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The Dermatological Effects of Vitamin D: Addressing Pore Size and Skin Roughness

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Abstract*. Vitamin D, or calciferol, is a fat-soluble vitamin produced endogenously when ultraviolet (UV) light triggers its synthesis in the skin. It also comes from food and supplements, existing as D2 (ergocalciferol) and D3 (cholecalciferol). Both forms convert into the active form, calcitriol, in the liver and kidneys, with D3 more effectively raising blood levels. Vitamin D supports bone health, regulates cellular functions, and offers anti-inflammatory, antioxidant, and neuroprotective benefits. It improves skin health by regulating oil production, soothing inflammation, promoting skin renewal, and strengthening the skin barrier. Deficiency (<20 ng/dL) weakens the skin barrier, causing dryness and roughness. The global prevalence of vitamin D deficiency is rising, with Southeast Asia, including Indonesia, experiencing rates between 35.1% and 91.7%. This study explores the relationship between vitamin D levels and skin health, focusing on pores and roughness in geriatric populations. This cross-sectional study analyzed 26 elderly, measuring vitamin D levels (Vitamin D 25-hydroxy (25(OH)D), skin pore size, and roughness (RGB analysis), with Spearman and partial correlation assessing relationships while controlling for age. Bivariate analysis showed a significant positive relationship between vitamin D levels and pore size (p = 0.03) and a strong, statistically significant relationship between pore size and skin roughness (p < 0.01). Vitamin D influences skin health, including pore size and texture. Monitoring vitamin D levels enables early intervention, improving skin appearance, reducing roughness, and preventing complications from vitamin D deficiency.*

Keywords*: Dermatology, Skin pores, Skin roughness, Vitamin D*

Abstrak. Vitamin D, atau kalsiferol, adalah vitamin yang larut dalam lemak yang diproduksi secara endogen saat sinar ultraviolet (UV) memicu sintesisnya di kulit. Vitamin ini juga berasal dari makanan dan suplemen, yang ada sebagai D2 (ergokalsiferol) dan D3 (kolekalsiferol). Kedua bentuk tersebut diubah menjadi bentuk aktif, kalsitriol, di hati dan ginjal, dengan D3 lebih efektif meningkatkan kadar darah. Vitamin D mendukung kesehatan tulang, mengatur fungsi seluler, dan memberikan manfaat antiinflamasi, antioksidan, dan neuroprotektif. Vitamin D meningkatkan kesehatan kulit dengan mengatur produksi minyak, meredakan peradangan, memicu regenerasi kulit, dan memperkuat sawar kulit. Kekurangan (<20 ng/dL) dapat melemahkan sawar kulit, menyebabkan kulit menjadi kering dan kasar. Prevalensi kekurangan vitamin D secara global meningkat, dengan Asia Tenggara, termasuk Indonesia, mengalami peningkatan antara 35,1% dan 91,7%. Studi ini mengeksplorasi hubungan antara kadar vitamin D dan kesehatan kulit, dengan fokus pada pori-pori dan kekasaran pada populasi geriatri. Studi cross-sectional ini melibatkan 26 lansia, mengevaluasi kadar vitamin D (25-hidroksi vitamin D/25(OH)D), ukuran pori-pori kulit, serta tingkat kekasaran kulit (analisis RGB). Hubungan antar variabel dianalisis menggunakan uji korelasi Spearman dan korelasi parsial dengan mengontrol faktor usia. Hasil analisis bivariat menunjukkan adanya hubungan positif yang signifikan antara kadar vitamin D dan ukuran pori-pori (p = 0,03), serta hubungan yang kuat dan signifikan antara ukuran pori-pori dan kekasaran kulit (p < 0,01). Temuan ini menunjukkan bahwa vitamin D dapat memengaruhi kesehatan kulit, termasuk ukuran dan tekstur pori-pori. Pemantauan kadar vitamin D memungkinkan intervensi dini, memperbaiki penampilan kulit, mengurangi kekasaran, dan mencegah komplikasi akibat kekurangan vitamin D.

