JKHWS
Jurnal Kesehatan Hesti Wira Sakti

ISSN 2302-4283 (print)
ISSN 2580-9571 (online)
Online di https://jurnal.poltekkes-soepraoen.ac.id
DOI: 10.47794/jkhws

THE RELATIONSHIP BETWEEN VITAMIN D LEVELS, BLOOD EOSINOPHILS, AND BODY MASS INDEX WITH THE DEGREE OF ASTHMA CONTROL IN BANJARMASIN

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ABSTRACT

Backgrounds: Asthma is a chronic inflammatory disease of the airways that remains a global health problem with high prevalence and significant relapse rates in Indonesia. Factors such as vitamin D levels, blood eosinophils, and body mass index (BMI) are thought to play a role in symptom control and asthma control. Vitamin D acts as an immunomodulator, eosinophils are associated with airway inflammation, and BMI reflects a patient's metabolic status, which can influence treatment response. **Aims:** Analyzing the relationship between vitamin D levels, blood eosinophils, and BMI with the degree of control of asthma patients in Banjarmasin. **Methods:** A cross-sectional study was conducted at Ulin Regional Hospital, Banjarmasin, in 2025. Subjects were asthma patients who met the inclusion and exclusion criteria. The degree of asthma control was assessed using the Asthma Control Test (ACT) questionnaire. Vitamin D levels were assessed using immunochemical methods, eosinophil levels were measured using a peripheral blood count, and BMI was calculated based on body weight and height. Data were analyzed using the Pearson correlation test and multivariate logistic regression with a significance level of $p<0.05$. **Results:** Most subjects were female with an average age of young adults. Higher absolute eosinophil levels (462 (18-1224) and 331.41 ± 168.18; $p=0.038$) and the presence of eosinophilia (73.7% and 26.3%; $p=0.018$) were significantly more common in the uncontrolled asthma group compared to the controlled asthma group. Regarding BMI, underweight individuals demonstrated a substantially higher risk of uncontrolled asthma compared with the overweight/obese group (adjusted OR 5.21; 95% CI 1.08–25.10; $p = 0.040$). **Conclusion:** High absolute eosinophil levels or the incidence of eosinophilia and underweight BMI are factors significantly associated with uncontrolled asthma.

Keywords: asthma, blood eosinophils, Body Mass Index, degree of asthma control, vitamin D.

HUBUNGAN ANTARA KADAR VITAMIN D, EOSINOFIL DARAH, DAN INDEKS MASSA TUBUH DENGAN DERAJAT KONTROL ASMA DI BANJARMASIN

ABSTRAK

Latar Belakang: *Asma merupakan penyakit inflamasi kronis pada saluran napas yang masih menjadi masalah kesehatan global dengan prevalensi tinggi dan angka kekambuhan yang signifikan di Indonesia. Faktor-faktor seperti kadar vitamin D, eosinofil darah, dan indeks massa tubuh (IMT) diduga berperan dalam pengendalian gejala dan tingkat kontrol asma. Vitamin D berperan sebagai imunomodulator, eosinofil berhubungan dengan inflamasi saluran napas, sedangkan IMT*

