle cycling; in mice, targeted deletion of VDR causes alopecia and disordered follicular regeneration. These findings underscore the critical role of vitamin D signaling in preserving normal hair biology and imply a mechanistic connection to AA. Whether a blood vitamin D deficit increases the likelihood or severity of AA has been examined in clinical study. AA patients had significantly lower serum 25-hydroxyvitamin D [25(OH)D] concentrations and much higher probabilities of deficiency than controls, according to a 2018 meta-analysis pooling international case-control data. Further evidence has been offered by later observational studies, which showed that AA patients in various geographic locations had noticeably lower vitamin D levels. But there is disagreement in the literature. While trends toward decreased levels of AA were still noted, several studies were unable to find statistically significant differences, especially in areas with high baseline prevalence of deficiency. This discrepancy could be caused by variations in latitude, season, assay technique, research design, and underlying genetic or environmental variations among populations. In South Asia, where vitamin D insufficiency is quite common, the information gap is especially noticeable. More than 70% of South Asians, according to recent syntheses, have poor vitamin D intake. This number is attributed to a combination of factors such as high levels of air pollution, cultural clothing customs, minimal dietary fortification, and urban indoor lifestyles. With studies showing startlingly high rates of deficiency in the general population, Pakistan is one of the most impacted nations in the region.¹² In spite of this context, there is still conflicting and limited data about the relationship between vitamin D and AA in Pakistan. While some case-control studies indicated that AA patients had considerably lower vitamin D levels than matched controls, indicating a disease-specific relationship, other investigations found no significant differences even if the levels were numerically lower. Concerns regarding methodological variability and confounding are raised by these disparities. This uncertainty serves as the justification for the current investigation. Small sample sizes, unclear diagnostic criteria, insufficient elimination of confounders such as concomitant autoimmune disease or systemic sickness, and dependence on tests with varying cut-offs have frequently restricted previous studies. Given the prevalence of vitamin D deficiency, it is critical to produce high-quality local data that elucidate whether vitamin D status is correlated with the severity of the disease and whether AA patients are disproportionately at risk of deficiency. These uncertainties can be cleared up and used to guide future interventional trials as well as clinical practice with the use of rigorous methodology that includes validated severity grading systems, standardized testing, and cautious participant selection. Therefore, the purpose of this study was to assess the association between vitamin D level and clinical severity of disease and to find out how common vitamin D deficiency was among alopecia areata patients in a tertiary care setting when compared to healthy controls.

METHODOLOGY

This descriptive cross-sectional study was conducted in the Department of Dermatology, Khyber Teaching Hospital, and CMH Peshawar, from 17 January 2025 to 17 July 2025 after approval from the Institutional Ethics Review Committee and in accordance with the Declaration of Helsinki; written informed consent was obtained from adults, and assent with parental/guardian consent was obtained for minors. Patients aged 5–50 years with a clinical diagnosis of alopecia areata (AA) were enrolled, with diagnosis confirmed by consultant dermatologists based on well-defined, smooth, non-scarring patches of hair loss; disease severity was assessed using the Severity of Alopecia Tool (SALT) score and categorized as mild, moderate, or severe. Patients were excluded if they had inflammatory scalp dermatoses, scalp infections (e.g., tinea capitis), had used topical or systemic AA treatment within the preceding 3 months, had taken vitamin D or calcium supplements within 2 weeks, or had conditions/medications known to alter vitamin D metabolism, including thyroid disorders, malabsorption syndromes, chronic kidney disease, chronic liver disease, or current use of glucocorticoids or anticonvulsants. Sample size was calculated using the WHO formula for a single population proportion, assuming a 42.4% prevalence of vitamin D deficiency among AA patients (D'Ovidio et al.), with 95% confidence ($Z = 1.96$) and 7% absolute precision, yielding a minimum sample of 262; non-probability consecutive sampling was used to recruit 262 eligible patients during the study period. Data were collected using a structured proforma capturing demographics (age, sex), clinical variables (disease duration, SALT score), and autoimmune/metabolic comorbidities. Five milliliters of venous blood were drawn aseptically and analyzed in the hospital's central pathology laboratory, where serum 25-hydroxyvitamin D [25(OH)D] was measured using liquid chromatography–tandem mass spectrometry (LC–MS/MS); vitamin D status was classified per Endocrine Society guidelines as deficient (<20 ng/mL), insufficient (21–29 ng/mL), or sufficient (≥ 30 ng/mL). Statistical analysis was performed using SPSS version 22.0, with continuous variables summarized as mean $\pm$ standard deviation and categorical variables as frequencies and percentages; associations were assessed using chi-square tests for categorical variables and Student's t-test or ANOVA for continuous variables, with stratification by age, sex, disease severity, and comorbidities, and a p-value <0.05 considered statistically significant.

