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Correlation of Vitamin D Serum Levels with Muscle Mass, Muscle Strength, and Physical Performance in the Elderly Community in Mohammad Hoesin General Hospital Palembang

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ABSTRACT

Background: Older people tend to have decreased activity and intake of macronutrients and micronutrients that are not in accordance with the body's needs. Research in 2017 on elderly men and women at the Center for Family Compensation (PUSAKA) in Central Jakarta showed that 80.2% of elderly people have vitamin D deficiency. Low serum levels of vitamin D in the body are the initial risk of decreased muscle mass and physical performance in old age, where there is a significant correlation between low serum vitamin D levels in the body with sarcopenia and mortality. The purpose of this study was to determine the correlation of vitamin D levels with muscle mass, muscle strength and physical performance in the elderly community at RSMH Palembang. **Methods:** This research is a study analytic observation with a cross-sectional approach that was carried out at the Integrated Geriatric Clinic Internal Medicine RSMH Palembang from November 2019 to November 2020. A sample of 34 people aged > 60 years were examined for muscle mass, muscle strength, physical performance and serum vitamin D levels. All processing and analysis The data in this study used SPSS version 25 for Windows. **Results:** From 34 subjects, it was found that there were 29 women (85.3%) and 5 men (14.7%). The mean value of muscle mass is 38.76 ± 4.1 kg / m², long runs within 6 meters 6.12 ± 0.9 m / sec, and hand grip strength 24.9 ± 5.2 kg. It was found that 18 (62.1%) female samples had vitamin D deficiency while 11 (37.9%) samples had vitamin D insufficiency. There was a significant correlation between muscle mass and hand grip strength with vitamin D with weak correlation strength and length of walking with vitamin D with moderate correlation strength. **Conclusion:** There is a significant correlation between muscle mass and grip strength and walking time of 6 meters with vitamin D.

1. Introduction

As they age, their lifestyle and dietary diet change, older people tend to have decreased activity and intake of macronutrients and micronutrients that are not in accordance with the body's needs. Boy in 2019 found that 59.2% of 100 elderly people in Medan are at risk of malnutrition, and 3.2% of elderly people experience malnutrition.¹ Advancing to aging conditions such as frailty, lack of muscle mass, and lack of muscle strength.² Therefore people aged ≥ 60 years often have a

health problem called geriatric syndrome. In general, geriatric syndrome is a condition in which muscle mass and function gradually decrease.²

Setiati et al in 2014, reported the number of patients with low hand grip strength of 8% and limited mobility of 2.8% of 251 outpatient geriatric patients.³ A 2017 study of elderly men and women in the Family Compensation Center (PUSAKA) Central Jakarta shows that 80.2% of elderly people have vitamin D

deficiency.⁴ Caniago et al. In 2019 found 4.3% of elderly people with vitamin D deficiency and 19.1% of elderly people who experience vitamin D insufficiency have weak hand grip strength.⁵ Yazar et al. In 2019 concluded, the increasing age, the lower the serum vitamin D levels in the body.¹ Some clinical problems that often occur in geriatric syndrome are weak muscles, easy falls and the body becomes weaker (*frailty*).⁶ Osteopenia / osteoporosis and sarcopenia are examples of problems that may occur in elderly people (elderly).⁶

When carrying out its role, vitamin D is bound to vitamin D receptors (VDR) which play a role in the immune system, so that vitamin D deficiency can increase the inflammatory process, in old age this inflammation is also called inflammation due to aging.^{7,8} In addition to bone mineralization and plays a role in preserving bone integrity and controlling the production and secretion of parathyroid hormone (PTH).⁹ When the body is deficient in vitamin D levels, VDR-RXR automatically takes protein bonds through muscle mass and calcium through bone mass. This can have an impact on decreased muscle function, physical performance and an increased risk of sarcopenia.⁸

According to EWGSOP 2 (2018) sarcopenia is a condition of skeletal muscle dysfunction characterized by decreased muscle strength, reduced muscle mass (quantitative and qualitative) and decreased physical ability.⁹ Sarcopenia can be differentiated based on its cause in primary sarcopenia, usually in the elderly and secondary sarcopenia namely decreased muscle function due to other causes such as chronic disease, lying down for a long time, low physical activity, being in an area with low gravity, metabolic disorders and poor nutritional intake.¹⁰

Conzade et al in 2019 concluded that low serum vitamin D levels in the body are an initial risk of decreased muscle mass and physical performance in old age, there is a significant correlation between low serum vitamin D levels in the body with sarcopenia and death.¹⁰ At the cellular level, serum levels vitamin D has an impact on muscle function which is divided into: 1.