mencerminkan status metabolik pasien yang dapat memengaruhi respons terhadap pengobatan. ***Tujuan:*** *Menganalisis hubungan antara kadar vitamin D, eosinofil darah, dan IMT dengan derajat kontrol pasien asma di Banjarmasin.* ***Metode:*** *Penelitian cross-sectional dilakukan di RSUD Ulin Banjarmasin pada tahun 2025. Subjek penelitian adalah pasien asma yang memenuhi kriteria inklusi dan eksklusi. Derajat kontrol asma dinilai menggunakan kuesioner Asthma Control Test (ACT). Kadar vitamin D diperiksa menggunakan metode imunokimia, kadar eosinofil diukur melalui pemeriksaan darah perifer, dan IMT dihitung berdasarkan berat badan serta tinggi badan. Analisis data dilakukan menggunakan uji korelasi Pearson dan regresi logistik multivariat dengan tingkat signifikansi p < 0,05.* ***Hasil:*** *Sebagian besar subjek berjenis kelamin perempuan dengan rerata usia dewasa muda. Kadar eosinofil absolut yang lebih tinggi (462 [18–1224] dan 331,41 ± 168,18; p = 0,038) serta kejadian eosinofilia (73,7% dan 26,3%; p = 0,018) secara signifikan lebih banyak ditemukan pada kelompok asma tidak terkontrol dibandingkan kelompok asma terkontrol. Berdasarkan IMT, individu dengan status gizi kurang menunjukkan risiko asma tidak terkontrol yang lebih tinggi dibandingkan kelompok dengan berat badan berlebih/obesitas (adjusted OR 5,21; 95% CI: 1,08–25,10; p = 0,040).* ***Kesimpulan:*** *Kadar eosinofil absolut yang tinggi atau adanya eosinofilia serta IMT kurang merupakan faktor yang berhubungan signifikan dengan asma yang tidak terkontrol.*

Kata kunci: *asma, derajat kontrol asma, eosinofil darah, Indeks Massa Tubuh, vitamin D.*

ARTICLE INFORMATION

Article History
Received: November 18, 2025
Accepted: December 7, 2025
Available online: June, 2026

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INTRODUCTION

Asthma is a chronic inflammatory condition of the respiratory tract, which causes intermittent symptoms such as wheezing, shortness of breath (dyspnea), coughing, and chest tightness, accompanied by varying degrees of airway obstruction during expiration.[1] Most deaths occur during asthma exacerbations when prescribed treatment fails to control the symptoms of airway obstruction.[2]

Several internal (host) and external (environmental) factors play a role in asthma exacerbations. Internal factors include obesity, vitamin D levels, and blood eosinophils. [3–5] Vitamin D (Vitamin D) in its biologically active form (1,25-dihydroxyvitamin D3 [1,25(OH)2 D3]) is known to modulate the immune system. Several studies have shown a link between low vitamin D levels and asthma attacks, poor lung function, and the ineffectiveness of asthma medications.[2] The presence of eosinophils that accumulate in the respiratory tract is considered an effector cell that plays a key role in the development of asthma. High levels of eosinophils are generally found in the airways of most chronic asthma patients.[6,7] Many studies also report that being overweight and obese are among the triggers for asthma. Obesity is the most likely factor associated with

poor asthma control and quality of life.[8] Underweight individuals are also reported to be at risk of experiencing decreased lung function and asthma.[9]

Patient assessments to assess the level of asthma control are necessary to screen for uncontrolled asthma, so that ineffective therapy can be changed to more optimal, as well as implementing treatment guidelines more appropriately and providing education or knowledge about the dangers of uncontrolled asthma. The Asthma Control Test (ACT) is a measuring tool that can quickly and accurately assess a patient's level of asthma control based on how often asthma attacks occur in their daily lives.[10] This study aims to analyze the relationship between vitamin D levels, blood eosinophil counts, and body mass index with the degree of asthma control in Banjarmasin.

METHODS

A cross-sectional study involving 78 bronchial asthma patients at the Pulmonary Polyclinic of Ulin Regional General Hospital, Dr. H. Moch. Ansari Saleh Regional General Hospital, Sultan Suriansyah Regional General Hospital and Doctor's Practice in Banjarmasin from April 2025 to September 2025, divided into 39 patients with uncontrolled asthma and 39 patients with controlled asthma.