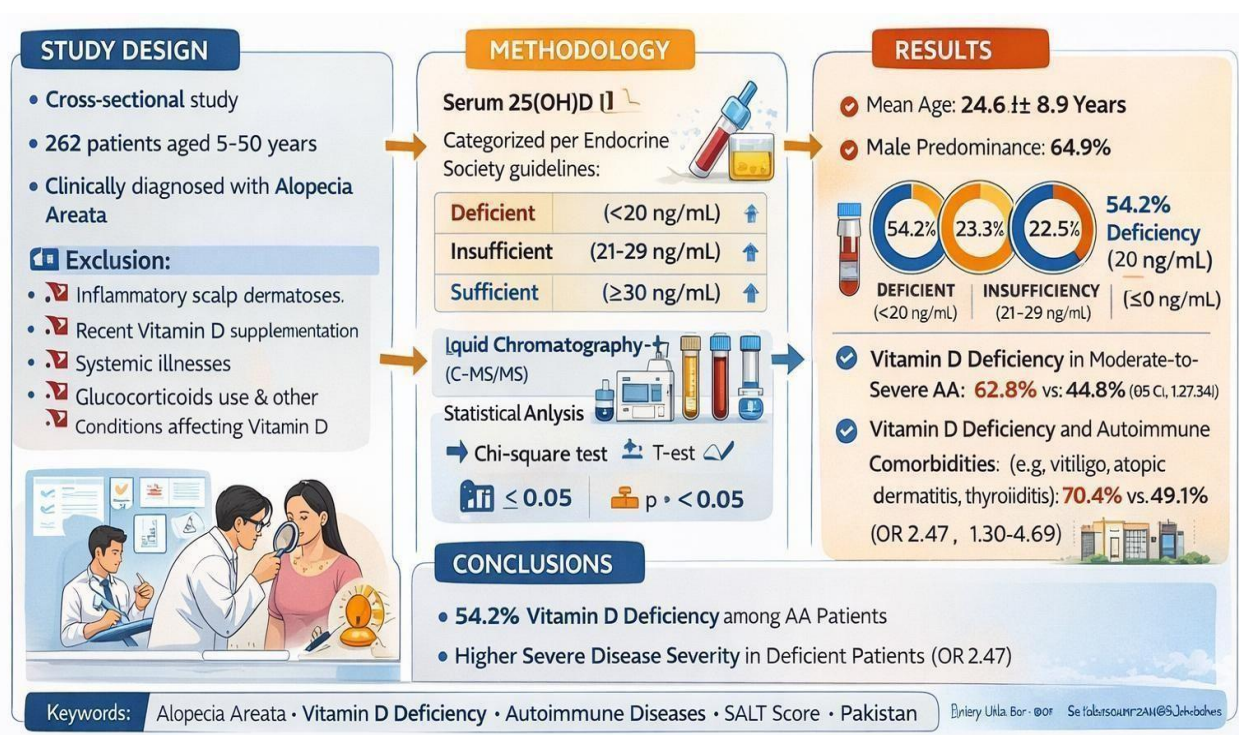


Figure Graphical overview of study design, methodology, and key findings of vitamin D deficiency in patients with alopecia areata

RESULTS:

