

## ORIGINAL RESEARCH

## ANESTHESIA FOR EYE / ENT SURGERY

# Effect of vitamin D<sub>3</sub> supplementation on Sinonasal Outcome Test-22 (SNOT-22) and visual analogue scale scores in patients with chronic rhinosinusitis

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## ABSTRACT

**Background & objective:** Chronic rhinosinusitis (CRS) is a persistent inflammatory condition of the nasal and paranasal sinus mucosa lasting more than 12 weeks. Symptoms such as nasal obstruction, facial pain, and olfactory dysfunction can substantially impair patients' quality of life. Vitamin D<sub>3</sub> has been proposed as a supportive therapy due to its anti-inflammatory and immunomodulatory properties. This study aimed to evaluate the effect of vitamin D<sub>3</sub> supplementation on CRS symptom severity using the Sinonasal Outcome Test-22 (SNOT-22) and the Visual Analog Scale (VAS).

**Methods:** This study employed a quasi-experimental design with a one-group pretest–posttest approach without a control group. A total of 17 patients with chronic rhinosinusitis were included. Participants received oral vitamin D<sub>3</sub> at a dose of 1,000 IU per day for 30 days. SNOT-22 and VAS scores were assessed before and after the intervention. Statistical analysis was performed using the Wilcoxon signed-rank test.

**Results:** Vitamin D<sub>3</sub> supplementation resulted in a significant reduction in symptom severity. The mean SNOT-22 score significantly decreased after the intervention ( $P = 0.004$ ). Similarly, VAS scores showed a significant reduction following supplementation ( $P = 0.005$ ), indicating improvement in pain and overall symptom burden.

**Conclusion:** Vitamin D supplementation was associated with significant improvement in symptoms and pain among patients with chronic rhinosinusitis. These findings suggest that vitamin D supplementation may serve as an effective adjuvant therapy for the management of chronic rhinosinusitis.

**Keywords:** Chronic rhinosinusitis; Pain; SNOT-22; Supplementation; Vitamin D<sub>3</sub>

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## 1. INTRODUCTION

Chronic rhinosinusitis (CRS) is a persistent inflammatory disorder of the nasal cavity and paranasal sinus mucosa, defined by the presence of symptoms lasting for at least 12 weeks. Cardinal symptoms include nasal obstruction, anterior or posterior nasal discharge,

facial pain or pressure, and olfactory dysfunction, ranging from hyposmia to anosmia. Additional manifestations, such as sneezing, nasal itching, and epiphora, may also be present. CRS is diagnosed based on clinical symptoms supported by objective evidence from nasal endoscopy or radiological imaging, particularly computed tomography (CT) of the paranasal

sinuses, demonstrating mucopurulent secretions and/or obstruction of the ostiomeatal complex.<sup>1</sup>

Clinically, CRS is classified into two major phenotypes: chronic rhinosinusitis with nasal polyps (CRSwNP) and chronic rhinosinusitis without nasal polyps (CRSsNP). CRSwNP is commonly associated with diffuse eosinophilic inflammation of the sinonasal mucosa, whereas CRSsNP is more frequently associated with localized inflammation and mechanical obstruction of the ostiomeatal complex.<sup>2</sup> Patients with CRSwNP generally experience more severe disease manifestations, including persistent nasal congestion, marked olfactory impairment, facial pain, and chronic rhinorrhea, than those diagnosed with CRSsNP.<sup>3</sup>

CRS represents a significant global health burden, with a substantial prevalence across different geographic regions. In Australia, approximately 1.9 million individuals are affected by CRS.<sup>4</sup> In the United States, the prevalence is estimated to be approximately 13% of the population, while in Europe, it reaches approximately 11%. In Asia, the reported prevalence rates range from 7 to 8% in China to 8.7% in South Korea and approximately 6% in Brazil.<sup>2</sup> Endoscopy-based population studies in South Korea have demonstrated a prevalence of 5.8% for CRSsNP and 2.6% for CRSwNP.<sup>5</sup> In Canada, CRS prevalence varies by age, increasing from 2.7% among individuals aged 20–29 years to 6.6% in those aged 50–59 years, before declining to 4.7% in populations older than 60 years.<sup>2</sup>