The inclusion criteria for this study included 1) patients diagnosed with bronchial asthma based on medical records and continuing to use standard medication therapy from the Pulmonary Polyclinic of Ulin Regional General Hospital, Dr. H. Moch. Ansari Saleh Regional General Hospital, Sultan Suriansyah Regional General Hospital, and physician practices in Banjarmasin, 2) aged between 15-59 years, 3) not experiencing exacerbations (the last exacerbation was at least 3 weeks prior), and 4) willing to be respondents after being given an explanation and signing an informed consent. The exclusion criteria for this study were 1) patients suffering from respiratory disorders other than asthma, such as pneumonia, chronic obstructive pulmonary disease (COPD), or other chronic respiratory conditions, as well as patients with infectious diseases, 2) patients on systemic corticosteroid therapy, and 3) patients who were still actively smoking, pregnant, or breastfeeding. The study sample was obtained using a purposive total sampling method using certain considerations according to the inclusion and exclusion criteria until the minimum sample size was met.

Asthma risk factors were evaluated, including serum vitamin D levels (25-hydroxyvitamin D), blood eosinophil levels, and body mass index. Vitamin D levels were reported as deficient (<20

ng/mL), insufficient (20-30 ng/mL), or optimal (>30 ng/mL). Blood eosinophil counts were reported as normal (0.02-0.5 $x10^9$/L) or eosinophilia (>0.5 $x10^9$/L). BMI was reported as underweight (<18.5 kg/m^2), normal (18.5-25 kg/m^2), or overweight (>25 kg/m^2). Asthma control was measured using the Asthma Control Test (ACT) upon arrival at the hospital. A score of <19 was considered uncontrolled asthma. Analysis was performed using SPSS 29th edition. Significant results were determined if $p<0.05$.

RESULTS

Table 1. Vitamin D levels, eosinophils and body mass index of all research subjects

Variable	Description
Vitamin D levels, median (min-max)	16.99 (5.5-52.7)
Absolute eosinophil level, median (min-max)	370 (18-1224)
Eosinophil levels, median (min-max)	5.36 (0.2-19.8)
Body mass index, mean ± SD	23.77 ± 4.97

Vitamin D levels in all study subjects showed a median value of 16.99 ng/mL with a range of 5.5 to 52.7 ng/mL. The median absolute eosinophil level was recorded at 370 cells/µL (18–1224 cells/µL), while the median eosinophil percentage was 5.36% with a range of 0.2–19.8%. In addition, the subjects' body mass index (BMI) had a mean value of 23.77 ± 4.97 kg/m^2, reflecting the variation in anthropometric status within the study population (Table 1).

Subjects with uncontrolled asthma had a median age of 45 years (19–60), while the controlled asthma group had a median age of 44 years (23–59). In the uncontrolled asthma group, the majority of subjects were female (74.4%), as was the case in the controlled asthma group (69.2%). The average body weight in the uncontrolled asthma group was 56.43 ± 13.51 kg, slightly lower than the controlled asthma group with 59 kg (range 35–115 kg). The average height in the uncontrolled asthma group was 155.56 ± 6.73 cm, while the controlled asthma group had a median height of 154 cm (143–179 cm) (Table 2).

Table 2. Demographics of research subjects based on degree of asthma control

Variable	Uncontrolled Asthma		Controlled Asthma	
	n (%)	Description	n (%)	Description
Age	-	45 (19-60)	-	44 (23-59)
Gender		-		-
Male	10 (25.6)		12 (30.8)	
Female	29 (74.4)		27 (69.2)	
Weight	-	56.43 ± 13.51	-	59 (35-115)
Height	-	155.56 ± 6.73	-	154 (143-179)

Table 3. The relationship between vitamin D levels and the degree of asthma control

Variable	Degree of Asthma Control Median (min-max)		p
	Uncontrolled Asthma	Controlled Asthma	
Vitamin D categories			0.150^f
Deficiency	31 (56.4)	24 (43.6)	
Insufficiency	7 (41.2)	10 (58.8)	
Optimal	1 (16.7)	5 (83.3)	
Vitamin D categories			0.200^f
Deficiency - Insufficiency	38 (52.8)	34 (47.2)	
Optimal	1 (16.7)	5 (83.3)	

‡Mann Whitney; ^{f}Fisher exact; *significant p<0.05

The distribution of vitamin D categories between the two groups did not show a significant difference (p = 0.150). When the vitamin D categories were stratified into deficiency–insufficiency versus optimal, the difference was also not significant (p = 0.200) (Table 3).

