Analysis of Vitamin D Status Predictor (VDSP), Body Composition and Vitamin D Levels as Predictors of Physical and Cognitive Function Assessment of Anesthesiology and Intensive Therapy Residents at Dr. Soetomo Hospital

Muzaiwirin[1]*, Prananda Surya Airlangga[2], Bambang Purwanto[3], Christrijogo Sumartono[2], Herdiani Sulistyo Putri[2], Atikah[4]

[1]Specialist Medical Education Program-1, Anesthesiology and Intensive Therapy Study Program, Faculty of Medicine, Universitas Airlangga, Dr. Soetomo General Academic Teaching Hospital Surabaya, Indonesia

[2]Anesthesiologist, Department of Anesthesiology and Reanimation, Faculty of Medicine, Universitas Airlangga, Dr. Soetomo General Academic Teaching Hospital Surabaya, Indonesia

[3]Department of Faal and Biochemistry Medicine, Faculty of Medicine, Universitas Airlangga Surabaya, Indonesia

[4]Department of Public Health and Preventive Medicine, Faculty of Medicine Universitas Airlangga Surabaya, Indonesia

*Corresponding Email: muzaiwirin@gmail.com

Abstract

Introduction: Vitamin D deficiency is a global problem that can negatively impact physical and cognitive function, with levels of 25(OH)D <20 ng/ml considered low. Anesthesiology and Intensive Therapy residents are particularly at risk of vitamin D deficiency due to limited sunlight exposure in their work environment, which can lead to decreased physical and cognitive function. A screening method is needed to detect early decline in physical and cognitive performance in these populations, and the Vitamin D Status Predictor (VDSP) questionnaire and Bioelectrical Impedance Analysis (BIA) for skeletal muscle body composition could be used as predictors compared to the gold standard of vitamin D levels. **Aim and Objective:** This study aimed to assess whether the VDSP questionnaire, body composition, and vitamin D levels could predict physical and cognitive function in Anesthesiology and Intensive Therapy residents. Materials and Methods: The study included 80 active Anesthesiology and Intensive Therapy residents at Dr. Soetomo Hospital who met the inclusion criteria and approved the research procedure. Each participant completed the VDSP questionnaire, underwent skeletal muscle weight measurement, had their blood levels of vitamin D examined, and completed physical function assessments using a hand grip dynamometer and cognitive function assessments using the Mini Mental State Examination (MMSE). Results and Conclusion: Two out of 80 subjects had vitamin D insufficiency (<30 ng/ml). The VDSP score was significantly related to Hand Grip Strengthening (HGS) physical function (r -0.243, P<0.05) but not to MMSE (P>0.05). Skeletal muscle scores were significantly related to HGS (r 0.428, P<0.05) but not to MMSE (P>0.05). Vitamin D levels were significantly associated with HGS (r 0.407, P<0.05) but not with MMSE (P>0.05). Of the three factors significantly related to HGS, namely skeletal muscle (ß 0.653, P<0.05) and vitamin D levels (ß 0.107, P<0.05), only skeletal muscle was a predictor of physical function assessment compared to cognitive function assessment. Skeletal muscle assessment and vitamin D levels can be used as predictors of physical function assessment compared to cognitive function assessment in Anesthesiology and Intensive Therapy residents.

Keywords: Vitamin D Status Predictor, Body Composition, Vitamin D Levels, Physical Function, Cognitive Function

1. Introduction

The prevalence of vitamin D deficiency is increasing globally, with rates ranging from 20% to 40% depending on the population of the country. In the United States, the prevalence is 36%, while Western Europe has a higher rate of 60%. Vitamin D deficiency is generally overlooked in Asian countries where there is believed to be sufficient sun exposure, but data on this issue in Southeast Asia is limited (Mendoza et al., 2013). One study in Vietnam reported that 30% of the population had vitamin D deficiency (Nguyen et al., 2012), while in Indonesia, the average 25(OH)D blood concentration of elderly

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women was 48 nmol/L, with 63% of them lacking vitamin D (Setiati, 2008).

