REVIEW ARTICLE

Exposure to Ultraviolet B Rays in Adolescents as a Stunting Prevention: A Scoping Review

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ABSTRACT

Stunting is a growth failure due to chronic malnutrition that needs to be prevented as early as possible through nutrition optimalization, including vitamin D. Vitamin D is a micronutrient that can be obtained through exposure to ultraviolet B (UVB). However, the role of exposure to UVB rays on vitamin D levels as a stunting prevention still requires further study. This study aims to describe ultraviolet B exposure on vitamin D. This study uses a scoping review approach which consists of five steps. The databases used were PubMed, Google Scholar, and ProQuest. Keywords include ultraviolet exposure, sunbathing, and vitamin D. The number of identified articles is reported on a PRISMA flow chart. JBI critical appraisal was carried out by both authors. Ten articles that met the inclusion criteria were obtained. The results revealed that exposure to UVB can increase levels of vitamin D, which plays a role in bone metabolism and prevention of stunting.

Keywords: Exposure to Ultraviolet Rays B, Vitamin D, Stunting, Adolescents

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INTRODUCTION

One of the health problems in children in Indonesia is stunting. Compared to other southeastern countries, the prevalence of stunting in Indonesia remains high. As of 2017, stunting affected 22.2%, or approximately 150.8 million, of children under the age of five worldwide. In the South-East Asia Region (SEAR), Indonesia is the third country with the highest incident of stunting with the prevalence 30.8% (1).

Stunting is a failure of growth and development which is caused by poor nutritional intake so that the child's height is shorter than children their age (2). According to the Indonesian Ministry of Health, the benchmark for stunting is the z-score. If the z-score is less than -2SD, it is categorized as stunting and if it is less than -3SD, it is classified as severe stunting (3). Stunting conditions will affect their childhood, adolescence, and adulthood. Stunting causes impaired growth, including cognitive and motor development retardation, suboptimal physical growth, and metabolic disorders (4–7). Eventually, cognitive capacities and academic performances may deteriorate. Aside from that, it weakens the body's immunity and increases the risk of obesity, diabetes, cancer, heart and blood vessel disease, stroke, and health impairments in the elderly later on, which leads to lower economic productivity (8)

The cumulative effect between generations affects the occurrence of stunting, such as the condition of the mother before pregnancy, during fetal development, and after giving birth. The causes of stunting are multifactorial. Broadly speaking, social, economic, environmental, and cultural conditions are the underlying determinants that contribute to intermediate factors (9). These factors include the fulfillment of maternal nutrition during pregnancy, both macronutrients and micronutrients, including vitamin D and the diversity of food types, access to health facilities, and environmental conditions such as sanitation and water hygiene (10). Unfulfilled calories and nutrients have implications for the inhibition of children's growth and development (9).

Indonesia is a tropical country where the sunlight emitted every day for 12 hours could be used optimally to fulfil the needs of vitamin D. Sources of vitamin D can come from food products, both plant and animal products such as fatty fish, egg yolks, and dairy products. In addition, vitamin D can be obtained from metabolism that occurs in the skin where 7- dehydrocholesterol in the skin is converted to pre-vitamin D with the help of UVB, which is then isomerized by body heat to vitamin D3. Then, it is stored in the liver and metabolized to the form of 25-hydroxyvitamin D (25-OH Vit D) which has been shown to be beneficial in calcium and phosphate regulation for bone health (11). Therefore, exposure to ultraviolet B rays is important in meeting the needs of vitamin D.

Although vitamin D is very beneficial for the body, vitamin D deficiency remains a health problem. The occurrence of vitamin D deficiency is influenced by many factors such as style of dress, skin pigmentation, duration of sun exposure, type of food consumption, and latitude of regions, such as South Asia and the Middle East (12–14). Vitamin D deficiency is reported to occur at all ages, including the elderly, adolescents, and children (14). In addition, women, including mothers, were significantly associated with lower serum 25(OH) D levels (13–15).