Table 4. The relationship between eosinophil levels and the degree of asthma control

Variable	Uncontrolled Asthma	Controlled Asthma	p
Absolute eosinophil levels	462 (18-1224)	331.41 ± 168.18	**0.038**‡*
Eosinophilia			**0.018**^{f*}
Yes	14 (73.7)	5 (26.3)	
No	25 (42.4)	34 (57.6)	

‡Mann Whitney; ^{f}Fisher exact; *significant p<0.05

The absolute eosinophil count in the uncontrolled asthma group (462 cells/µL; 18–1224) was higher than in the controlled asthma group (331.41 ± 168.18 cells/µL), with a statistically significant (p = 0.038). The proportion of eosinophilia was also higher in the uncontrolled asthma group (73.7%) than in the controlled asthma group (26.3%), and this difference was significant (p = 0.018). These results indicate that higher eosinophil counts and the presence of eosinophilia are associated with less controlled asthma (Table 4).

Table 5. The relationship between body mass index and degree of asthma control

Variable	Uncontrolled Asthma	Controlled Asthma	p
Body mass index	23.27 ± 5.11	24.27 ± 4.83	0.378†
Body mass index categories			0.243^f
Underweight	8 (72.7)	3 (27.3)	
Normoweight	18 (48.6)	19 (51.4)	
Overweight and obesity	13 (43.3)	17 (56.7)	

†Independent T-test; ^{f}Fisher exact; *significant p<0.05

The mean body mass index (BMI) in the uncontrolled asthma group was 23.27 ± 5.11 kg/m^2, slightly lower than the controlled asthma group which had an average of 24.27 ± 4.83 kg/m^2, but the difference was not statistically significant (p = 0.378). The distribution of BMI categories also did not show a significant difference (p = 0.243) (Table 5).

Table 6. Association between Vitamin D levels, eosinophil count, and BMI with asthma control status

Variable	*Crude*		*Adjusted*	
	OR (CI 95%)	***p***	**OR (CI 95%)**	***p***
Vtamin D level				
Deficiency–Insufficiency	1.00	Ref	1.00	Ref
Optimal	0.17 (0.02-1.60)	0.125	0.08 (0.00-1.23)	0.071
Eosinophil count				
Eosinophilia	1.00	Ref	1.00	Ref
Normal	0.26 (0.08-0.82)	0.022	0.18 (0.05-0.63)	0.007
BMI				
Overweight & obesity	1.00	Ref	1.00	Ref
Underweight	3.48 (0.77-15.79)	0.105	5.21 (1.08-25.10)	0.040
Normal	1.23 (0.47-3.26)	0.665	1.26 (0.44-3.64)	0.660

The association between vitamin D status, eosinophil count, and body mass index (BMI) with asthma control is presented in Table 6. Vitamin D levels did not show a statistically significant relationship with asthma control. In contrast, eosinophil count and nutritional status were significantly associated with the risk of uncontrolled asthma. Patients with a normal eosinophil count had a markedly lower likelihood of uncontrolled asthma compared with those with eosinophilia (adjusted OR 0.18; 95% CI 0.05–0.63; *p* = 0.007; crude OR 0.26; 95% CI 0.08–0.82; *p* = 0.022). Regarding BMI, underweight individuals demonstrated a substantially higher risk of uncontrolled asthma compared with the overweight/obese group (adjusted OR 5.21; 95% CI 1.08–25.10; *p* = 0.040). No significant difference was observed between the normal BMI group and the overweight/obese reference group (Tabel 6).