Vitamin D is a hormone that the body produces when the skin is exposed to sunlight. This process occurs when UVB rays convert 7-dehydrocholesterol into previtamin D. Only a small amount of vitamin D is obtained from food, with plants providing ergochalciferol (vitamin D2) and animals providing cholecalciferol (vitamin D3). Many countries face challenges with inadequate sun exposure and vitamin D intake. Vitamin D deficiency occurs when 25-hydroxyvitamin D [25(OH)D] levels drop below 50 nmol/L or (20ng/mL) in both children and adults globally, putting up to 80% of people, especially older adults, at risk. Low levels of 25(OH)D can lead to a variety of non-skeletal issues, including falls, type 2 diabetes mellitus, cardiovascular disease, sarcopenia, and cognitive impairment (Sultan et al., 2020).

Cognitive decline and dementia are prevalent long-term conditions that have a negative impact on the wellbeing of older people. Despite testing over 150 drugs for dementia, a suitable treatment has not been found yet. Therefore, it is crucial to prioritize identifying and modifying risk factors to prevent dementia. Half of the people with dementia have a poor lifestyle, which increases the risk of cognitive decline and requires medical intervention. Furthermore, vitamin D deficiency is a significant indicator of cognitive decline in older adults, and it is one of the areas targeted for therapy (Menesgere et al., 2022).

Research has shown that vitamin D plays a role in the function of the brain, which is supported by the presence of vitamin D receptors in many areas of the brain, as well as the conversion of 25-hydroxyvitamin D to its active form, which is found in brain cells. Animal studies have demonstrated that vitamin D deficiency can lead to structural and neurochemical changes in the brain during development. However, there have been few studies that investigate whether there is a causal link between vitamin D deficiency and cognitive decline in young adults (Bivona et al., 2019).

Individuals who have insufficient levels of vitamin D may experience various health issues such as secondary hyperparathyroidism, bone fractures, and osteoporosis. In severe cases of vitamin D deficiency, osteomalacia may occur which is characterized by muscle pain, bone pain, and muscle weakness. Older adults have a higher risk of developing vitamin D deficiency due to factors such as decreased skin capacity to synthesize vitamin D, low vitamin D intake, and lack of exposure to sunlight. Vitamin D supplementation is known to not only reduce the occurrence of falls but also to suppress osteoporosis among the elderly population. Although vitamin D's role in maintaining bone health is well-established, the extent of its involvement in physical performance is still unclear, and it is uncertain if vitamin D levels can predict declines in physical performance (Knechtle & Nikolaidis, 2020).

Vitamin D deficiency can be easily prevented and corrected by taking oral supplements and getting enough sunlight exposure. Measuring the levels of vitamin D in the blood (25(OH)D assay) is the only reliable way to determine if a person is deficient or not. However, testing the vitamin D levels in the blood can be expensive compared to the cost of vitamin D supplements, making it a concern in some countries. The US and French health authorities have recently reviewed the usefulness of testing vitamin D levels in the blood and decided that it should not be done routinely to reduce healthcare costs (Annweiler et al., 2017).

The Institute of Medicine and the Endocrine Society recommend vitamin D supplementation without testing serum 25(OH)D concentrations first. Studies have shown that taking vitamin D supplements for up to six years does not cause toxicity effects. Pietras et al. (2009) found that taking 50.000 IU of vitamin D twice a month (equivalent to 3300 IU/day) helped maintain circulating vitamin D levels around 100±150 nmol/L (40±60 ng/mL) in healthy adults (Holick, 2011). However, some studies have raised concerns that high doses of vitamin D supplements may increase the risk of falls and allergies in adults who are already receiving supplementation without first knowing their vitamin D status. Therefore, some argue that there is a need to screen the adult population for vitamin D status before starting supplementation to help reduce healthcare costs (Lee et al., 2013).

Residency programs in Indonesia for specialist medical education require residents to spend long hours indoors. While the exact schedules vary depending on the specific program, both medical and surgical residents typically begin work at 6am before sunrise and leave the hospital after sunset at 6pm. This lasts for an average of four years for medical specialties and up to six years for some surgical disciplines. Anesthesia residents, in particular, spend a significant amount of time in operating rooms and intensive care units where there is little exposure to sunlight. Consequently, they are a highly vulnerable population to vitamin D deficiency and at risk of experiencing a decline in cognitive and physical performance (Mendoza et al., 2013).