Until now, studies on the role of exposure to UV B rays on vitamin D as one of the way to prevent stunting are still limited, thus requiring further studies. Therefore, this study aims to describe UVB sunlight exposure on vitamin D. Scoping review is utilized in this study. This can facilitate researchers to explore topics that have not been widely studied and require broader references.

METHOD

Five stages of O'Maley's scoping review were used to answer the review questions (16). First, data search was conducted in some databases, including PubMed, ProQuest, and search engine Google Scholar. Keywords in English applied for all databases were ultraviolet exposure and "vitamin D", Keywords in Indonesian used in Google Scholar were berjemur, and "vitamin D," Articles discussing the effect of ultraviolet B exposure on vitamin D, published between the last ten years (2010-2020), written in Indonesian and English, and available in free full-text were included. This study was limited to original articles. Articles that met the criteria were assessed using the JBI Critical Appraisal. This assessment aims to get quality articles. The two authors, WM and HSM, were involved in assessing eligible articles. If there was disagreement, then both authors considered by discussing them to make a final decision. The 10 articles were extracted based on the author's information, year, purpose, place, sample, method, and research results (Figure 1).

RESULTS

The total number of articles obtained through Google Scholar was 1,660 articles in Indonesian and 17,700 articles in English. From PubMed database were obtained 104 articles and ProQuest as many as 2,548 articles. Articles found were published within the period 2011-2021. From the 10 identified articles, five were from Indonesia and the rest from various country. Data extraction (Table I) showed what interventions were given and how this affected the levels of serum 25 (OH) D.

The results of research numbers 1, 4, 5, 6, 7, 8, 9 and 10 show that the average concentration of vitamin D, in this case serum 25 (OH)D, before exposure to sunlight increased after the intervention (15,17–23). Meanwhile, study number 2 and 3 showed that the average concentration of vitamin D, in this case serum 25 (OH)D, before exposure to sunlight did not increase significantly after the intervention (24,25).

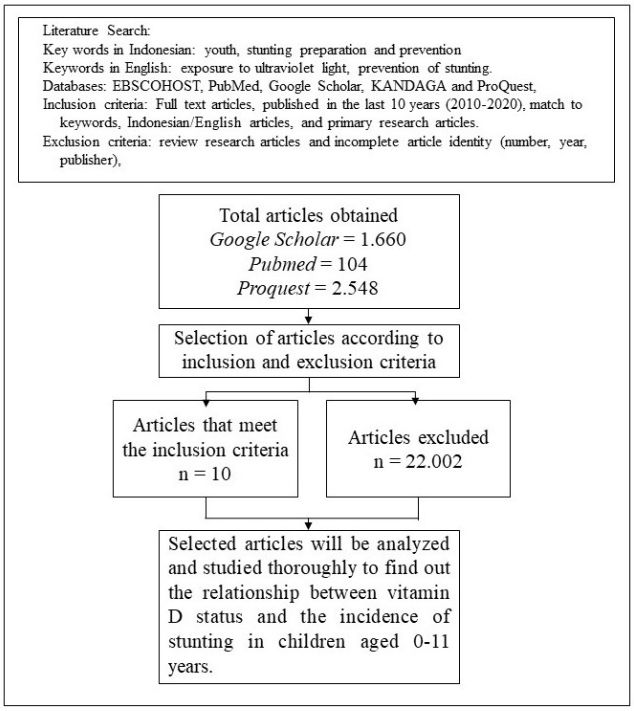

Figure 1: Flow chart of the review process

Based on the results of the analysis, several factors were identified that influence exposure to UVB rays to increase vitamin D levels and include physical activity, clothing materials, places exposed to UVB rays, both when working indoors and outdoors, habits of using sunscreen, and duration of exposure to sunlight. Vitamin D levels are known to be higher in people who work outdoors. In addition to exposure to UVB rays, the intake of foods containing vitamin D also has a significant effect on the level of vitamin D that a person acquires (15,19).

DISCUSSION

Vitamin D is a micronutrient that has a significant role in the growth process. Inadequate calcium and vitamin D have been linked with the prevalence of stunting in children aged 2-5 years (27,28).