Genomic effects, which increase the 1.25D-VDR-RXR binding as a receptor to increase gene expression; 2. *Non-genomic effects* which increase the signal transduction pathway in intra-cellular after binding to 1.25D which can regulate protein kinase in muscle skeleton.^{11,12}

Lieberman et al in 2019 concluded that elderly people who have vitamin D deficiency have high levels of IL6, IL8 and CRP so they suffer from sarcopenia and *chronic low-grade inflammatory profile* (CLIP), after consuming 800 IU of vitamin D and 1200 mg of calcium in 13 weeks, there is an inverse correlation where the increase in serum vitamin D levels in the body can reduce IL6 and IL8 levels and improve CLIP and physical performance.¹¹

In line with Lieberman et al, Garcia et al.2019 in a *review study* concluded that vitamin D is associated with muscle fiber metabolism expressed by VDR, serum vitamin D levels are directly related to age, sex and pathological factors in influencing decreased muscle mass and muscle function. and muscle strength in the elderly.¹³ El Hajj et al. 2019 found that giving Cholecalciferol 10.000 IU for 6 months was proven to increase muscle mass and physical performance in those with pre-sarcopenia and sarcopenia.¹⁴

Different from the study Ceglia et al. found that a cross sectional study did not find a consistent relationship between vitamin D and muscle mass. It is explained that in healthy elderly people there is a decrease in muscle strength and accompanied by severe comorbidity of disease combined with low levels of physical activity can cause muscle weakness and daily functional disorders that cannot be prevented by giving vitamin D supplementation.

There is very little understanding of the importance of vitamin D in the general public, coupled with inadequate nutritional intake and decreased physical activity and other risk factors, putting the elderly at risk of *frailty*, decreased muscle mass, decreased muscle strength, osteoporosis and sarcopenia. Because the research on sarcopenia in Indonesia is

characterized by a decrease in muscle mass, muscle strength and physical performance of the elderly in healthy elderly communities, this study aims to determine the correlation of serum vitamin D levels with muscle mass, hand grip and walking speed in the elderly. at RSMH Palembang. This study is expected to be a preliminary study on the importance of knowing serum vitamin D levels in the elderly in order to improve the quality of life of the elderly, prevent and treat sarcopenia.

2. Methods

This research is an observational analytic study with cross sectional design. The target population in this study were all elderly patients in the elderly community at RSMH Palembang. The affordable population is all samples aged ≥ 60 years who are members of the elderly community at RSMH Palembang. The research subjects were 34 people who met the inclusion and exclusion criteria. Inclusion criteria were elderly aged ≥ 60 years, able to communicate well and understandably, willing to participate in research and sign *informed consent*. The exclusion criteria were subjects with acute conditions or illnesses, subjects with autoimmune diseases, subjects with severe liver or kidney disorders, subjects with malignant diseases.

The independent variables are muscle mass, muscle strength, and physical performance. The dependent variable: serum Vitamin D levels. Confounding variables: age, gender, physical activity, smoking. The selection of research subjects was carried out by using the *consecutive sampling* technique, in which patients who met the inclusion criteria were taken as samples until they met the specified number. Patients were drawn from the elderly community or geriatric patients at RSMH Palembang. Processing and data analysis using the SPSS 25 for Windows program. Data is presented in tables and graphs. Univariate, bivariate analysis and correlation test between variables were performed.

3. Results

Table 1 shows the baseline characteristics of the study subjects, where the majority of study subjects were women, aged between 60-70 years.

This study obtained samples with an average vitamin D level of 18.4 ± 6.29 ng/mL. Serum vitamin D levels in this study were dominated by 21 (61.8%) samples with vitamin D deficiency (vitamin D serum levels <20 ng/mL) and 13 (38.2%) samples experiencing insufficiency (vitamin D levels. 20-30 ng/mL).

Table 2. displays data regarding serum vitamin D levels in the elderly. In this study, 18 (62.1%) samples of women had vitamin D deficiency while 11 (37.9%) samples had vitamin D insufficiency, obtained 3 (60%) samples of men who experienced vitamin D deficiency while 2 (40%)) others experienced vitamin D insufficiency. At age, 18 (62.1%) samples aged ≤ 70 years experienced vitamin D deficiency while 11 (37.9%) samples had vitamin D insufficiency, obtained 3 (60%) samples > 70 years experienced vitamin D deficiency while the other 2 (40%) had vitamin D insufficiency.

