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Research Article

Prevalence and Contributing Factors of Vitamin D Deficiency among Anesthesiology Residents

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ABSTRACT

Background: Vitamin D plays a vital role in bone metabolism, immune function, and overall health. Healthcare professionals, particularly those working indoors, may be at increased risk for deficiency due to limited sunlight exposure. This study aimed to evaluate serum vitamin D levels and explore associated factors among anesthesiology residents.
Methods: A retrospective cross-sectional study was conducted among 50 anesthesiology residents at Dr. Wahidin Sudirohusodo General Hospital in Makassar from January to February 2025. Data were collected through self-administered questionnaires and medical records. Serum 25-hydroxyvitamin D [25(OH)D] levels were used to determine vitamin D status. Statistical analysis was performed using SPSS version 26, with P values < 0.05 considered significant.
Results: Among the 50 participants, 76% were found to be vitamin D deficient. No significant associations were found between vitamin D levels and sex, age, or BMI. However, vitamin D deficiency was more common among residents with obesity and younger age groups. Vitamin D supplementation ($p = 0.022$) and duration of sunlight exposure ($p = 0.029$) showed significant associations with serum vitamin D levels. Dietary intake and comorbidities were not significantly related to vitamin D status.
Conclusion: A high prevalence of vitamin D deficiency was observed among anesthesiology residents, likely due to occupational limitations on sun exposure. Supplementation and regular sun exposure appear to be protective factors. Targeted strategies, including routine screening and preventive interventions, are recommended for at-risk healthcare workers.

Introduction

Vitamin D (calciferol) is a fat-soluble pro-hormone essential for bone health and calcium homeostasis. It facilitates the absorption of calcium and phosphate in the intestine, supporting bone mineralization and muscle function. Approximately 80% of vitamin D is synthesized in the skin upon exposure to ultraviolet B (UVB) rays from sunlight, while the remaining amount is obtained from dietary sources or supplementation. A deficiency in vitamin D can lead to impaired bone mineralization, increasing the risk of osteomalacia in adults, rickets in children, osteoporosis, and muscle weakness [1]. Beyond skeletal health, vitamin D deficiency has been associated with numerous extraskeletal disorders, including cardiovascular disease, diabetes mellitus, autoimmune diseases, infections, mood disorders, and complications during pregnancy and infancy [1-2].

Sun exposure remains the most efficient and natural way to maintain adequate vitamin D levels. Experts

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suggest 5 to 30 minutes of sunlight exposure between 10 a.m. and 3 p.m., at least twice per week, targeting the face, arms, legs, or back without sunscreen [1-2]. However, multiple factors can influence cutaneous vitamin D synthesis, including age, skin pigmentation, use of sunblock, clothing, geographic location, air pollution, and certain medications or medical conditions that cause malabsorption [2-3]. Dietary sources of vitamin D include eggs, mushrooms, cod liver oil, and fatty fish such as salmon, tuna, trout, and sardines. Additionally, fortified foods like milk and dairy products contribute to daily vitamin D intake, particularly in populations with limited sun exposure [3-4].

Serum 25-hydroxyvitamin D [25(OH)D] is considered the most accurate biomarker for assessing vitamin D status. Levels below 75 nmol/L (30 ng/mL) are commonly considered insufficient, while concentrations under 25–30 nmol/L (10–12 ng/mL) are indicative of severe deficiency and have been linked to a heightened risk of osteomalacia and rickets [5]. The Endocrine Society classifies serum levels of 30–100 ng/mL as sufficient, with toxicity reported at concentrations above 125 ng/mL due to excessive supplementation. Deficiency is defined as levels below 20 ng/mL, and insufficiency as levels between 21–29 ng/mL [2].

Understanding the factors affecting vitamin D status is crucial, especially for individuals at risk due to lifestyle or occupational limitations on sun exposure. This study aims to evaluate serum vitamin D levels and explore the influencing factors among anesthesiology residents.