Kata kunci: Dermatologi, Pori-pori kulit, Kekasaran kulit, Vitamin D

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1. INTRODUCTION

Vitamin D, or calciferol, is a fat-soluble vitamin that can be produced endogenously. Endogenous production occurs when ultraviolet (UV) light from the sun hits the skin, triggering the synthesis of vitamin D.(Dominguez et al., 2021) Apart from being synthesized by the skin, vitamin D can also be obtained from food and supplements. Vitamin D consists of 2 primary forms, namely D2 (ergocalciferol) and D3 (cholecalciferol). After exposure to sunlight or food intake, both forms of vitamin D will be bound by proteins in the blood and then converted into the active form, calcitriol, in the liver and kidneys.(Janoušek et al., 2022) Vitamin D has the most widely recognized function in bone health and in regulating many cellular functions in the body.(Mavar et al., 2024)

Vitamin D also has anti-inflammatory, antioxidant, and neuroprotective properties that support the immune system. The anti-inflammatory properties of vitamin D contribute to reducing irritation and promoting an even, healthy skin texture. In addition, vitamin D can soothe the skin and reduce the risk of acne or eczema.(Danimayostu et al., 2023) This mechanism occurs through the reduction of excess oil production that can clog pores and the correction of imbalances in skin function. By regulating oil production and supporting the balance of skin cells, vitamin D helps prevent pore clogging, leading to inflammation and acne formation, while relieving eczema symptoms caused by irritation and inflammation. Calcitriol will encourage skin cell production and renewal and support cell turnover so skin texture remains smooth and even. This new skin cell turnover prevents pore clogging, which can lead to large pores.(Ao et al., 2021)

In addition, vitamin D also strengthens the skin barrier, preventing moisture loss and protecting the skin from environmental stresses that cause dryness, irritation and roughness. The normal blood vitamin D level is 30-100 ng/dL. It is considered deficient if the level is <20 ng/dL. Vitamin D deficiency causes the natural skin barrier function to weaken, resulting in rough and uneven skin as the skin struggles to retain moisture and shed dead cells effectively.(Yeon & Nafaisa, 2024) In recent years, it has been reported that the prevalence of vitamin D deficiency is increasing significantly worldwide. Based on regional comparisons, the Middle East and South Asia have the highest vitamin D3 deficiency. The prevalence of vitamin D deficiency in Malaysia (2017) was 60%; in India (2018) was 61.3%. In comparison, the prevalence of vitamin D deficiency in Indonesia ranges from 35.1% - 91.7%. This study aims to determine the relationship between vitamin D levels and size of pores and skin roughness to maintain skin health, especially in the geriatric population.(Siddiqee et al., 2021)

2. METHODS

Study Design

This cross-sectional, analytic observational study was conducted at the Santa Anna Elderly Home to investigate the role of vitamin D in influencing skin texture, specifically pore size and skin roughness, in older adults. A total of 26 elderly participants, aged over 50 and meeting the inclusion criteria, were selected using total sampling. Inclusion criteria required participants to undergo skin examinations and provide blood samples for vitamin D analysis. Exclusion criteria included individuals with skin disorders, vitamin D metabolism disorders, or those taking high doses of vitamin D supplements or drugs affecting vitamin D levels.

Variables and Instruments

Vitamin D levels (25(OH)D) were measured from venous blood samples using the ELISA method under standard laboratory protocols. Skin pore size and roughness were assessed with high-resolution dermatological imaging tools, which measured RGB (Red, Green, Blue) Pore and RGB Roughness values across multiple facial areas.

Statistical Analysis

The study employed Spearman correlation to evaluate the relationship between vitamin D levels, pore size, and skin roughness, given the expected non-normal data distribution. Partial correlation analysis, controlling for age, was also performed to determine the independent effect of vitamin D levels on skin texture while accounting for age. This research received ethical approval from the Human Research Ethics Committee of Tarumanagara University.