Vitamin D is also known as the "Sunshine vitamin," and during sun exposure the skin converts 7-dehydrocholesterol into vitamin D3. Vitamin D3 has played a significant role in vertebrate evolution throughout history. Vitamin D is not only essential for bone health, but it also has a variety of biological roles that help in the prevention of chronic disease.

In the process of children's growth, Insulin-Like Growth

Table I. Data extraction

Title	Objective	Settings	Sample Research	Methods	Exposure Ultraviolet B Adolescents
The Role of Ultraviolet B Sunlight on Status Vitamin D and Blood Pressure in Women of Childbearing Age Yosephin P Betty, Khomsan Ali, Dodik, Briawan Rimbawan, (2014)	Analyzing sun exposure To improve vitamin d status, which results on improving blood pressure in women of childbearing age.	in Bogor Regency, West Java	21 healthy women of childbearing age.	Design Intervention study without a control group (one group pretest postest design)	The average concentration of vitamin D, in this case serum 25(OH)D before sun exposure was 15.7 ng/dL increased to 18.2 ng/dL
The Effectiveness of Pregnant Exercise With Ultraviolet Light Exposure for 15 Minutes on Vitamin D levels 25-OH in Pregnant Women Mulyani, Sri, Mawarti Indah,. (2020)	Indetifying the effectiveness of pregnancy exercise with ultraviolet light exposure	in PUSKESMAS, Jambi	16 pregnant women > 22 weeks	Pretest and posttest the design. Research measured vitamin d 25-OH pregnant exercise with uv light exposure for 15 minutes was carried out 3 times a week for 1 month	Result of the statistical test of the Asymp value. Sig for 0327> 0.05(α5%) to accept Ho. There is no significant difference between vitamin D levels before and after treatment
The Effect of Ultraviolet Light on Vitamin D Levels and Blood Pressure in Women in Islamic Boarding Schools in Palu City Masulili Fitria, Zainul, Junaidi (2017)	Determine the effect of ultraviolet light on vitamin D levels and blood pressure in women.	in Islamic boarding schools in Palu	11 women with hijab	Pre-experimental research design with pre-post test in one group. The intervention was irradiating morning ultraviolet rays to the face, arms and legs for 3 weeks. Data analysis with dependent t test.	The results of the analysis found that there was no difference in the mean vitamin D levels of women after the intervention (p value = 0.744)
Vitamin D levels after UVB radiation: effects by UVA additions in a randomized controlled trial. Sallander Ellinor, Wester Ulf, Emil Bengtsson, Desiree Wiegleb Edstrum, (2013)	To examine how different combinations of UVA and UVB radiation affect S-25(OH)D for the same vitamin D-weighted exposure.	Stockholm	UVB (n = 23) , UVAB (n = 23) and UVA (n = 10). The controls (n = 19) had no intervention.	Healthy participants were recruited and subsequently divided into four comparable groups regarding initial 25(OH)D value. The different radiations given were whole-body The exposure times were chosen to give the same calculated vitamin D effective dose (suberythemal exposures 1 standard erythema dose). Blood samples were collected before the first irradiation (t0), immediately after the last (fifth) irradiation (t1) and then after another 2 days after the last (fifth) irradiation (t2).	UVB and UVAB radiation significantly increased 25(OH) D levels. In the UVA group the increase was less with the same vitamin D-weighted radiation dose. Short sessions of UVB or UVAB radiation with the same vitamin D-weighted exposure increased 25(OH)D levels. The UVA dose does not influence 25(OH) D levels under short exposure times. However, there was a significantly lower increase of 25(OH)D levels during longer UVA irradiation (≥9 min).
Vitamin D intake and sun exposure in people who work indoors and outdoors Rimahardika Rosita et al. (2017)	Comparing vitamin D intake and sun exposure between people who work indoors and outdoors.	Sayung Subdistrict,, Demak Regency	60 samples aged 19-64 years were taken by consecutive sampling	Descriptive analytical performed with vitamin D intake measured by SQ-FFQ, analyzed using nutri survey. Sun exposure was obtained through interviews using a questionnaire and recall of sun exposure 3x24 hours. Data were analyzed using descriptive and bivariate tests	Frequency of sun exposure was higher in people who worked indoors (p=0.001), more closed body parts in indoor workers (p=0.02), more frequent use of body shield for indoor workers (p=0.001), the total duration of sun exposure was higher for people who worked outdoors (p=0.001), polyester clothing material was more often used by people who worked outdoors (p= 0.07), and vitamin D intake of people who worked outdoors higher than people who work in the room (p = 0.79) .it can be conclude that people who work indoors at higher risk of vitamin D deficiency due to low intake of vitamin D and sun exposure due to the frequent use of closed and protective clothing body