Methods

This study used a retrospective cross-sectional design to evaluate serum vitamin D levels and related influencing factors among anesthesiology residents (PPDS Anestesiologi) at Dr. Wahidin Sudirohusodo General Hospital in Makassar. The study was carried out from January to February 2025. This hospital serves as a tertiary referral and teaching hospital affiliated with Universitas Hasanuddin.

All anesthesiology residents who were actively assigned to clinical duties during the study period and working in the operating rooms were considered eligible. Residents who were pregnant, breastfeeding, on leave, or unable to participate during data collection were excluded. The final sample consisted of 50 participants, selected using a total sampling approach, as the number of eligible residents was limited and manageable.

Data were obtained from medical records and a structured self-administered questionnaire completed by participants. The questionnaire collected information on demographic characteristics (age, sex, and BMI), work patterns, sunlight exposure habits, dietary intake of vitamin D-rich foods, and use of vitamin D supplementation. Sunlight exposure and protection behaviors (e.g., use of sunscreen, time of day) were assessed using a scoring system adapted from previous studies.

Serum vitamin D levels were obtained from laboratory records based on 25-hydroxyvitamin D [25(OH)D] concentrations, which are considered the standard biomarker for assessing vitamin D status. These values were categorized according to widely used clinical thresholds to define sufficiency, insufficiency, or deficiency.

All completed questionnaires were reviewed for accuracy and completeness, then coded and entered into Microsoft Excel 2020. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 26 (IBM Corp., USA). Descriptive statistics were used to summarize the characteristics of the participants and their serum vitamin D status. Continuous variables were presented as means with standard deviations, while categorical variables were reported as frequencies and percentages. The association between vitamin D levels and potential influencing factors was explored using appropriate statistical tests, and a P value < 0.05 was considered statistically significant.

This study was approved by the institutional ethics committee, and written informed consent was obtained from all participants prior to data collection.

This study was approved by the Health Research Ethics Committee of the Faculty of Medicine, Universitas Hasanuddin, with approval number 1104/UN4.6.4.5.31/PP36l/2024. Written informed consent was obtained from all participants prior to data collection.

Results

This study involved 50 anesthesiology residents from Dr. Wahidin Sudirohusodo General Hospital. The majority of participants were male (74%) and aged between 21 and 35 years (88%), representing a relatively young population of health professionals.

Only a small proportion (12%) were in the 36–45 age group. Based on body mass index (BMI), most participants were classified as overweight or obese (68%), with 32% categorized as overweight, 36% as obesity grade I, and 8% as obesity grade II. The remaining participants were within the normal BMI range (22%), and one respondent (2%) was underweight. This distribution reflects a tendency toward higher body weight, which has been previously linked to alterations in vitamin D metabolism (Table 1).

Table 1- Characteristics of Respondents

Characteristic	Category	n	%
Sex	Male	37	74.0
	Female	13	26.0
Age	21–35 years	44	88.0

	36–45 years	6	12.0
Body Mass Index	Underweight	1	2.0
	Normal	11	22.0
	Overweight	16	32.0
	Obesity Grade I	18	36.0
	Obesity Grade II	4	8.0

The analysis of serum 25-hydroxyvitamin D [25(OH)D] levels revealed a concerning trend: 76% of respondents were vitamin D deficient, while only 24% had sufficient levels. This high prevalence of deficiency among anesthesiology residents indicates a potential occupational risk, as their daily routines typically involve limited sun exposure due to long working hours in indoor environments such as operating theaters and intensive care units (Table 2).