Tables 1-3 and Figures 1-2 present the findings of this investigation. There were 262 alopecia areata (AA) patients in all (Table 1). There were 92 (35.1%) female participants and 170 (64.9%) male participants, with an average age of 24.6 ± 8.9 years. Six months was the median length of the illness (IQR 3–12). 54 individuals (20.6%) had concurrent autoimmune disorders, including 14 patients (5.3%) with thyroid disease and 23 patients (8.8%) with diabetes mellitus. Table 2 and Figure 1 demonstrate the distribution of vitamin D status. In all, 59 (22.5%) patients had adequate levels of vitamin D (≥ 30 ng/mL), 61 (23.3%) had insufficient levels (21–29 ng/mL), and 142 patients (54.2%) had inadequate levels (< 20 ng/mL). Table 3 displays the results of a bivariate analysis of clinical and demographic parameters. Patients with moderate-to-severe SALT involvement had a substantially higher prevalence of vitamin D deficiency (86/137, 62.8%) than patients with mild illness (56/125, 44.8%; $p = 0.004$). In moderate-to-severe cases, the odds of deficiency more than doubled (OR 2.08, 95% CI 1.27–3.41), as Figure 2 further demonstrates. Additionally, the likelihood of being deficient was higher in patients with autoimmune comorbidities (38/54, 70.4%) than in those without (104/208, 49.1%) ($p = 0.01$, OR 2.47, 95% CI 1.30–4.69). Females had a larger percentage of deficit (57/92, 62.0%) than males (84/170, 49.4%), albeit this difference was not statistically significant ($p = 0.08$, OR 1.67, 95% CI 0.99–2.80). Likewise, the frequencies of deficiency were slightly greater among individuals under 20 years of age (47/76, 61.8%) than among those over 20 (95/186, 51.1%) ($p = 0.09$, OR 1.55, 95% CI 0.90–2.68). Vitamin D deficiency was not linked to the prevalence of diabetes mellitus; 11/23 (47.8%) of diabetic patients had the status, whereas 131/239 (55.6%) of non-diabetics did ($p = 0.21$, OR 0.76, 95% CI 0.32–1

Table 1. Baseline demographic and clinical characteristics of patients

Variable	Mean $\pm$ SD / n (%)
Age (years)	24.6 $\pm$ 8.9
Male sex	170 (64.9)
Female sex	92 (35.1)
Disease duration, months (median, IQR)	6 (3–12)
Autoimmune comorbidity (any)	54 (20.6)
Diabetes mellitus	23 (8.8)
Thyroid disease	14 (5.3)

Table 2. Distribution of vitamin D status among alopecia areata patients

Vitamin D category	n	%
Deficient (< 20 ng/mL)	142	54.2
Insufficient (21–29 ng/mL)	61	23.3
Sufficient (≥ 30 ng/mL)	59	22.5

Table 3. Association of vitamin D deficiency with demographic and clinical factors

Variable	Deficient n (%)	Sufficient/Insufficient n (%)	p-value
Sex: Male (n=170)	84 (49.4)	86 (50.6)	0.08
Sex: Female (n=92)	57 (62.0)	35 (38.0)	
Age < 20 years (n=76)	47 (61.8)	29 (38.2)	0.09
Age ≥ 20 years (n=186)	95 (51.1)	91 (48.9)	
SALT mild ($\leq 25\%$, n=125)	56 (44.8)	69 (55.2)	0.004
SALT mod–severe ($> 25\%$, n=137)	86 (62.8)	51 (37.2)	
Autoimmune disease present (n=54)	38 (70.4)	16 (29.6)	0.01
Autoimmune disease absent (n=208)	104 (49.1)	108 (50.9)	
Diabetes mellitus (n=23)	11 (47.8)	12 (52.2)	0.21
Non-diabetic (n=239)	131 (55.6)	108 (44.4)	