Screening for vitamin D levels is a common practice for the elderly population but it can be expensive. On the other hand, young adults who are at risk of vitamin D deficiency require a screening tool that can determine their vitamin D status without the need for blood tests. The Vitamin D Status Predictor (VDSP) is a questionnaire consisting of 16 items designed to predict an individual's vitamin D status without checking their blood levels. By using VDSP, healthcare costs can be reduced, and risk factors can be identified and resolved (Annweiler et al., 2017).

A non-invasive method for analyzing body composition is needed to assess physical performance in addition to the VDSP screening. Bioelectrical impedance analysis (BIA) is an inexpensive and easy-to-use method that measures muscle mass. BIA works by passing electric currents of different frequencies through the body, with high frequencies passing through both extracellular and intracellular fluids and low frequencies only passing through extracellular fluid. This electric current passes through various body parts such as fat cells, muscles, and body fluids, causing impedance, which is the resistance encountered by the electric current when passing through these body parts. Insulators, such as fat, cause high impedance, while conductors, such as muscles and body fluids, cause low impedance. This method is especially useful in clinical practice due to its relative affordability and ease of use (Khalil et al., 2014). There has been no previous research investigating the effectiveness of Vitamin D Status Predictor (VDSP) and body composition analysis using Bioelectrical Impedance Analysis (BIA) in young adults with a high risk of vitamin D deficiency, specifically in the Anesthesia resident population, and comparing the results with the gold standard of vitamin D levels. The goal is to determine whether these screening methods can assess physical and cognitive performance in Anesthesia residents. Therefore, the researchers aim to investigate the relationship between VDSP, body composition analysis, and vitamin D levels with the physical and cognitive performance of Anesthesia residents at Dr. Soetomo Hospital. The purpose of this study is to determine the effectiveness of VDSP, skeletal muscle body composition, and vitamin D levels as predictors of physical and cognitive performance in Anesthesiology and Intensive Therapy Residents at Dr. Soetomo Hospital.

2. Research Method

Research Design

This study was an observational analytic study with a cross-sectional design. The initial Anesthesiology and Intensive Therapy Residents were assessed for Vitamin D Status Predictor, Skeletal Muscle Body Composition Analysis with Bioelectrical Impedance Analysis (BIA), Vitamin D Level examination as a gold standard examination, Physical Function Assessment with Hand Grip Dynamometer, and cognitive function with Mini Mental State Examination.

Population and Sample

The population of this study was active Anesthesiology and Intensive Therapy Residents. The research samples that fulfilled the inclusion criteria were Anesthesiology and Intensive Therapy residents who were willing to participate in the study and signed informed consent.

The exclusion criteria were samples that could not complete the data, samples with infectious diseases and malignancies, samples taking vitamin D and having an allergy to vitamin D, and incomplete data where the subject could not fill in the research sheet properly and correctly.

Sample Size and Research Site

The study involved a population of 80 active residents in the Anesthesiology and Intensive Therapy department of Dr. Soetomo Hospital. The sampling technique used in this study was total sampling, which involves taking all members of the population as respondents or samples. The study was conducted at the Department of Anesthesiology and Intensive Therapy of Dr. Soeotomo Hospital in Surabaya, Indonesia.

Data Analysis

The collected data was recorded and tabulated for further analysis. SPSS software was used to process the data. Descriptive statistics, including mean and standard deviation for numerical values, and number and percentage for categorical data, were used to summarize the data. Kolmogorov normality test was used to analyze the relationship between VDSP, skeletal muscle, and vitamin D levels with physical and cognitive function assessment. Pearson test was used for normal data distribution, while Spearman test was used for non-normal data distribution. The statistical significance was set at $p<0.05$. Finally, multivariate tests were performed with linear regression tests, with a statistical significance level of $p<0.05$.

3. Results and Discussion

Descriptive Data

Vitamin D levels by age

Table 1 shows the Vitamin D levels by age category, including the number of subjects with insufficiency, the number of subjects with adequate levels, and the mean vitamin D level with standard deviation (SD) for each age group.