Table I. Data extraction (Continued)

Title	Objective	Settings	Sample Research	Methods	Exposure Ultraviolet B Adolescents
Optimizing ultraviolet B radiation exposure to prevent vitamin D deficiency among pregnant women in the tropical zone: report from cohort study on vitamin D status and its impact during pregnancy in Indonesia Raden Tina Dewi Judistiani et al. (2020)	Search for the best time of UVB exposure and duration of exposure which can be suggested to prevent vitamin D deficiency in pregnant women, both those who wear hijab or not.	4 most populous provincial cities, West Java, Indonesia	304 first trimester pregnant women, 75-76 mothers	A 3-day record of the duration, time and type of outdoor activities and the clothes worn by the women were collected. Radiation intensity UVB was obtained. Calculations of the body surface area exposed to direct UVB radiation and the intensity of UVB radiation were carried out. Measurement of vitamin D levels in serum was carried out in the same week.	The median maternal serum vitamin D level was 13.6 ng/mL and the average exposed area was about 0.48 m2 or 18.59% of the total body surface area. Radiation intensity peaks around 10:00 and 13:00, but the average duration of UVB exposure during this window is lower than expected. A significant correlation was found between serum vitamin D levels and body surface area exposed ($r = 0.36$, $p < 0.002$) or percentage of body surface exposed ($r = 0.39$, $p < 0.001$) and radiation intensity ($r = 0.15$, $p = 0.029$). Further analysis showed that the duration of UVB exposure is longer in pregnant women who wear a headscarf compared to women without a headscarf.
Relationship between Sun Exposure, Nutritional Status, and Food Intake on Vitamin D Levels in Children and Adolescents with Type 1 Diabetes Mellitus Kusumastuty Inggita et al. (2021)	Analyzed the relationship between sun exposure, nutritional status, food intake and vitamin D levels in children and Adolescents with Type 1 diabetes .	Malang, East Java, Indonesia,	31 children and adolescents with Type 1 Diabetes aged 5-19 years.	Cross-sectional with Sun exposure. Data collection using the Sun Exposure Questionnaire form, nutritional status BMI/U with WHO Anthro, food intake using Semi - Quantitative Food Frequency Questionnaire and vitamin D levels with ELISA method. Statistical analysis using SPSS Version 21 with the Pearson and Spearman correlation test	All respondents have vitamin D deficiency; most respondents have less sun exposure and nutritional status in the normal weight category. Most respondents have good energy and protein intake, excess fat, fewer carbohydrates, less vitamin D and calcium. There is a positive relationship between sun exposure and vitamin D levels ($p = 0.001$, $r = 0.627$). However, there is no relationship between nutritional status, intake of protein, fat, carbohydrates, vitamins D and calcium with vitamin D levels ($p=0.409$; $p=0.240$; $p=0.311$; $p= 0.822$; $p= 0.231$; 0.382)
Low Vitamin D Status despite Abundant Sun Exposure Binkley N., R et al. (2007)	Documenting the 25(OH) D status of healthy individuals with high sun exposure.	in Honolulu, Hawaii	93 adults (30 women and 63 men)	Serum 25(OH)D concentrations were measured using the appropriate HPLC essay. Low vitamin D status was defined as a circulating 25(OH)D concentration of less than 30 ng/ml.	The mean serum concentration of 25(OH)D was 31.6 ng/ml. Using a 30 ng/ml cutpoint, 51% of this population had low vitamin D status. The highest concentration of 25(OH)D was 62 ng/ml.
Effect of physical activity and sun exposure on vitamin D status of Saudi children and adolescents Abdulaziz Al-Othman et al. (2012)	Determine whether the prevalence of vitamin D deficiency is related to degree of physical activity and sun exposure among healthy children and adolescents, a little studied Population. Methods: Vitamin D were analyzed.	Saudi	331 Saudi children aged 6–17 years (153 boys and 178 girls	Cross sectional study A total of) were included in this. Levels of physical activity and sun exposure were determined using a standard questionnaire. Anthropometry, serum calcium and 25-(OH)	All subjects were vitamin D deficient, the majority being moderately deficient (71.6%). Age was the single most significant predictor affecting 25 (OH) Vitamin D levels, explaining 21% of the variance perceived ($p = 1.68$ x 10-14). Age-matched comparisons revealed that for groups having the same amount of sun exposure, those with moderate or are physically active will have higher levels of vitamin D status, though levels in across groups
The association between ultraviolet B irradiance, vitamin D status and incidence rates of type 1 diabetes in 51 regions worldwide Mohr S B et al. (2008)	analysis of the relationship between ultraviolet B (UVB) irradiance, the primary source of circulating vitamin D in humans, and age-standardised incidence rates of type 1 diabetes mellitus in children, according to region of the world	in 51 regions worldwide	Children aged <14 years during 1990--1994	The association of UVB irradiance adjusted for cloud cover to incidence rates of type 1 diabetes in was assessed using multiple regression. Incidence data were obtained from the Diabetes Mondial Project Group.	Incidence rates were generally higher at higher latitudes ($R2 = 0.25$, $p < 0.001$). According to multiple regression, UVB irradiance adjusted for cloud cover was inversely associated with incidence rates ($p < 0.05$), while per capita health expenditure ($p < 0.004$) was positively associated (overall $R2 = 0.42$, $p < 0.0001$)