Samples with vitamin D insufficiency had a mean muscle mass of 38.76 ± 4.1 kg/m², an average walking speed of 6.12 ± 0.9 m/s and a hand grip strength of 24.9 ± 5.2 . kg. samples with vitamin D deficiency had a mean muscle mass of 38.68 ± 6.09 kg/m², an average walking speed in 6 m of 6.77 ± 1.67 m/sec and a hand grip strength of 24.9 ± 5.2 kg. The results of the analysis using the chi square and one way Anova showed that there was no significant relationship between gender, age, muscle mass, walking speed and hand grip strength.

The results of this study using the Pearson test showed that there was a significant correlation between muscle mass and grip strength with vitamin D with weak correlation strength and walking speed with vitamin D with moderate correlation strength. Can be seen in Table 3 and Figure 1.

The results of multivariate analysis using linear regression with the dependent variable of vitamin D

showed that the correlation with vitamin D in this study was age with very weak negative correlation strength (-0.192) and muscle mass with moderate correlation strength. Based on table 4.4. interpreted,

the increasing age, the lower the vitamin D levels in the body and the lower the vitamin D levels, the smaller the muscle mass.

Table 1. Baseline Characteristics

Sample Characteristics	N (%)
Sex	
• Male	5 (14.7%)
• Female	29 (85.3%)
Age	
	65 ± 4.5 years
• ≥ 60-70 years	29 (85.3%)
• > 70 Years	5 (14.7%)
Comorbid	
• Diabetes mellitus	3 (8.82%)
• Hypertension	9 (26.4%)
• Corona Artery Disease	3 (8.82%)
BMI	
	5 (14.7%)
• Less	12 (35.2%)
• Normal	6 (17.6%)
• Obesity	11 (32.2%)

Table 2. Serum Vitamin D Levels in the Elderly

	Insufficiency	Deficiency	p
Sex			
• Male	2 (40%)	3 (60%)	0.930 ^a
• Female	11 (37.9%)	18 (62.1%)	
Age (yo)			
• ≥ 60 – 70	11 (37.9%)	18 (62.1%)	0.930 ^a
• > 70	2 (40%)	3 (60%)	
Muscle mass	38.76 ± 4.1 kg/m ²	38.68 ± 6.09 kg/m ²	0.064 ^b
Walking speed	6.12 ± 0.9 m/s	6.77 ± 1.67 m/s	0.062 ^b
Hand Grip Strength	24.9 ± 5.2 kg	24.9 ± 5.2 kg	0.059 ^b

Table 3. Correlation of Vitamin D levels with muscle mass, walking speed and hand grip

	r	p	N
Muscle mass	0.178	0.044	34
Walking speed	0.221	0.040	34
Hand Grip Strength	0.170	0.045	34

Pearson correlation test, the p value is significant if $p < 0.05$, the strength of the correlation is very weak if $r < 0.2$, weak if $r = 0.2-0.4$, moderate if $0.4-0.6$, strong if $0.6-0.8$ and very strong if > 0.8

Table 4. Multivariate Analysis of Vitamin D Linear Regression in the elderly

	R	p	N
Age	-.192	.092	34
Muscle mass	.230	.005	34

Pearson correlation test, the p value is significant if $p < 0.05$, the strength of the correlation is very weak if $r < 0.2$, weak if $r = 0.2-0.4$, moderate if $r = 0.4-0.6$, strong if $r = 0.6-0.8$ and very strong if $r > 0.8$