Table 2- Distribution of Serum Vitamin D Levels

Vitamin D Status	n	%
Deficient	38	76.0
Not Deficient	12	24.0

When the relationship between vitamin D status and respondent characteristics was examined (Table 3), no statistically significant association was found between sex and serum vitamin D levels (p = 0.398). However, more than half of male respondents (54%) experienced deficiency, suggesting a possible trend worth further investigation. Similarly, age did not show a significant correlation with vitamin D levels (p = 0.141), although younger residents appeared more likely to be deficient. The analysis of BMI also did not yield a statistically significant result (p = 0.276), but a pattern emerged indicating that individuals with obesity, particularly in grades I and II, were more prone to vitamin D deficiency compared to those with normal or lower BMI.

Discussion

This study found varying serum vitamin D levels among anesthesiology residents at Dr. Wahidin Sudirohusodo Hospital, with several individuals showing either deficiency or insufficiency. These results contrast with a study by Tantri et al., which reported a lower prevalence of vitamin D deficiency in Indonesian anesthesiology residents, with an average serum vitamin D level of 39.99 ng/mL. That study also found no significant associations between vitamin D levels and lifestyle factors such as supplement use, physical activity, or sun exposure [6]. In contrast, the current findings align with research conducted by Villasis-Keever et al., who reported a 69.4% prevalence of vitamin D deficiency among healthcare workers in Mexico. Type 2 diabetes and obesity were identified as major risk factors [7]. Environmental and occupational conditions also play a significant role. Park et al. showed that night shifts and limited physical activity contributed to lower vitamin D levels among adults in Korea [8]. These findings are particularly relevant for anesthesiology residents, who typically work indoors with minimal sun exposure. Similarly, a study from South Asia found a high rate of deficiency among anesthesiologists, with only 18.8% showing normal vitamin D levels. Ethnic background, such as Asian descent, was linked to an increased risk of deficiency [9].

Statistical analysis revealed no significant association between serum vitamin D deficiency and age, sex, or obesity status (p>0.05). However, a trend indicated that sex might influence vitamin D status. Female students were more likely to have low vitamin D levels than males. This trend supports earlier findings that women are at higher risk for vitamin D deficiency due to physiological and lifestyle factors [10–13]. For example, estrogen fluctuations and metabolic disorders can affect vitamin D metabolism [11-12]. Cultural norms, such as wearing clothing that limits sun exposure or spending more time indoors, may also contribute [10-11]. Nevertheless, some studies have reported that men may also be at high risk [14]. Although this study did not find a significant association between vitamin D levels and age or obesity, other research has shown a relationship. Vitamin D can accumulate in adipose tissue, reducing its bioavailability in circulation [15]. A meta-analysis found that individuals with obesity respond less effectively to vitamin D supplementation [16]. Additionally, serum vitamin D is inversely correlated with body mass index (BMI), total fat mass, visceral adiposity, and waist circumference [17]. Among the variables analyzed, vitamin D supplementation and sun exposure duration were significantly associated with reduced rates of vitamin D deficiency. Prior studies have demonstrated the effectiveness of supplementation in addressing deficiency [18-19].

Table 3- Association Between Contributing Factors and Serum Vitamin D Levels

Characteristic	Category	Deficient (n, %)	Not Deficient (n, %)	P value
Sex	Male	27 (54.0%)	10 (20.0%)	0.398
	Female	11 (22.0%)	2 (4.0%)	
Age	21–35 years	35 (70.0%)	9 (18.0%)	0.141
	36–45 years	3 (6.0%)	3 (6.0%)	
BMI	Underweight	1 (2.0%)	0 (0.0%)	0.276
	Normal	10 (20.0%)	1 (2.0%)	
	Overweight	12 (24.0%)	4 (8.0%)	

Obesity Grade I	11 (22.0%)	7 (14.0%)
Obesity Grade II	4 (8.0%)	0 (0.0%)

The Institute of Medicine recommends adequate daily intake to support bone health and prevent deficiency-related conditions [18]. In countries like Poland, prevention protocols include cholecalciferol and, in some cases, calcifediol for faster correction [19].