Table 1: Vitamin D levels by age

	Insufficiency	Adequate	Mean ± SD
26-35 yrs	2	71	55,88 ± 20,40
36-45 yrs	0	7	53,71 ± 21,06

This study categorized the subjects into two age groups: 26-35 years and 36-45 years. Among the subjects in the first group, two had vitamin D insufficiency and 71 had adequate levels, with a mean vitamin D level of 55.88 + 20.4. In the second age group, none of the subjects had vitamin D insufficiency and 7 had adequate levels, with a mean vitamin D level of 53.71 + 21.06.

Vitamin D levels by gender

Out of the 80 subjects, there were 18 females and 62 males, with 2 males having insufficient vitamin D levels. The mean vitamin D levels for females and males were 34.5 + 6.2 and 60 + 19.6, respectively.

Table 2: Vitamin D levels by gender

	Insufficiency	Adequate	Mean ± SD
Women	0	18	36,69±6,2
Men	2	60	61,29±19,6

Vitamin D levels based on comorbidities

Out of the 80 subjects, 25 had comorbidities. Among them, one subject with obesity had insufficient vitamin D levels of 24 ng/mL, while 24 subjects had adequate levels with a mean vitamin D level of 54.36

+ 20.48 ng/mL. For non-comorbid subjects, one had insufficient vitamin D levels of 30 ng/mL, while 54 subjects had adequate levels with a mean of 56.19 + 20.48 ng/mL. The comorbidities observed in this study were allergic rhinitis (3 subjects), hypertension (3 subjects), obesity (19 subjects), asthma (3 subjects), and hypothyroidism (1 subject).

Table 3: Vitamin D levels by comorbidities			
	Insufficiency	Adequate	Mean + SD
No Comorbid	1	54	56,19 + 20,55
Comorbid	1	24	54,36 + 20,48

Vitamin D levels by body mass index

This study categorized the subjects based on their body mass index (BMI). Out of the 80 participants, 1 subject in the obesity group and 1 subject in the overweight group had vitamin D insufficiency. On the other hand, 9 subjects in the underweight group had an average vitamin D level of 59.44 + 21.71.

Table 4: Vitamin D levels by body mass index			
	Insufficiency	Adequate	Mean + SD
Underweight	0	9	59,44 + 21,71
Normal weight	0	29	51,93 + 20,14
Overweight	1	22	60,52 + 19,30
Obesity	1	18	53,79 + 21,69

Vitamin D levels based on the global physical activity questionnaire

In this study, the physical activity of respondents was assessed by filling out the Global Physical Activity Questionnaire (GPAQ) where it was found that the low category (MET <600) was 13 subjects with 1 subject experiencing insufficiency and 12 subjects were adequate with a mean value of 44.23 + 17.83. Whereas in the medium category (MET 600-3000), 1 subject experienced insufficiency and 12 subjects were adequate with a mean value of 54.33 + 19.53. While in the high category (MET> 3000) no one experienced insufficiency. The mean value of vitamin D levels in the high category was higher than the other groups, namely 66.95 + 19.7.

Table 5: Vitamin D levels based on the Global Physical Activity Questionnaire			
	Insufficiency	Adequate	Mean + SD
Low	1	12	44,23 + 17,83
Medium	1	47	54,33 + 19,53
High	0	19	66,95 + 19,70

Normality Test Data

In this study, 80 respondents were assessed for Vitamin D Status Predictor, skeletal muscle body composition, and vitamin D levels, which were associated with hand grip strength assessment and mini-mental state examination. Normality tests were conducted using the Kolmogorov method since the number of respondents was >50. The test results showed that the data on skeletal muscle assessment had a P-value of 0.200 (P > 0.05) and the data on hand grip strength had a P-value of 0.060 (P > 0.05), indicating normal distribution. However, the VDSP assessment data had a P-value of 0.001 (P < 0.05), while the vitamin D levels and MMSE data had P-values of 0.009 and 0.001, respectively (P < 0.05), indicating non-normal distribution.