Factor-1 (IGF-1) acts as an intermediary for growth hormone (Growth Hormone / GH) to reach bones and stimulates the region growth plate that plays a role in the elongation of long bones (29). Calculation of serum 25(OH)D levels in the blood is often used to determine the amount of vitamin D in a person. Serum 25(OH)D was chosen as an indicator of vitamin D status because it is stable, reflects the overall vitamin D levels in the body and has a long life span of about three weeks (23,30).
25(OH)D plays an important role in regulating calcium and phosphate metabolism for maintenance of metabolic functions and for skeletal health. Most cells and organs in the body have a vitamin D receptor and many cells and organs are able to produce 125(OH) D. As a result, 25(OH)D influences a large number of biologic pathways which may help explain association studies relating vitamin D deficiency and living at higher latitudes with increased risk for many chronic diseases, including autoimmune diseases, some cancers, cardiovascular disease, infectious disease, schizophrenia and type 2 diabetes. A three-part strategy of increasing food fortification programs with vitamin D, sensible sun exposure recommendations and encouraging ingestion of a vitamin D supplement when needed should be implemented to prevent global vitamin D deficiency and its negative health consequences(11).

In addition, a diverse range of contributing factors are, to varying degrees, associated with stunting, demonstrating the importance of considering how those predictors, for example nutrients (micronutrients), interact with nutrition. Integrated health promotion, prevention and interventions is needed to prevent new stunting children in Indonesia (7).

CONCLUSION

The results of this review provide information about how exposure to ultraviolet B rays has a role in preventing stunting. After the intervention was given, exposure to ultraviolet B light can be seen to increase vitamin D levels whereby this component contributes to bone growth and prevents stunting.