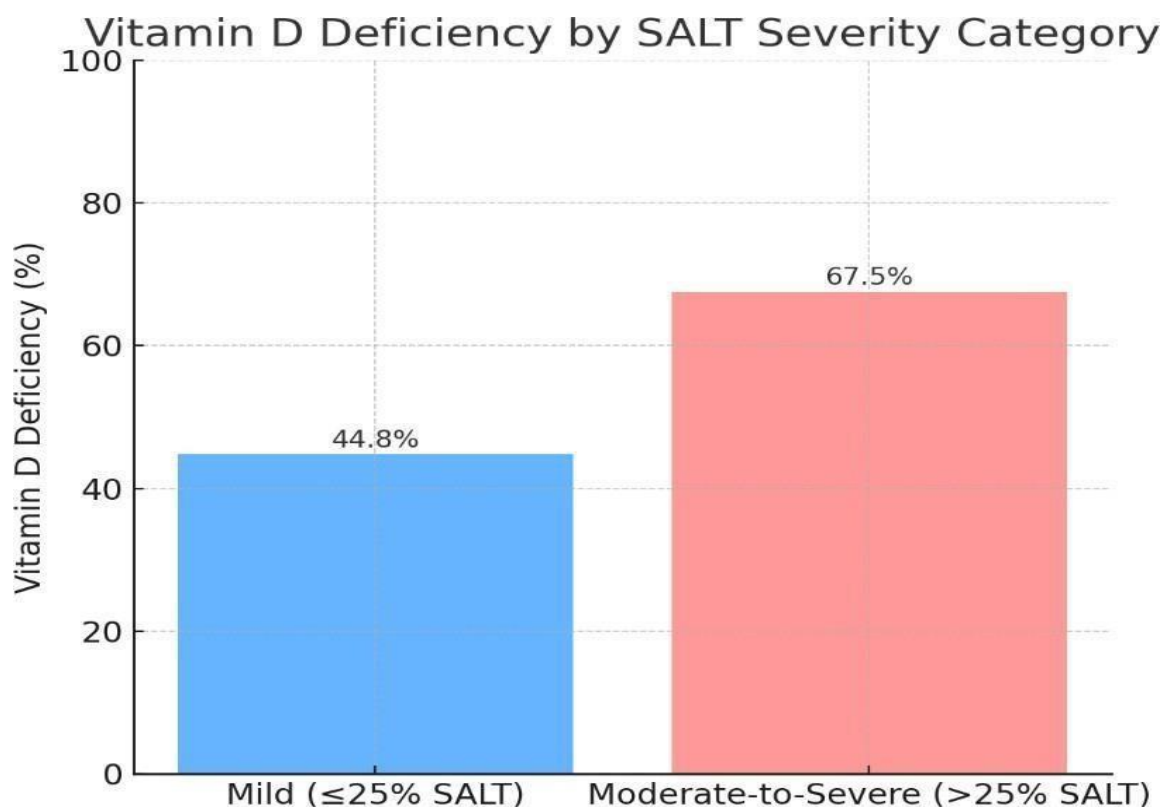


Figure 1: vitamin D categories among alopecia areata patients

Vitamin D Status Among Alopecia Areata Patients

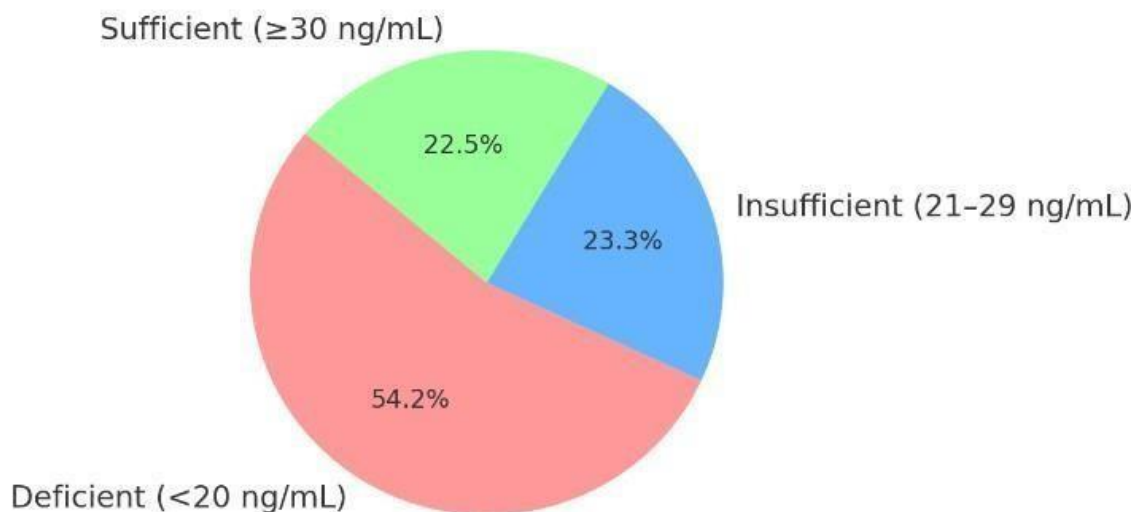


Figure 2: Proportion of vitamin D deficiency by SALT severity category ($p=0.004$).

Discussion:

This cross-sectional study evaluated the prevalence of vitamin D deficiency in alopecia areata (AA) patients in a Pakistani tertiary care dermatology environment. Only one-fifth of subjects had adequate levels of vitamin D, with over half (54.2%) being deficient and another 23.3% being insufficient. Crucially, autoimmune comorbidities and higher disease severity as determined by the SALT score were both substantially correlated with vitamin D insufficiency. In contrast, although females and younger patients tended to have higher deficiency rates, no significant variations were found by sex,