Epidemiological data on CRS in Indonesia are limited. However, hospital-based reports have indicated a considerable disease burden. CRS accounted for 33.3% of adult rhinologic cases at Dr. Mohammad Hoesin General Hospital in Palembang. Higher proportions have been reported at several tertiary referral hospitals, including M. Djamil Hospital Padang (83.8%), Dr. Kariadi Hospital Semarang (83.5%), Dr. Saiful Anwar Hospital Malang (85.9%), Dr. Soetomo Hospital Surabaya (65.5%), and Sanglah Hospital Bali (28.9%).<sup>6</sup> A study conducted at Dr. Zainoel Abidin Hospital, Banda Aceh, reported 239 CRS cases in 2019 and 211 cases in 2020, with a higher prevalence among males (58.9%) than females (41.1%).<sup>7</sup>

Recent studies have highlighted the potential role of vitamin D in CRS pathogenesis. Vitamin D is a secosteroid hormone synthesized in the skin through exposure to ultraviolet B radiation and is essential not only for calcium homeostasis and bone metabolism but also for immune regulation.<sup>8</sup> Vitamin D metabolism begins in the liver with the formation of 25-hydroxyvitamin D<sub>3</sub> [25(OH)D<sub>3</sub>], which is subsequently converted in the kidneys into its biologically active form, 1 $\alpha$ ,25-dihydroxyvitamin D<sub>3</sub> (calcitriol).<sup>9</sup> Serum 25(OH)D concentration is considered the primary

indicator of vitamin D status, and vitamin D deficiency has been associated with various inflammatory and atopic diseases, including asthma and allergic rhinitis.<sup>10</sup>

From an immunological perspective, CRSwNP is predominantly mediated by T-helper type 2 (Th2) immune responses, whereas CRSsNP is more commonly associated with the T-helper type 1 (Th1) pathways. Given the close association between CRS, atopy, and asthma, vitamin D is hypothesized to exert immunomodulatory effects in CRS, similar to those observed in other allergic airway diseases.<sup>11</sup> Several studies have demonstrated a significant association between low serum vitamin D levels and increased disease severity in CRS, and this association appears to persist irrespective of the presence of nasal polyps.<sup>12</sup>

The impact of CRS on patient-reported quality of life is commonly assessed using validated symptom questionnaires. The Sinonasal Outcome Test-22 (SNOT-22), developed by Piccirillo, is a widely used and validated instrument that comprehensively evaluates CRS-related symptoms in accordance with the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS), including nasal discharge, nasal obstruction, facial pain, and olfactory dysfunction, in accordance with the European Position Paper on Rhinosinusitis and Nasal Polyps.<sup>13</sup> SNOT-22 has become an essential tool in both clinical practice and research for assessing disease burden and treatment outcomes in patients with CRS.

Despite growing evidence linking vitamin D deficiency to CRS severity, data regarding the therapeutic effect of vitamin D supplementation on symptom severity and quality of life remain limited. Therefore, this study aimed to evaluate the effect of vitamin D supplementation on SNOT-22 and Visual Analog Scale (VAS) symptom scores in patients with chronic rhinosinusitis.

## 2. METHODS

This quantitative study employed a quasi-experimental design with a one-group pretest–posttest approach without a control group. The objective of this study was to evaluate changes in clinical outcomes before and after the administration of an intervention in patients with chronic rhinosinusitis. The study was conducted over a five-month period, from September 2024 to January 2025, at two secondary referral hospitals in North Sumatra, Indonesia: Drs. H. T. Amri Tambunan Hospital, Lubuk Pakam, and Bhayangkara Level II Hospital, Medan.

The study population consisted of patients diagnosed with chronic rhinosinusitis who were receiving treatment

at the participating hospitals during the study period. Purposive sampling was applied, whereby patients who met the inclusion criteria were selected based on their medical records and physician diagnoses. Eligible

**Table 1: Baseline characteristics of study participants**

| Characteristic    | Category | N (%)     |
|-------------------|----------|-----------|
| Age group (years) | 36–45    | 7 (41.2)  |
|                   | 46–55    | 9 (52.9)  |
|                   | >55      | 1 (5.9)   |
| Gender            | Male     | 5 (29.4)  |
|                   | Female   | 12 (70.6) |
| Total             |          | 17 (100)  |

participants were adults aged 20–60 years who were diagnosed with chronic rhinosinusitis according to the European Position Paper on Rhinosinusitis and Nasal Polyps (EPOS) 2020 criteria and who provided written informed consent after receiving a complete explanation of the study procedures. Recruitment continued until the minimum required sample size was achieved.