Table 6: Normality Test of VDSP, Skeletal Muscle, Vitamin D Level Data, Hand Grip Strengthening and MMSE			
	Total	Mean + SD	P-value
VDSP Value	80	3,81 + 1,27	0,001
Skeletal muscle	80	30,35 + 3,70	0,200
Vitamin D levels	80	55,69 + 20,42	0,009
Hand grip strengthening	80	37,93 + 8,24	0,060
MMSE	80	29,98 + 0,15	0,001

Analysis of Vitamin D Status Predictor with Hand Grip Strengthening and MMSE

The analysis test used to assess the relationship between VDSP values with hand grip strengthening and MMSE was the Spearman Test. This is because the VDSP data in the normality test was found to be non-normal. Based on the results of the Spearman test, the correlation between VDSP and hand grip strengthening was significant with a P-value of 0.030 (<0.05). Therefore, it can be concluded that there is a significant relationship between the value of VDSP and hand grip strengthening. The correlation coefficient (r) of -0.243 indicates that the relationship between VDSP and hand grip strengthening is negative and the strength of the relationship is weak (24.3%). However, the Spearman test revealed that there was no significant relationship between the value of VDSP and MMSE, with a correlation coefficient of -0.150 and a P-value of 0.180 (>0.05).

Table 7: Vitamin D Status Predictor Test with Hand Grip Strengthening and MMSE			
	Amount (n)	VDSP(r)	P-value
Hand Grip Strengthening	80	-0,243	0,030*
MMSE	80	-0,150	0,180
*Spearman test, significant if P<0.05			

Skeletal Muscle Analysis with Hand Grip Strengthening and MMSE

The analysis of the relationship between skeletal muscle and hand grip strengthening was tested using the Pearson test. This is because the normality test of skeletal muscle and hand grip strengthening data is normal. Based on the results of the Pearson test on skeletal muscle with hand grip strengthening of 0.001 (P <0.05), it is concluded that there is a significant relationship between skeletal muscle and hand grip strengthening. The correlation coefficient (r) of 0.428 means that the relationship between skeletal muscle and hand grip strengthening is unidirectional, with a relationship strength of 42.8%, which is included in the moderate category.

Table 8: Skeletal Muscle Analysis Test with Hand Grip Strengthening			
	Amount (n)	Vitamin D levels (r)	P-value
Hand Grip Strengthening	80	0,428	0,001*
* Pearson test, significant if P<0.05			

To test the analysis of the relationship between skeletal muscle and MMSE, the Spearman test was used because the normality test for MMSE data is abnormal. Based on the results of the Spearman test, the relationship between skeletal muscle and MMSE was 0.040 (P >0.05). Hence, it can be concluded that there is no significant relationship between skeletal muscle and MMSE.

Table 9: Skeletal Muscle Analysis Test with MMSE			
	Amount (n)	*Skeletal Muscle* (r)	P-value
MMSE	80	0,04	0,720
*Spearman test, significant if P<0.05			

Vitamin D Level Analysis with Hand Grip Strengthening and MMSE

This study analyzed the relationship between vitamin D levels, hand grip strengthening, and MMSE (Mini-Mental State Examination) using the Spearman test, as the normality test of vitamin D level data was not normal. The results of the Spearman test showed that there was a significant relationship between vitamin D levels and hand grip strengthening (P<0.05) with a correlation coefficient (r) of 0.407. This means that the relationship between vitamin D levels and hand grip strengthening is unidirectional, with a relationship strength of 40.7%, which is included in the moderate category.
However, based on the results of the Spearman test of vitamin D levels with MMSE, there was no significant relationship (P>0.05) between vitamin D levels and MMSE.

Table 10: Table 10 Test Analysis of Vitamin D Level with Hand Grip Strengthening and MMSE			
	Amount (n)	Vitamin D levels (r)	P-value
Hand Grip Strengthening	80	0,407	0,001*
MMSE	80	-0,009	0,930
*Spearman test, significant if P<0.05			

Analysis of Vitamin D Status Predictor, Skeletal Muscle and Vitamin D Level with Hand Grip Strengthening and MMSE

The analysis of several variables or multivariate tests between the value of VDSP (Vitamin D status predictor), skeletal muscle, and vitamin D levels with hand grip strengthening used a linear regression test, as the data tested was in the form of ratios. Based on the results of the linear regression test, the value of VDSP was 0.453 (P>0.05), skeletal muscle was 0.019 (P<0.05), and vitamin D levels were 0.017 (P<0.05). Therefore, it can be concluded that of the three variables that can be factors in hand grip strengthening, skeletal muscle variables and vitamin D levels are significant (P<0.05). The R square value shows that the relationship between the three variables accounts for 24.4% of the HGS function.
However, the multivariate test between the value of VDSP, skeletal muscle, and vitamin D levels with MMSE values could not be tested because the relationship test showed that the value of VDSP, skeletal muscle, and vitamin D levels had no significant effect on MMSE.