REFERENCES

1. Riskesdas. Laporan Nasional Riskesdas 2018. Badan Penelitian dan Pengembangan Kesehatan. 2018.
2. World Health Organization (WHO). Stunting in a Nutshell. https://www.who.int/news/item/19-11-2015-stunting-in-a-nutshell. 2015.
3. TNP2K. 100 Kabupaten/Kota Prioritas untuk Intervensi Anak Kerdil (Stunting): Tim Nasional Percepatan Penanggulangan Kemiskinan. Jakarta. 2017;
4. Yunitasari E, Pradanie R, Arifin H, Fajrianti D, Lee BO. Determinants of Stunting Prevention among Mothers with Children Aged 6–24 Months. Open Access Maced J Med Sci. 2021;
5. Aguayo VM, Menon P. Stop stunting: Improving Child Feeding, Women's Nutrition and Household Sanitation in South Asia. Matern Child Nutr. 2016;
6. Shekar M, Kakietek J, Dayton Eberwein J, Walters D. An Investment Framework for Nutrition: Reaching the Global Targets for Stunting, Anemia, Breastfeeding, and Wasting. An Investment Framework for Nutrition: Reaching the Global Targets for Stunting, Anemia, Breastfeeding, and Wasting. 2017.
7. Mediani HS. Predictors of Stunting among Children Under Five Year of Age in Indonesia: A Scoping Review. Glob J Health Sci [Internet]. 2020 Jun 8 [cited 2021 Aug 1];12(8):83. Available from: https://scite.ai/reports/predictors-of-stunting-among-children-Xxd6k099
8. Scott LK. Kaitan antara Status Gizi, Perkembangan Kognitif, dan Perkembangan Motorik pada Anak Usia Prasekolah (Relationship Between Nutritional Status, Cognitive Development, And Motor Development In Preschool Children). Ekp. 2013;13(3):62–72.
9. Goudet SM, Bogin BA, Madise NJ, Griffiths PL. Nutritional Interventions for Preventing Stunting in Children (Birth To 59 Months) Living in Urban Slums in Low-And Middle-Income Countries (LMIC). Cochrane Database Syst Rev. 2019;
10. Nurhayati E, Paramashanti BA, Astiti D, Arif &, Aji S. Dietary Diversity, Vitamin D Intake and Childhood Stunting: A Case-Control Study in Bantul, Indonesia. Mal J Nutr [Internet]. 2020 [cited 2021 Dec 11];26(2):273–87. Available from: https://doi.org/10.31246/mjn-2020-0021
11. Wacker M, Holick MF. Sunlight And Vitamin D: A Global Perspective for Health. Dermato-Endocrinology. 2013.
12. Sizar O, Khare S, Goyal A, Bansal P, Givler A. Vitamin D Deficiency. Endocrinol Diabetes A Probl Approach [Internet]. 2021 Jul 21 [cited 2021 Dec 11];9781461486848:293–304. Available from: https://www.ncbi.nlm.nih.gov/books/NBK532266/
13. Mithal A, Wahl DA, Bonjour JP, Burckhardt P, Dawson-Hughes B, Eisman JA, et al. Global Vitamin D Status and Determinants of Hypovitaminosis D. Osteoporosis International. 2009.
14. Soliman A, De Sanctis V, Elalaily R, Bedair S, Kassem I. Vitamin D deficiency in adolescents. Indian Journal of Endocrinology and Metabolism. 2014.
15. Judistiani RTD, Nirmala SA, Rahmawati M, Ghrahani R, Natalia YA, Sugianli AK, et al. Optimizing Ultraviolet B Radiation Exposure to Prevent Vitamin D Deficiency Among Pregnant Women in the Tropical Zone: Report from Cohort Study on Vitamin D Status and its Impact during Pregnancy in Indonesia. BMC Pregnancy Childbirth. 2019;
16. Arksey H, O'Malley L. Scoping studies: towards a