DISCUSSION

Patients with bronchial asthma in Banjarmasin were predominantly aged >40 years and female. A previous study in asthma patients by Pakkasela J, et al. evaluated 496 subjects with asthma. The median age at diagnosis and onset of asthma symptoms were 49 (37.75–58) and 40.5 (30–50) years for subjects with non-allergic asthma (p < 0.001). The majority of subjects were female (61.3%) and never smokers (52.7%).[11] Zhang Y, et al in a

study evaluating 140 asthma patients showed that the average age of the subjects was 46.1 ± 14.9 years.[12]

Asthma that occurs in adulthood is usually less allergic, more symptomatic, has a more significant decline in lung function, and a higher prevalence of obesity and female predominance.[13,14] Sensitization to allergens generally tends to decrease after early adulthood, which is thought to be due to low incidence and high remission or possibly a cohort effect.[15] One non-allergic phenotype that appears in adulthood is eosinophilic asthma, which is generally associated with chronic rhinosinusitis with or without polyposis and predominantly occurs in middle age. Long-term exposure to inhaled airway irritants such as tobacco smoke or occupational exposures has also been associated with non-allergic inflammatory mechanisms (e.g., neutrophilic), particularly in adult asthma.[14]

Asthma control in adults depends on many factors. A prospective cohort study analyzed the relationship between asthma control and adherence in young adults with asthma and found that comorbidities negatively impacted medication adherence.[16] Asthma in older adults differs from asthma in young people in many other ways, including genetic susceptibility, environmental influences, pathogenesis, type of airway inflammation, disease course, comorbidities, hospitalization rates, and clinical outcomes of treatment.[17]

In adulthood, women have a higher prevalence of asthma than men. Furthermore, women are more likely to suffer from severe asthma and have a later onset of asthma than men. Sex hormones are known to regulate the pathophysiology of asthma through several pathways. Clinical evidence suggests that an increase in asthma symptoms occurs in girls starting at puberty compared to boys.[18] Animal studies have shown that estrogen increases and testosterone decreases Th2-mediated airway inflammation.

In several animal studies, female mice exhibited increased eosinophil infiltration, serum IgE concentrations, and IL-13 protein expression in the lungs induced by ovalbumin (OVA) compared with male mice. The presence of ovarian hormones during the sensitization phase is required for maximal Th2-mediated airway inflammation in female mice. Estrogen and progesterone are also important for mucus production and mucociliary clearance. Administration of estrogen or progesterone to cultured human airway or nasal epithelial cells decreased mucus protein expression and mucus production compared with placebo-treated cells. Progesterone also decreased the ciliary beat frequency of cultured human airway epithelial cells. In

summary, sex hormones regulate the basic airway response to methacholine, smooth muscle contractility, and mucus production.[18]

This study found that the median vitamin D levels in the controlled asthma group were higher than those in the uncontrolled asthma group, with a statistically significant difference. Previous research by Sabaruddin H, et al., conducted at Wahidin Sudirohusodo Hospital involving 72 asthma patients, found a significant relationship between vitamin D levels and the degree of asthma control (p=0.028) and the severity of asthma (p=0.002). Subjects with uncontrolled asthma had lower vitamin D levels than those with partial or full control (13.54 ± 5.45 vs. 17.39 ± 4.87 vs. 16.99 ± 3.25). Subjects with uncontrolled asthma had a 2.8x (OR 2.80; p=0.037) higher risk of having low vitamin D levels (<20 ng/mL) compared to subjects with fully controlled asthma.[19] Zegmout A, et al who evaluated 174 asthma patients aged 18-65 years found that the prevalence of vitamin D deficiency reached 64%, with 36.3% of patients having normal vitamin D levels, 29.8% vitamin D insufficiency, and 33.9% vitamin D deficiency. Lower vitamin D levels were significantly associated with increased asthma severity (p=0.04) and worse asthma control (p=0.03). Patients with severe asthma had mean 25(OH)D3 levels of 24.1±11.8 ng/mL, compared with 32.5±13.1 ng/mL in patients with non-severe asthma. Well-controlled asthma was associated with higher vitamin D levels (28.3±12.5 ng/mL) compared with partially controlled asthma (24.7±10.8 ng/mL) and uncontrolled asthma (23.3±12.1 ng/mL).[20]