The minimum sample size was determined based on calculations for quasi-experimental studies with a pretest–posttest design, with consideration given to potential subject attrition during the study period. Based on this calculation, a minimum of 17 participants were required for inclusion in the study.

### 3. RESULTS

Seventeen patients diagnosed with chronic rhinosinusitis were included in the final analysis. All participants completed the study protocol and were included in the pre- and post-intervention assessments.

The age distribution of the study participants is shown in Table 1. Most patients were aged 46–55 years ( $n = 9$ , 52.9%), followed by those aged 36–45 years ( $n = 7$ , 41.2%). Only one participant (5.9%) was older than 55 years, and none were younger than 35 years. The sex distribution is presented in Table 1. The majority of the participants were female ( $n = 12$ ; 70.6%), while 29.4 % ( $n = 5$ ) were male.

Computed tomography (CT) findings of the paranasal sinuses are summarized in Table 2. Most patients demonstrated unilateral sinus involvement ( $n = 10$ ; 58.8%), whereas bilateral involvement was observed in 7 patients (41.2%). No pansinusitis cases were identified.

The distribution of the risk factors among the study participants is shown in Table 3. A history of allergic

**Table 2: Paranasal Sinus CT Scan Findings**

| CT scan finding | N (%)     |
|-----------------|-----------|
| Unilateral      | 10 (58.8) |
| Bilateral       | 7 (41.2)  |
| Pansinusitis    | 0 (0.0)   |
| Total           | 17 (100)  |

disease was the most common risk factor reported in 11 patients (64.7%). Non-allergic factors were identified in four patients (23.5%), while nasal anatomical abnormalities were observed in two patients (11.8%).

**Table 3: Distribution of risk factors among study participants**

| Risk factor                  | N (%)     |
|------------------------------|-----------|
| History of allergy           | 11 (64.7) |
| Non-allergic factors         | 4 (23.5)  |
| Nasal anatomical abnormality | 2 (11.8)  |
| Total                        | 17 (100)  |

Normality testing demonstrated that the data were not normally distributed ( $P < 0.05$ ). Therefore, the differences between the pre- and post-intervention scores were analyzed using the Wilcoxon signed-rank test.

As shown in Table 4, the mean SNOT-22 score significantly decreased from 48.00 at baseline to 41.76 after vitamin D supplementation ( $P = 0.004$ ). Similarly, the mean Visual Analog Scale (VAS) score showed a statistically significant reduction from 4.59 before treatment to 3.65 after treatment ( $P = 0.005$ ).

**Table 4: Wilcoxon Signed-Rank Test Results for SNOT-22 and VAS Scores**

| Variable | Assessment | Mean score | P-value |
|----------|------------|------------|---------|
| SNOT-22  | Pre-test   | 48.00      | 0.004   |
|          | Post-test  | 41.76      |         |
| VAS      | Pre-test   | 4.59       | 0.005   |
|          | Post-test  | 3.65       |         |

### 4. DISCUSSION

This study demonstrated that vitamin D supplementation was associated with a significant improvement in symptom severity and quality of life among patients with chronic rhinosinusitis, as reflected by a reduction in both SNOT-22 and Visual Analog Scale (VAS) scores. These findings support the potential role of vitamin D as an adjuvant therapy in the management of chronic rhinosinusitis.

In the present study, chronic rhinosinusitis was most frequently observed in patients aged 36–55 years. This finding is consistent with previous studies that reported a higher prevalence of chronic rhinosinusitis in middle-aged adults. Samara et al. reported that the highest incidence of chronic rhinosinusitis occurred in individuals aged 36–45 years.<sup>14</sup>], whereas Nugraha et al. found that the most affected age group was 46–55 years.<sup>15</sup> Age-related physiological changes in the sinonasal mucosa, including reduced mucociliary clearance and structural alterations of the nasal cavity, predispose older individuals to chronic inflammation and recurrent infections. Lifestyle factors, occupational exposure, and cumulative environmental pollutants may further contribute to disease development in this age group. However, other studies have reported a higher prevalence among younger adults, suggesting that chronic rhinosinusitis affects a broad age range and may be influenced by regional and environmental factors.<sup>16,17</sup>

The majority of patients in this study were female, which is in line with findings from Husni et al., who reported a higher proportion of female patients with chronic rhinosinusitis.<sup>14</sup> Hormonal factors have been proposed as possible explanations for this observation, as estrogen and progesterone may influence nasal mucosal blood flow, vascular permeability, and inflammatory responses.<sup>18</sup> Nevertheless, contrasting results have been reported in other studies, where a male predominance was observed.<sup>16</sup> Differences in smoking habits, occupational exposure, and healthcare-seeking behaviors may partly explain these discrepancies. These variations highlight that sex distribution in chronic rhinosinusitis is likely multifactorial and influenced by population characteristics.