methodological framework. Int J Soc Res Methodol [Internet]. 2005 Feb 1;8(1):19–32. Available from: https://doi.org/10.1080/1364557032000119616
17. Yosephin B, Khomsan A, Briawan D, Rimbawan R. Peranan Ultraviolet B Sinar Matahari terhadap Status Vitamin D dan Tekanan Darah pada Wanita Usia Subur (The Role of Ultraviolet B Sunlight on Vitamin D Status and Blood Pressure in Women of Childbearing Age). Kesmas Natl Public Heal J. 2014;
18. Sallander E, Wester U, Bengtsson E, Wiegleb Edstrum D. Vitamin D Levels After UVB Radiation: Effects by UVA Additions in a Randomized Controlled Trial. Photodermatol Photoimmunol Photomed. 2013;
19. Rimahardika R, Subagio HW, Wijayanti HS. Asupan Vitamin D dan Paparan Sinar Matahari pada Orang yang Bekerja di Dalam Ruangan dan di Luar Ruangan (Vitamin D Intake and Sun Exposure in People Working Indoors and Outdoors). J Nutr Coll. 2017;
20. Binkley N, Novotny R, Krueger D, Kawahara T, Daida YG, Lensmeyer G, et al. Low vitamin D status despite abundant sun exposure. J Clin Endocrinol Metab. 2007;
21. Mohr SB, Garland CF, Gorham ED, Garland FC. The Association between Ultraviolet B Irradiance, Vitamin D Status and Incidence Rates of Type 1 Diabetes in 51 Regions Worldwide. Diabetologia. 2008;
22. Al-Othman A, Al-Musharaf S, Al-Daghri NM, Krishnaswamy S, Yusuf DS, Alkharfy KM, et al. Effect of Physical Activity and Sun Exposure on Vitamin D Status of Saudi Children and Adolescents. BMC Pediatr. 2012;
23. Widyaswari MS, Zulkarnain I, Indramayu DM. Kadar Serum Vitamin D (25[OH]D) pada Pasien Dermatitis Atopik (Serum Vitamin D (25[OH] D) Levels in Atopic Dermatitis Patients). Period Dermatology Venereol. 2016;
24. Sri Mulyani IM. Efektifitas Senam Hamil Dengan Paparan Sinar Ultraviolet Selama 15 Menit terhadap Vitamin D 25-OH Ibu Hamil (The Effectiveness of Pregnant Exercise With Ultraviolet Light Exposure for 15 Minutes Against Vitamin D 25-OH Pregnant Women). J Ilm Terap Univ Jambi. 2020;
25. Masulili F, Zainul, Junaidi. Pengaruh Sinar Ultraviolet Terhadap Kadar Vitamin D Dan Tekanan Darah Pada Perempuan Di Pesantren Di Kota Palu (The Effect of Ultraviolet Light on Vitamin D Levels and Blood Pressure in Women in Islamic Boarding Schools in Palu City). J Keperawatan Sriwij. 2017;
26. Kusumastuty I, Handayani D, Tjahjono HA, Sari EP, Rahayuningtyas SK, Saputra AB. Hubungan Paparan Sinar Matahari, Status Gizi, dan Asupan Makan terhadap Kadar Vitamin D Anak dan Remaja Penderita Diabetes Mellitus Tipe 1 (Relationship between Sun Exposure, Nutritional Status, and Food Intake on Vitamin D Levels in Children and Adolescents with Type 1 Diabetes Mellitus). Amerta Nutr. 2021;
27. Suryadinata RV, Wirjatmadi B, Adriani M, Sumarmi S. Effects of Knowledge of Vitamin D on Attitudes toward Sun Exposure among Middle-Aged and Elderly Indonesian adults. Indian J Public Heal Res Dev. 2018;
28. Sahiratmadja E, Yunivita V. Gambaran Tingkat Pengetahuan Siswa MA di Bandung mengenai Vitamin D bagi Kesehatan (An overview of the knowledge level of MA students in Bandung about Vitamin D for Health). J Pengabdi Kpd Masy. 2019;
29. Racine HL, Serrat MA. The Actions of IGF-1 in the Growth Plate and Its Role in Postnatal Bone Elongation. Current Osteoporosis Reports. 2020.
30. Chiang CM, Ismaeel A, Griffis RB, Weems S. Effects of Vitamin D Supplementation on Muscle Strength in Athletes: A systematic review. Journal of Strength and Conditioning Research. 2017.