age, or diabetes status. Our discovery that vitamin D deficiency affected more than half of AA patients is consistent with multiple worldwide research. In Turkey, Ceriman and associates found that 91% of AA patients had a deficit, compared to 33% of controls, indicating a high correlation with the condition. A systematic review and meta-analysis by Lee et al., which included 14 studies, confirmed both lower mean 25(OH)D concentrations and increased odds of deficiency among AA patients.¹⁵ Similarly, Dovidio et al. in Italy found mean serum vitamin D levels significantly lower in AA patients compared to controls, with lower levels observed in severe phenotypes.⁷ More recent meta-analyses have echoed these conclusions, although heterogeneity in cut-off definitions and assay methods has been noted as a limitation.¹⁷ However, not every study shows statistically significant differences. Due to a small sample size and a high baseline deficiency in the local population, a study conducted in Rawalpindi, Pakistan, found mean vitamin D levels lower in AA than controls but did not reach significance.¹¹ Our study improves on this by using a larger sample size and stratifying by severity, which clearly shows a link between deficiency and moderate-to-severe disease. There is considerable biological support for vitamin D's involvement in AA. Normal cycling and immune privilege depend on the expression of the vitamin D receptor (VDR) in keratinocytes and immune cells within the follicular microenvironment.^{4,6} In vitro studies demonstrate that vitamin D analogues promote keratinocyte differentiation, and animal models lacking VDR signaling develop alopecia.¹⁸ Vitamin D also downregulates pro-inflammatory cytokines like interleukin-17 and interferon- γ , while enhancing regulatory T-cell activity.^{5,19} This immunomodulatory profile directly counteracts the breakdown of follicular immune privilege, which is thought to be the pathogenesis of AA. Therefore, mechanistic data is consistent with our observation of more severe disease in deficient patients. Interestingly, we found that patients with diabetes mellitus had somewhat lower rates of deficit, while this difference was not statistically significant. The literature that links vitamin D insufficiency to type 1 and type 2 diabetes contradicts this paradox.²⁰ One explanation could be treatment bias or survival bias. Diabetic patients in our sample would have been more likely to get dietary recommendations or supplements as part of their regular care, which would have mitigated deficiency despite underlying risk. Alternatively, the potential to identify real correlations may be limited due to the small number of diabetes (n=23). As a result, this discovery needs to be carefully evaluated and examined in bigger, prospective populations. This study has a number of advantages. It improves the accuracy of estimates by being one of the biggest single-center cohorts of AA patients assessed for vitamin D in Pakistan. Compared to immunoassays used in many previous findings, the use of liquid chromatography tandem mass spectrometry, which is regarded as the gold standard test, enhances reliability.²¹ We also employed established Endocrine Society definitions of deficit, which allowed for comparability with international literature. However, limits must be recognized. It is impossible to tell whether a deficiency causes AA development or is the outcome of disease-related behavioral changes (such as decreased sun exposure) due to the cross-sectional design, which limits causal inference. Because it was a single-center study, results might not apply to other provinces or rural populations. We did not account for dietary intake, sun exposure patterns, or seasonal change, all of which have an impact on vitamin D status. Non-probability successive sampling also raises the possibility of selection bias. Lastly, it is unable to directly quantify excess insufficiency above population background levels due to the absence of a healthy control group. Our findings have significant clinical relevance notwithstanding certain limitations. In our environment, systematic screening of vitamin D status in AA is reasonable because over half of patients were deficient and insufficiency was associated with autoimmune comorbidity and disease severity. Supplementing could be a straightforward, inexpensive supplementary treatment. Small studies show that topical calcitriol or oral supplementation improves SALT scores, despite the mixed results of randomized controlled trials of vitamin D analogues in AA.^{12,22} Larger, multi-center trials in South Asian populations are necessary to elucidate therapeutic benefit and optimal dosing. The significant prevalence of deficiency highlights the need for more comprehensive public health measures, such as sun exposure campaigns and nutritional fortification. Including vitamin D testing in dermatology clinics could aid in identifying high-risk patients, especially those with severe AA or other autoimmune conditions.

Conclusion

vitamin D deficiency was found in more than half of alopecia areata patients, and it was substantially linked to higher disease severity and autoimmune comorbidities. These results demonstrate how vitamin D screening and supplementation may be used as AA treatment adjuncts. To find out if correcting a defect improves patient outcomes, randomized trials and regular assessment must be included into clinical practice.

Author Contributions:

Najeeb Ullah Khan: study, designed the methodology, and drafted the initial manuscript. Khalid Iqbal: Assisted in data collection, analysis, and interpretation. Humaira Wazir: Contributed to patient recruitment and literature review. Hayat Khan: Supported data management and manuscript editing. Seyab Ur Rahman correspondence author Supervised the study, ensured data integrity

Conflict of Interest:

The authors declare no conflict of interest.

Consent:

Informed written consent was obtained from all participants prior to inclusion.

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