Sunlight exposure is a key factor in natural vitamin D synthesis, but its effectiveness depends on exposure duration, season, latitude, skin pigmentation, and environmental conditions [20]. For instance, elderly individuals in high-latitude areas of Ireland showed lower deficiency rates when they spent more time outdoors [21]. Factors such as UVB intensity, atmospheric pollution, and ozone levels can also influence cutaneous vitamin D production [22].

Maintaining optimal serum vitamin D levels is crucial not only for bone health but also for immune system support. Supplementation has been shown to reduce the risk of osteoporosis and autoimmune diseases, especially in individuals with low sun exposure. Thus, understanding the connection between vitamin D intake and serum levels can help inform dietary and preventive health strategies.

Further research should investigate optimal dosing and supplementation duration to establish clear guidelines. Encouraging healthy lifestyles, outdoor activities, and informed supplementation can collectively enhance vitamin D status in at-risk populations. Educational programs should be developed to inform the public about dietary sources of vitamin D and practical strategies for increasing intake. These efforts must be accessible and culturally sensitive, involving various stakeholders, such as schools, NGOs, and local governments.

Supplementation plays a vital role in maintaining optimal vitamin D levels, especially for individuals with limited sun exposure or those living in regions with low sunlight. Regular intake of vitamin D supplements can help prevent deficiencies that contribute to weakened bones, compromised immunity, and increased susceptibility to chronic conditions. Public health strategies that promote access to supplements, routine screening, and educational outreach are essential for early detection and prevention.

While sun exposure remains a natural source of vitamin D, it is not always sufficient—making dietary intake an important complementary strategy. Foods rich in vitamin D, such as fatty fish, eggs, and fortified dairy products, support calcium absorption and overall health. Additionally, vitamin D levels are intricately linked with comorbidities; chronic diseases like diabetes, hypertension, and cardiovascular conditions can impair vitamin D metabolism, and deficiencies may worsen these conditions. Ensuring adequate vitamin D—through supplementation, diet, and lifestyle—can mitigate health risks and support long-term well-being.

Conclusion

This study found a high prevalence of vitamin D deficiency among anesthesiology residents at Dr. Wahidin Sudirohusodo Hospital in Makassar. Most participants had serum vitamin D levels below the recommended threshold, suggesting that several factors may influence their vitamin D status. Limited sun exposure due to predominantly indoor work and minimal use of supplements were among the primary contributors. Body mass index also showed a correlation with vitamin D levels, while trends suggested that men and certain age groups may be more prone to deficiency.

Based on these findings, routine screening for vitamin D levels is recommended for medical personnel, particularly those with restricted sun exposure. Increasing awareness about the importance of vitamin D, its natural sources, and the health risks of deficiency is also essential. Encouraging lifestyle changes, such as regular outdoor activity in the morning and a balanced diet that includes fatty fish, egg yolks, and fortified foods, may help improve vitamin D status.

Vitamin D supplementation should be considered, especially for individuals with confirmed deficiency or high risk. A daily dose of 2000 IU is generally effective and safe for maintaining adequate levels, while higher doses up to 4000–6000 IU may be needed in more severe cases. These steps are vital to support the overall health and well-being of healthcare workers.

References

[1] Holick MF. Vitamin D deficiency. N Engl J Med. 2007;357(3):266–81.
[2] Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, et al. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. J Clin Endocrinol Metab. 2011;96(7):1911–30.
[3] Calvo MS, Whiting SJ, Barton CN. Vitamin D intake: a global perspective of current status. J Nutr. 2005;135(2):310–6.
[4] Ovesen L, Andersen R, Jakobsen J. Geographical differences in vitamin D status, with particular reference to European countries. Proc Nutr Soc. 2003;62(4):813–21.
[5] Martineau AR, Jolliffe DA, Hooper RL, Greenberg L, Aloia JF, Bergman P, et al. Vitamin D supplementation to prevent acute respiratory tract infections: systematic review and meta-analysis of

individual participant data. BMJ. 2017;356:i6583.