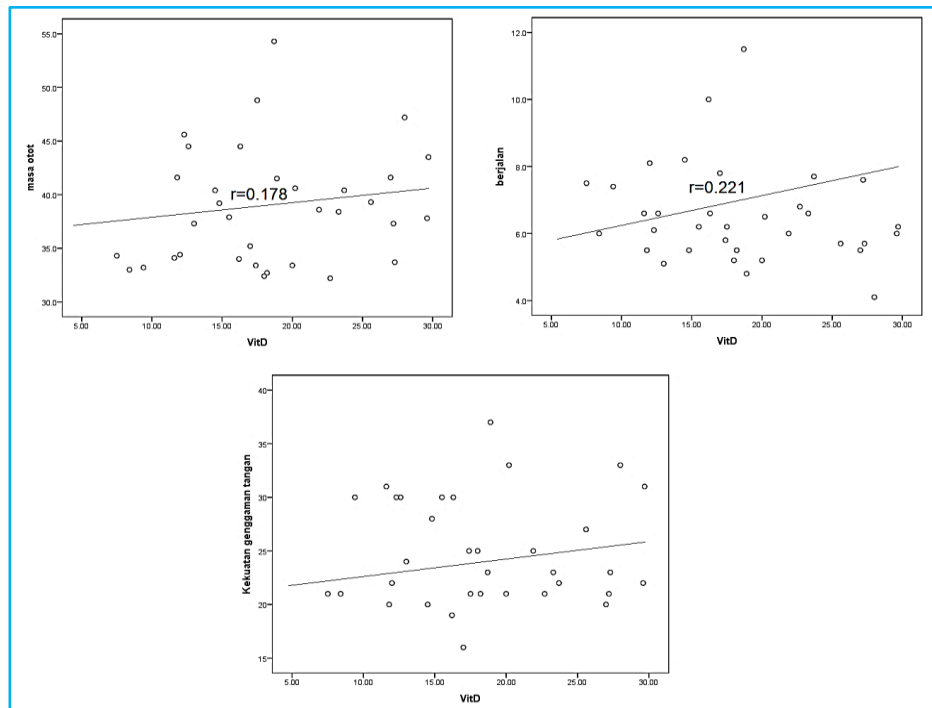


Figure 1. Graph of Vitamin D Correlation with Muscle Mass, Walking Speed and Hand Grip Strength

4. Discussion

This study was dominated by 21 (61.8%) samples with vitamin D deficiency (vitamin D levels < 20 ng/mL) and 13 (38.2%) samples experiencing insufficiency (vitamin D levels 20-30 ng/mL) with a mean of 18.4 ± 6.29 ng/mL. This study is in line with the research of Conzade et al. 2019 which found differences in muscle mass and muscle strength in the elderly who have serum vitamin D levels ≤ 25 nmol/nL with elderly people who have serum vitamin D levels of 26 -50 nmol/nL. The reduced serum vitamin D levels in the body, the higher the incidence of sarcopenia in the

elderly.¹⁰

Research conducted by Mendes et al who conducted a similar study on 834 samples who were over 60 years old and dominated by elderly people who experienced a vitamin D deficiency of 45% while 27% of the sample had insufficiency and others had normal vitamin D levels.⁸⁹ Oba et al al in 2020 found that at 257 elderly people, the average vitamin D in the body was 18 ng/mL with the lowest level was 15 ng/mL and the highest was 21 ng/mL.⁹⁰

Vitamin D deficiency and insufficiency is common in various regions around the world. Vitamin D

insufficiency was defined as a serum 25-hydroxyvitamin D (25 [OH] D) level <20 ng/mL by the Institute of Medicine.²¹ Newborns and the elderly are the age group with the greatest risk for vitamin D deficiency²³. In addition, vitamin D levels were linked to gender. The central role of vitamin D in calcium homeostasis is well known and is related to seasonality, sun exposure, body mass index, physical activity, smoking and alcohol consumption.²⁶⁻³⁰ Vitamin D and calcium are known to be important for the skeletal system, and low vitamin D levels lead to less intestinal calcium absorption, and higher PTH levels. In addition to increasing tubular reabsorption of calcium and production of active vitamin D in the kidneys, PTH activates osteoblasts to increase the number of osteoclasts that dissolve bone matrix. This leads to faster bone turnover and thus osteopenia and osteoporosis.⁵⁰

Specific receptors for 1,25-dihydroxyvitamin D (VDR) are present in the bones and gastrointestinal tract, where calcium flow is most active.²⁴⁻²⁶ In addition, vitamin D receptors are also present in skeletal muscle,^{20,23,24} but physiological functions are and its relevance to normal muscle physiology is not well understood. It is estimated that VDR in muscle tissue is an intranuclear receptor that can bind 1,25-dihydroxyvitamin D (calcitriol) with high affinity to further act as a transcription factor for protein synthesis.^{26,28,29} Vitamin D deficiency has traditionally been associated with disorders of the bones such as rickets, osteomalacia, and osteoporosis. Various studies have found another role for vitamin D and the effects of its deficiency on various organ systems³⁶

There are a number of direct and indirect effects of aging on vitamin D levels.²³⁻²⁶ Aging reduces the production of 1,25-dihydroxyvitamin D (1,25 [OH] 2 D), which is the active form of vitamin D, by up to 50%.²³ This results from decreased kidney function in the elderly. Renal function decreases with age, decreases in the renal enzyme 1 α -hydroxylase which converts 25 (OH) D into its active form, 1,25 (OH) 2 D. The serum level of 1,25 (OH)2 D is inversely proportional to the level of serum creatinine and glomerular filtration rate