3. RESULT AND DISCUSSION

This study involved 26 elderly respondents with an average age of 73.53 years with an age range of 52 to 88 years. Most respondents were female (69.2%), while the average vitamin D level of respondents was 20.15 ng/mL. Respondents' average skin pore analysis was 22.19%, with a minimum value of 5% and a maximum of 46%. Meanwhile, the average skin roughness had a minimum value of 16% and a maximum of 31%, so average was 19.50%. (Table 1)

Table 1. Respondents Characteristics

Parameter	N (%)	Mean (SD)	Med (Min-Max)
Age (years)	26 (100)	73.53 (1.79)	73.50 (52-88)
Gender			
Male	8 (30.8)		
Female	18 (69.2)		
Vitamin D (ng/mL)		20.15 (1.32)	20 (12-42)
Pore (%)		22.19 (1.43)	21.50 (5-46)
Roughness (%)		19.50 (0.63)	19 (16-31)

Spearman analysis showed that vitamin D had a moderate and significant positive correlation with pore size (r=0.46, p=0.02) and roughness (r=0.46, *p*=0.02). Thus, low vitamin D levels can lead to poor pore size and roughness. In addition, the pore is strongly and significantly correlated to roughness (r=<0.01, *p*=0.99). This means poor pores size will result in poor roughness (Table 2).

Table 2. Correlation between Vitamin D, pore, and roughness

	Parameter		Vitamin D	Pore	Roughness
Spearman's rho	**Vitamin D**	Correlation Coefficient	1.00	0.46	0.46
		Sig. (2-tailed)	.	0.02	0.02
	Pore	Correlation Coefficient	0.46	1.00	0.99
		Sig. (2-tailed)	0.02	.	<0.01
	Roughness	Correlation Coefficient	0.46	0.99	1.00
		Sig. (2-tailed)	0.02	<0.01	.

Bivariate analysis showed the results of correlation analysis between Vitamin D, pores size, and roughness with the control variable of age. Considering the effect of age, it was found that there was a moderate positive relationship between Vitamin D and pore (r = 0.44, *p* = 0.03), which was statistically significant. The relationship between Vitamin D and roughness had a weak positive correlation (r = 0.39) but was not statistically significant (*p* = 0.05). In addition, with age control, Pore and Roughness showed a robust and statistically significant relationship (r = 0.95, *p* < 0.01). These results suggest that age as a control variable influences the relationship between variables, where its influence is more apparent in the significant relationships between Vitamin D and pore and between pore size and roughness. (Table 3)

Table 3. Correlation between Vitamin D, pore, and roughness with Age as a Controlling Variable

	Parameter		Vitamin D	Pore	Roughness
Age	**Vitamin D**	Correlation Coefficient	1.00	0.44	0.39
		Sig. (2-tailed)	.	0.03	0.05
	Pore	Correlation Coefficient	0.44	1.00	0.95
		Sig. (2-tailed)	0.03	.	<0.01
	Roughness	Correlation Coefficient	0.39	0.95	1.00
		Sig. (2-tailed)	0.05	<0.01	.

This finding underscores the correlation between vitamin D and pore and roughness. Pore quality will be achieved if vitamin D levels are normal. The sebaceous glands play a role in pore quality by producing sebum to lubricate the skin and maintain skin integrity. However, excess sebum production can clog pores, a significant factor in acne vulgaris. Vitamin D will prevent excess sebum production, reducing pore clogging and acne formation.(Janoušek et al., 2022; Khammissa et al., 2018; Khazai et al., 2008)

Vitamin D plays a role in keratinocyte proliferation and differentiation to maintain skin barrier integrity and ensure normal pore function. Vitamin D modulates the expression of key structural proteins filaggrin and involucrin to maintain a functional skin barrier and reduce pore blockage. Vitamin D deficiency will result in hyperkeratosis which make stratum corneum thickenned and clogged. This pore blockage or blackheads correlates with acne vulgaris due to abnormal keratinocyte turnover.(Chen et al., 2024)

In addition to playing a role in skin proliferation and differentiation and controlling sebum production, vitamin D has anti-inflammatory properties. Vitamin D receptor (VDR) activity will suppress pro-inflammatory cytokines such as TNF-α, IL-1, and IL-6 and promote the production of anti-inflammatory cytokine IL-10. This will dampen inflammation in hair follicles and sebaceous glands, producing inflammatory acne lesions such as papules and pustules. Vitamin D also modulates the activity of skin immune cells, such as dendritic cells and T lymphocytes, which helps prevent the development of pore-related dermatoses.(Janjetovic & Slominski, 2024; Mostafa & Hegazy, 2014)