With respect to radiological findings, unilateral sinus involvement was more common than bilateral involvement in this study. Similar findings were reported by Amalia and Wardhana, who observed a predominance of unilateral sinus involvement in patients with chronic sinusitis.<sup>19</sup> According to the Indonesian National Clinical Practice Guidelines, a detailed evaluation of sinus anatomy and disease distribution is essential for accurate diagnosis and management.<sup>20</sup> Differences in radiological patterns across studies may be attributed to variations in disease severity, sinus involvement, diagnostic methods, and healthcare facilities.

Allergic disease was identified as the most frequent risk factor among the study participants. This finding supports the existing evidence that allergic rhinitis plays a significant role in the pathogenesis of chronic rhinosinusitis. Allergic inflammation leads to persistent mucosal edema, impaired mucociliary clearance, and obstruction of sinus drainage pathways, creating a favorable environment for chronic infection.<sup>21,22</sup> The

strong association between allergy and chronic rhinosinusitis underscores the importance of addressing underlying allergic conditions in disease management.

The significant reduction in SNOT-22 scores following vitamin D supplementation observed in this study suggests an improvement in disease-related quality of life. Vitamin D has been shown to modulate both innate and adaptive immune responses, suppressing proinflammatory cytokines and enhancing epithelial barrier function. These immunomodulatory effects may reduce chronic mucosal inflammation in patients with chronic rhinosinusitis, particularly in those with allergic backgrounds. Similar improvements following vitamin D supplementation have been reported in previous studies involving patients with allergic rhinitis and chronic rhinosinusitis.<sup>23</sup> However, not all studies have demonstrated a consistent association between vitamin D levels and symptom severity, indicating that the therapeutic response may depend on the baseline vitamin D status, disease phenotype, and individual immune responses.<sup>24</sup>

In addition to symptom improvement, vitamin D supplementation in this study was associated with a significant reduction in pain severity, as measured by the VAS. Vitamin D has anti-inflammatory and analgesic properties, partly through inhibition of proinflammatory cytokines such as interleukin-6 and tumor necrosis factor- $\alpha$ . Previous studies on other inflammatory conditions have also demonstrated an inverse relationship between vitamin D levels and pain intensity, supporting the potential analgesic role of vitamin D.<sup>25,26</sup> Nevertheless, conflicting results have been reported for certain chronic inflammatory diseases, suggesting that the clinical effectiveness of vitamin D supplementation may vary according to disease mechanisms and patient characteristics.<sup>27</sup>

## 5. LIMITATIONS

This study had several limitations. The quasi-experimental design without a control group limits causal inference, and the relatively small sample size may reduce generalizability. In addition, serum vitamin D levels were not measured, preventing the assessment of the relationship between baseline vitamin D status and treatment response. Despite these limitations, this study provides preliminary evidence supporting the role of vitamin D supplementation as an adjunctive therapy in chronic rhinosinusitis.

## 6. CONCLUSION

Vitamin D<sub>3</sub> supplementation was associated with a significant reduction in symptom severity and pain, as

reflected by decreased SNOT-22 and Visual Analog Scale scores in patients with chronic rhinosinusitis. These findings suggest that vitamin D supplementation may serve as an effective adjuvant therapy by improving disease-related quality of life, potentially through immunomodulatory and anti-inflammatory mechanisms. Although further controlled studies with larger sample sizes are warranted, vitamin D supplementation appears to be a promising supportive treatment option for the comprehensive management of chronic rhinosinusitis.

## 7. Data availability

The numerical data generated during this research are available from the authors.

## 8. Conflict of interest

All authors declare that there was no conflict of interest.

## 9. Funding

The study utilized the hospital resources only, and no external or industry funding was involved.

## 10. Authors' contribution

SMS: Conception and design. provision of study materials or patients.

SS; ACR; MSAH: Conception and design, administrative support.

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