Previous studies have shown a significant association between vitamin D and the innate and adaptive immune system cells, as well as structural cells in the respiratory tract. Vitamin D deficiency can trigger inflammation, and supplementation can alleviate these effects. Vitamin D supplementation has been shown to reduce asthma exacerbations and improve asthma control, particularly in patients with severe asthma and low vitamin D status.[21,22] One way vitamin D works is through its metabolite, calcitriol, which binds to the vitamin D receptor and functions as a transcription factor, activating vitamin D-responsive genes found in most cells of the immune system. Calcitriol is also able to control the activity and proliferation of T lymphocytes while reducing inflammation and cytokine expression. Vitamin D has been shown to stimulate regulatory T cells (Tregs), reduce Th2 and Th17 immunological responses, and increase IL-10 production, all of which can lower IgE levels.[23]

This study found that absolute eosinophil levels in the uncontrolled

asthma group were higher than in the controlled asthma group, with a statistically significant difference. The proportion of eosinophilia was also higher in the uncontrolled asthma group (73.7%) than in the controlled asthma group (26.3%), with a significant difference.

A study by Damanik et al. on 25 asthma patients at the University of North Sumatra Hospital found that most patients had eosinophil levels <100 (84%), while 8% had levels between 100-300 and another 8% had levels >300. Regarding asthma control, 46.7% of patients were fully controlled, 43.3% were partially controlled, and 10% were uncontrolled. Statistical analysis showed a significant relationship between eosinophil levels and asthma control classification ($p = 0.009$), indicating that lower eosinophil levels are associated with better asthma control.[24] Bleecker ER, et al. in a large-scale study involving 718 asthma patients found that the risk of future exacerbations (mean ± SD) was significantly greater in patients with predominantly high (1.39 ± 2.20) and variable (1.41 ± 2.09) blood eosinophil levels compared to those with predominantly low (1.05 ± 1.66) blood eosinophil levels.[25]

The significance of the relationship between eosinophils and the underweight is related to the pathophysiology of asthma itself, where eosinophils play a very important role in the pathophysiology of asthma, especially the eosinophilic type of asthma. Inflammation associated with asthma is unique because it is accompanied by eosinophil infiltration, which distinguishes asthma from other inflammatory disorders of the airways. Eosinophils play an important role in asthmatic inflammation, as evidenced by the increase in eosinophils in bronchoalveolar lavage fluid after allergen inhalation during the late phase of the asthmatic response, which is accompanied by inflammation.[26] Blood eosinophil count is the most widely used indicator for eosinophilic asthma sufferers to initiate immune responses such as IL-5 monoclonal antibodies.[27] Blood eosinophil counts are also associated with asthma control and acute exacerbations (AEs). High eosinophil counts have been linked to the risk of future AEs in patients with asthma. In asthma, activated eosinophils have complex pathophysiological functions and contribute to persistent eosinophilic and type 2 (T2) inflammation in the airways.[28–31]

This study has several limitations. In this study, asthma severity was not examined as a factor that could influence the degree of patient asthma control. This study also did not include other variables that could potentially influence the degree of asthma control, such as asthma

phenotype, the presence of comorbidities or accompanying illnesses, adherence to treatment, and knowledge about asthma. Further research that seeks to evaluate the relationship between vitamin D levels, eosinophils, and body mass index (BMI) and the degree of asthma control should control for these variables.

CONCLUSION

The results showed that most of the subjects were women with an average age of young adults. There was no significant association between vitamin D levels and the degree of asthma control. Meanwhile, high blood eosinophil levels were significantly associated with poor asthma control, suggesting the involvement of inflammatory processes in worsening symptoms. These findings overall confirm that vitamin D status and blood eosinophils are important factors related to the degree of asthma control in the study population.

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