Table 11: Analysis Test of Vitamin D Status Predictor, Skeletal Muscle and Vitamin D Level with Hand Grip Strengthening			
	Amount (n)	B	P-value
VDSP	80	-0,557	0,453
Skeletal Muscle	80	0,653	0,019*
Vitamin D levels	80	0,107	0,017*
*Line Regression Test, significant if P<0.05			

4. Discussion

Vitamin D Status Predictor with Hand Grip Strengthening and MMSE

The first objective of this study was to investigate whether the Vitamin D Status Predictor (VDSP) can be a predictor in assessing physical strength with hand grip strengthening and cognitive function with MMSE. The modified components of VDSP which consists of 11 components were evaluated. The age predictor was based on a systematic review conducted by Palacios in 2013, which found that healthy individuals in East Asia had a high prevalence of vitamin D insufficiency in adulthood, especially in those aged >45 years. However, this study found that vitamin D insufficiency was only 2.5% in those aged <35 years compared to those aged >35 years, which is contradictory to the previous study. The reason for this result remains unclear, but it is possible that the age of the study subjects (anesthesia residents) does not represent the general population in adulthood. It is known that increasing age is associated with a decrease in the concentration of 7-dehydrocholesterol precursors in the skin and a decrease in the capacity to produce vitamin D (Holick, 2009).
This study is supported by a national study conducted in Korea (Choi et al., 2011). The study found that vitamin D insufficiency was most common in young adults compared to those aged >50 years. Therefore, the age factor should be taken into account when assessing vitamin D status in individuals.
The next factor is gender. In some countries in Asia, such as India (Majumdar et al., 2011), the average 25(OH)D level in women reaches 97% (<30 ng/ml), in Vietnam (Ho-Pham et al., 2011) reached 46% (<30 ng/ml), and in Korea (Rhee et al., 2012) reached 60% (<20 ng/ml). However, there is not enough data on

this topic in Indonesia. A study conducted by Setiati (2008) found that 35% of elderly women experienced vitamin D deficiency with an average of <30 ng/ml. This contradicts the results of this study where vitamin D insufficiency occurred in the male group and was not found in women. It is suspected that the protective effect of estrogen levels that are still high in young adulthood (Maltais et al., 2009) could contribute to this. Among the 18 female respondents who experienced menstruation, only 2 people had lower vitamin D levels compared to those who did not menstruate. In the follicular phase of the menstrual cycle, high levels of estrogen are associated with high levels of vitamin D (Franasiak et al., 2016). However, further research is needed to examine the correlation between estrogen levels and vitamin D levels.

The results of this study showed that the average vitamin D levels in the female group reached 31 ng/ml compared to 61 ng/ml for males. Possible factors that contribute to this difference are clothing worn by women (such as wearing clothes with long pants and headscarves) and the use of sunscreen. This is supported by a study conducted by Moy & Bulgiba (2011) where 86% of women had vitamin D deficiency.

Based on the data analysis results, the VDSP value was found to have a significant relationship with hand grip strengthening. This is possibly due to several factors, including physical activity and sunlight exposure, as almost all respondents scored the lowest at 2 points in these areas. A study by Dodds et al. (2014) showed that hand grip strength reaches its maximum in young adulthood and declines with age and decreased physical activity. In addition, both men and women have similar strength until adolescence, but men have a dominant increase with the highest mean of 51 kg at the age of 29 to 39 years compared to women with 31 kg at the age of 26 to 42 years. In this study, the mean value for women was 27 kg, while for men it was 41 kg. Although these values are much lower when compared to previous studies, it should be noted that different standards were used; the previous studies were conducted on the European population, while this study used the Asian Working Group for Sarcopenia (AWGS) reference. On the other hand, the analysis of VDSP values on MMSE did not reveal any significant relationship. It is suspected that the cognitive component of the VDSP value did not affect memory. This is supported by the MMSE values of all respondents, which were found to be normal with the lowest value of 29.