(GFR). It was further found that a deficiency of 1,25 (OH)2 vitamin D triggers a decrease in the formation of 1,25 (OH)2 vitamin D, because the conversion to the active form of vitamin D in the kidneys is dependent on adequate supplies of vitamin D25 substrate.²⁵ The lower production of pro-vitamin D in the skin in the elderly also affects vitamin D23 levels.²³ The decrease in the formation of pro-vitamin D produced in the skin of the elderly is associated with less reaction to UV rays and a reduced ability to produce 7-dehydrocholesterol in the skin.^{23,28}

In this study, there was a significant correlation between muscle mass and grip strength with vitamin D with weak correlation strength and walking speed with vitamin D with moderate correlation strength. The multivariate test results showed that the increasing age, the lower the vitamin D levels in the body and the lower the vitamin D levels, the smaller the muscle mass.

Consistent with this study, Mendes et al. Found a strong positive correlation between vitamin D and muscle mass, walking speed and hand grip strength.⁸⁹ Oba et al also found a correlation between vitamin D (25 OH) muscle mass, hand grip strength, walking speed, and lower limb function.⁹⁰ Skaaby et al in 2018 concluded that low vitamin D levels have been linked to muscle mass, body performance and a number of diseases commonly found among the elderly, for example, osteoporosis, falls and fractures and sarcopenia.²⁴

Vitamin D deficiency is known to cause muscle weakness², and muscles may need vitamin D for optimal functioning because muscles have VDR². Thus, muscle strength is shown to increase when vitamin D levels increase from 4 to > 40 ng/mL (10-100 nmol/L).⁵² Several studies have suggested a possible effect of vitamin D on the development of sarcopenia.^{13,52} In line with previous studies, a study of 864 men and women by Walsh et al.¹³ found that genetic variation in VDR was moderately associated with muscle strength in both sexes and the risk of sarcopenia in women. Vitamin D supplements have the potential to reduce the risk of sarcopenia and prevent disability. In a

randomized controlled trial (RCT) of 380 adults with sarcopenia, vitamin D, and leucine-fortified *whey protein* were given as a supplement for 13 weeks and this resulted in increased muscle mass and lower limb function.⁴⁸

About one-third of women aged between 60 and 70 years and two-thirds of women 80 years or older have osteoporosis.⁵⁰ It is estimated that nearly half of women will experience an osteoporotic fracture in the rest of their lives. Risk factors for osteoporosis include, for example, age, female sex, menopause, inactivity, and inadequate intake of calcium and vitamin D.⁵¹ Vitamin D and calcium are known to be important for the skeletal system, and low levels of vitamin D lead to less intestinal calcium absorption, and higher levels of PTH. In addition to increasing tubular reabsorption of calcium and production of renal active vitamin D, PTH activates osteoblasts to increase the number of osteoclasts that dissolve bone matrix. This leads to faster bone turnover and thus osteopenia and osteoporosis.⁵¹

A meta-analysis of observational studies found that farmers working in the fall had lower levels of vitamin D (<20 ng / mL) than non-fall³⁴. In many RCT studies it was found that only doses of vitamin D that were sufficiently large were efficient in preventing falls, one RCT study even reported an increased risk of falls in elderly women, after giving each year a dose of 500.000 IU of vitamin D supplementation for 3-5 years a reduced risk of falls compared to the placebo group³⁵. A review study found that supplementation vitamin D of ≥ 800 IUs reduces the risk of falls in the elderly.³⁶ A meta-analysis showed that 800 IU of vitamin D3 per day plus calcium was more effective in preventing and lowering the risk of falls in the elderly 400 IU of vitamin D3 per day.⁷

RCTs primarily examine the effects of vitamin D on hip and nonvertebral fractures. A meta-analysis of 20 large RCTs showed that fractures were reduced in people who consumed > 400 IU of vitamin D supplementation per day.³⁹ An analysis of 11 RCTs found that doses > 800 IUs / day of vitamin D have a beneficial effect in preventing hip and nonvertebral

fractures in the elderly.^{6,38} Serum levels of Vitamin D absorption appear to be important for example, the Women's Health Initiative study reported that levels of vitamin D serum vitamin D ≤ 26 ng / mL had little effect on fracture risk^{48,39}

5. Conclusion

There is a significant correlation between muscle mass and grip strength with vitamin D with weak correlation strength and walking speed with vitamin D with moderate correlation strength. The multivariate test results showed that the increasing age, the lower the vitamin D levels in the body and the lower the vitamin D levels, the smaller the muscle mass.

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