[6] Tantri AR, Soenarto RF, Firdaus R, Theresia S, Anakotta V. Low Incidence of Vitamin D Levels Deficiency in Anesthesiology PPDSts: A Cross-Sectional, Retrospective Study. Bali J Anesthesiol. 2022;6(4):210.

[7] Villasis-Keever MA, Zurita-Cruz JN, Garduño-Espinosa J, López-Alarcón M, Barradas Vázquez AS, Miranda-Novales MG, et al. Factors associated with vitamin D deficiency in health care workers exposed to SARS-CoV-2: a cross-sectional study. Front Nutr. 2024;11:1440185.

[8] Park HY, Lim YH, Park JB, Rhie J, Lee SJ. Environmental and occupational factors associated with vitamin D deficiency in Korean adults: the Korea National Health and Nutrition Examination Survey (KNHANES) 2010–2014. Int J Environ Res Public Health. 2020;17(24):9166.

[9] Bishnoi S, Gombar S, Ahuja V, Bhardwaj N, Kaur J. Vitamin D Levels of Anesthesiologists Working in Tertiary Care Hospital of South Asian Country: An Observational Study. J Anaesthesiol Clin Pharmacol. 2021;37(2):237.

[10] Alharbi AA, Alharbi MA, Aljafen AS, Aljuhani AM, Almarshad AI, Alomair IA, et al. Gender-specific differences in the awareness and intake of Vitamin D among adult population in Qassim Region. J Family Community Med. 2018; 25(3):148-154.

[11] Yan X, Zhang N, Cheng S, Wang Z, Qin Y. Gender differences in vitamin D status in China. Med Sci Monit. 2019;25:7094–101.

[12] Ciarambino T, Crispino P, Minervini G, Giordano M. Vitamin D: can gender medicine have a role? Biomedicines. 2023;11(6):1762.

[13] Alsheekh AMA, Abais MF, Eljamay SM. Vitamin D Deficiency Relationship with Age and Gender. Derna Acad J Appl Sci. 2025;3(2).

[14] Vallejo MS, Blümel JE, Arteaga E, Aedo S, Tapia V, Araos A, et al. Gender differences in the prevalence of vitamin D deficiency in a southern Latin American country: a pilot study. Climacteric. 2020;23(4):410–6.

[15] Bennour I, Haroun N, Sicard F, Mounien L, Landrier JF. Vitamin D and obesity/adiposity—a brief overview of recent studies. Nutrients. 2022;14(10):2049.

[16] Perna S. Is vitamin D supplementation useful for weight loss programs? A systematic review and meta-analysis of randomized controlled trials. Medicina. 2019;55(7):368.

[17] McGill AT, Stewart JM, Lithander FE, Strik CM, Poppitt SD. Relationships of low serum vitamin D3 with anthropometry and markers of the metabolic syndrome and diabetes in overweight and obesity. Nutr J. 2008;7:4.

[18] Bordelon P, Ghetu MV, Langan RC. Recognition and management of vitamin D deficiency. Am Fam Physician. 2009;80(8):841–6.

[19] Płudowski P, Kos-Kudła B, Walczak M, Fal A, Zozulińska-Ziółkiewicz D, Sieroszewski P, et al. Guidelines for preventing and treating vitamin D deficiency: a 2023 update in Poland. Nutrients. 2023;15(3):695.

[20] Sakamoto RR. Sunlight in vitamin D deficiency: Clinical implications. J Nurse Pract. 2019;15(4):282–5.

[21] O'Sullivan F, Laird E, Kelly D, van Geffen J, van Weele M, McNulty H, et al. Ambient UVB dose and sun enjoyment are important predictors of vitamin D status in an older population. J Nutr. 2017;147(5):858–68.

[22] Wacker M, Holick MF. Sunlight and Vitamin D: A global perspective for health. Dermatoendocrinol. 2013;5(1):51–108.