Skeletal Muscle with Hand Grip Strengthening and MMSE

Out of the 80 respondents, who were divided into four categories, the mean value of vitamin D levels in the obese group was higher at 53 ng/ml compared to those who were normal weight at 51 ng/ml. This is contrary to some previous studies that have shown that high abdominal obesity affects low serum vitamin D levels (McCarty, 2009). Vitamin D is easily soluble in fat, which means it is deposited in adipose tissue. This leads to a decrease in the bioavailability of vitamin D metabolites that regulate the transcription of antiproliferative genes, differentiation, and immunomodulatory effects. Consequently, obese individuals are more susceptible to metabolic syndrome and cardiovascular disease (Rueda et al., 2008). Moreover, an increase in waist circumference and the percentage of body fat makes the menstrual cycle in women irregular (Purwanto et al., 2018). Out of the two subjects who experienced vitamin D insufficiency, one was obese and one was overweight.

The high prevalence of overweight and obesity (50%) in this study affects the body composition of skeletal muscle. Body composition consists of Fat Mass (FM) and Fat-Free Mass (FFM). Fat-free mass includes bone mineral and body cell mass, including skeletal muscle mass. The mean skeletal muscle ratio (skeletal muscle mass kg/body weight kg x 100) in this study was 30%, which is lower than the normal range of 33-36%. The evaluation of skeletal muscle using the bioelectrical impedance analysis (BIA) method needs attention in terms of validity and precision. In this study, the Omron HBF 375 BIA was used to measure body segment bioimpedance muscle mass from hands to feet, which had a smaller standard error than MF BIA or whole-body BIA. However, this method should also be considered in subjects with hydration changes (e.g., edema) or an obese body shape (apple-shaped body fat distribution) and certain ethnicities (body-to-foot length with certain regional fat tissue). This can minimize measurement bias when using body segment bioimpedance.

Vitamin D levels with Hand Grip Strengthening and MMSE

In recent decades, vitamin D deficiency has become a controversial health issue, not only among geriatric populations with frailty and fracture risk but also among younger, healthy populations with cardiometabolic potential. This is due to urban populations spending more time indoors, resulting in less exposure to sunlight, as well as low consumption of foods containing ergocalciferol and cholecalciferol. Doctors and the general public are aware of this problem, and measuring 25(OH)D levels is almost a routine blood test in some countries, although not in Indonesia due to the cost. In this study, it was found that anesthesia residents were at high risk of vitamin D deficiency, as 82% of them were exposed to sunlight for less than 5 hours per week and none of them took multivitamins containing vitamin D. However, only 2.5% were found to have vitamin D insufficiency based on blood examination. This is in contrast to a study by Mendoza et al. (2013) on surgical residents who routinely took vitamin D 600 IU and calcium 800 mg with low sun exposure. The study found 31% were deficient with an average of 16 ng/ml. The difference is thought to be that anesthesia residents consume more foods containing vitamin D, such as egg yolks, milk, and sea fish.

This study found no significant relationship between vitamin D levels and cognitive function assessment. This contradicts a prospective cross-sectional study that showed a positive relationship between serum vitamin D levels and cognitive performance (Goodwill & Szoeke, 2017). However, the results of this study can be compared to Al-Daghri et al. (2022), which examined a healthy population in India, where 75% of the participants had vitamin D insufficiency but it was not associated with MMSE cognitive function, but rather with depressive scores.

It is important to understand why many studies have shown a link between vitamin D and cognitive performance. Additionally, vitamin D insufficiency is associated with an increased risk of depression and cardiovascular disease, which in turn can affect cognitive performance. Thus, it can be said that perhaps vitamin D plays an indirect role in cognitive function in healthy populations. In this study, anesthesia residents had good cognitive function assessment. However, further research is needed to assess whether there is a correlation between vitamin D insufficiency and depressive conditions, using depression scale scores, for example.

Vitamin D Status Predictor, Skeletal Muscle and Vitamin D Levels with Hand Grip Strengthening and MMSE

This study was conducted in February-March 2023 during the rainy season, where there was limited sun exposure. The respondents were from Surabaya, where 80% of the city's lowlands are situated at an altitude of 3-6 meters above sea level. Previous studies have shown that altitude topography and season can affect vitamin D insufficiency (Looker et al., 2002). The Third National Health and Nutrition Examination Survey (NHANES) found that 40% of adults aged 20-39 years had vitamin D levels below 20 ng/ml during winter with low latitude. However, in contrast to these findings, only 2.5% of the subjects in our study had vitamin D insufficiency during the rainy season. Thus, further evaluation is needed to determine whether sampling during the rainy season would yield similar results as sampling during summer, as this may affect the value of hand grip strengthening and MMSE.