Chronic UV exposure will lead to ageing. Signs of ageing include fine lines, wrinkles, and pore dilation. Vitamin D has been shown to reduce the effects of sun ageing by modulating matrix metalloproteinase (MMP) activity, an enzyme that damages collagen and

elastin fibres in the dermis. Calcitriol will reduce MMP activity, thus maintaining skin integrity and preventing pore enlargement.(Amaro-Ortiz et al., 2014; Rittié & Fisher, 2015)

The analysis also found that vitamin D had a moderate and significant positive correlation with roughness. Vitamin D functions on the epidermal barrier, consisting of lipids and proteins. This barrier function will maintain the skin's hydration, softness, and integrity. If this function is disrupted, it will cause excessive water loss through the epidermis or transepidermal water loss/TEWL. TEWL will cause dryness, roughness and formation of scaly or flaky skin. Calcitriol stimulates the expression of enzymes involved in lipid synthesis, such as SCD1 (stearoyl-CoA desaturase 1), which is important for producing ceramide, cholesterol, and free fatty acids. These lipids will contribute to maintaining smooth and supple skin.(Gutiérrez-Juárez et al., 2006; Russell, 2012)

Pores size and roughness have a significant and intense relationship as they are interdependent. Ageing leads to loss of collagen and elastin fibres, which causes pores to become more prominent, causing rough skin texture. The two are connected because enlarged pores are often associated with skin that has reduced elasticity, hydration, or warmth. In addition, age causes the skin to lose the ability to retain moisture, resulting in increased transepidermal water loss, which causes enlarged pores and roughness.(Miyamoto et al., 2021; Thadanipon & Kitsongsermthon, 2020)

The bivariate analysis found that aging process will make the skin undergoes physiological changes that will affect the skin's structure, function, and appearance, which are related to pores size and roughness. Age causes the epidermis to thin due to decreased keratinocyte proliferation ability and skin barrier disruption. Thus, pores become more significant and skin roughness increases. With aging, there is also a decrease in collagen and elastin production, which plays a role in pore size and roughness. In addition, sebaceous glands in the elderly become less active, so the skin becomes dry and rough.(He et al., 2023; Miyamoto et al., 2021, 2023)

After controlling for age, the moderate and significant positive association between vitamin D and pores size suggests that structural changes in the skin are age-related. With aging, there is a decrease in collagen and elastin production, which make the skin loses its structural support, causing pores to become visible. In addition, in the elderly, there is a decrease in sebum production, which causes the skin to become dry and pores to appear more prominent. The skin barrier function also decreases with aging, reducing hydration and lipid production and affecting skin texture, especially pore size.(He et al., 2023)

However, there was a weak positive and insignificant relationship between vitamin D and roughness after age was used as a control variable. This analysis suggests skin becomes dry with aging due to decreased sebaceous gland activity and a weakened lipid barrier. It is known that vitamin D can regulate sebum production, but this is not enough to overcome the more significant loss of hydration and barrier function due to ageing. Thus, the effects of vitamin D, which helps keep the skin soft, become less noticeable in the elderly due to ageing.(Russell, 2012)

With aging, there is an abnormal deficiency of keratinocytes, resulting in hyperkeratinocytes and rough skin. Although vitamin D plays a role in keratinocyte differentiation, this effect cannot overcome such significant changes due to ageing. Therefore, the weak correlation between vitamin D and roughness is due to the dominant role of the age factor.(Cao et al., 2020; Csekes & Račková, 2021)

4. CONCLUSION

Vitamin D plays an important role in maintaining healthy skin, with its influence extending across various dermatological aspects, including pore size and skin texture. Healthcare providers can more easily identify individuals at risk of developing rough skin conditions and enlarged pores by routinely monitoring vitamin D levels, allowing for quicker intervention. This proactive approach can help improve the appearance of the skin and its overall health, as well as reduce the severity of a dermatological problem, such as enlarged pores and roughness while preventing further complications related to vitamin D deficiency.

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