Several studies have shown a positive correlation between physical activity and vitamin D levels. Individuals who engage in high levels of outdoor activity are often exposed to sunlight, which can increase vitamin D circulation (Orces, 2019). This finding is consistent with the results of this study, where the mean vitamin D level was 66 ng/ml higher in the high category GPAQ group compared to the low category group, which had a mean of 44 ng/ml. However, it should be noted that this result may be biased due to the potential impact of working hours on sun exposure for the subjects in this study. While the VDSP questionnaire indicated that almost all participants engaged in sports activities less than three times per week and had less than five hours of sun exposure per week, lower levels of physical activity were associated with vitamin D insufficiency.

Of the three independent variables assessed, only two were found to have a significant effect on physical function assessment, namely skeletal muscle body composition and vitamin D levels. However, the conceptual framework of this study suggests that other factors can also affect physical function outcomes, such as bone composition. Indeed, one of the weaknesses of this study was not assessing bone composition. In a previous study by (Babatunde & Forsyth, 2013), Quantitative Ultrasound (QUS) was used to assess bone health, which has several advantages over Dual X-ray Absorptiometry (DXA), including low cost, non-invasiveness, lack of radiation, simplicity, and portability. The results of that study showed that physical activity intervention can increase calcaneal bone density to prevent osteoporosis, particularly in conjunction with vitamin D deficiency. This can be a valuable input for future research in assessing bone mineral density body composition.

In addition, data analysis of this study revealed no relationship between the three independent variables and MMSE cognitive function. This could be due to the cross-sectional design of the study, which makes it difficult to determine causal factors and can introduce bias in the accuracy of the subject's questionnaire responses.

Although the results of this study suggest that vitamin D levels are quite good, there is still a possibility of insufficiency in residents who work long hours in enclosed environments, such as operating rooms or intensive care units. Therefore, further research could investigate the influence of prolonged working hours on vitamin D levels in both residents and anesthesiologists.

One limitation of this study is the lack of a healthy population comparison group with low risk factors for vitamin D deficiency. Additionally, conducting the study with a larger sample size and across multiple centers could provide more robust results.

5. Conclusion

Based on the analysis of vitamin D status predictors, skeletal muscle body composition, and their effects on physical function and MMSE cognitive function, this study concludes that high VDSP values may predict reduced physical performance, but not cognitive function. Similarly, low skeletal muscle body composition and vitamin D levels may predict reduced physical performance, but not cognitive function. However, low skeletal muscle body composition and vitamin D levels together can predict reduced physical performance.

To obtain further evidence on the benefits of screening for vitamin D deficiency and skeletal muscle body composition, the researchers recommend conducting additional studies with a larger sample size and a comparison group of healthy populations at low risk of vitamin D deficiency. Additionally, it may be worthwhile to explore other cognitive function assessments, such as the Frontal Assessment Battery and the Computerized Assessment of Information Processing, to gain a more comprehensive understanding of the relationship between vitamin D status and cognitive function. Finally, the study highlights the importance of preventing vitamin D insufficiency in anesthesia residents by increasing sun exposure, promoting outdoor sports activities, and providing vitamin D supplementation.

Conflict of Interest

The authors hereby declare that there is no conflict of interest in this study.

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7. Author Contribution

1. Muzaiwirin -contributed in designing the study, execution of the project, statistical analysis, manuscript drafting.
2. Prananda Surya Airlangga -contributed in designing the study, execution of the project, statistical analysis, manuscript drafting.
3. Bambang Purwanto -contributed in designing the study, execution of the project, statistical analysis, manuscript drafting.
4. Christrijogo Sumartono -contributed in designing the study, statistical analysis, manuscript drafting.
5. Herdiani Sulistyo Putri -contributed in study design, guiding the research work, proofreading and manuscript correction.
6. Atikah -contributed in study design, guiding the research work, proofreading and manuscript correction.

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