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# The Relationship between Vitamin D Levels and Muscle Mass in Obese Children

**Hefira Rosadiani[1*], Wistiani[2], Galuh Hardaningsih[2]**

[1]Specialized Residency Training, Department of Pediatrics, Faculty of Medicine, Universitas Diponegoro/Dr. Kariadi General Hospital, Semarang, Indonesia

[2]Staff, Department of Pediatrics, Faculty of Medicine, Universitas Diponegoro/ Dr. Kariadi General Hospital, Semarang, Indonesia

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***Corresponding author:**
Hefira Rosadiani

**E-mail address:**
*hefirarosadiani@gmail.com*

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**A B S T R A C T**

Obesity can result in the secretion of proinflammatory mediators, which can result in vitamin D deficiency and decreased muscle mass. Good muscle mass is necessary for a good quality of life in obese children. This study aimed to determine the relationship between vitamin D levels and muscle mass in obese children. The average muscle mass in obese children is 15.04 kg. As many as 24.4% of children have normal muscle mass levels, while 75.6% of obese children have low muscle mass. This study is an analytic observational study with a cross-sectional approach. A total of 86 research subjects participated in this study. Measurement of muscle mass and vitamin D levels was carried out in this study. Data analysis was performed using SPSS version 20 using univariate and bivariate methods. The average vitamin D level was 26.65 ng/mL. As many as 69.8% of obese children had normal vitamin D levels, while 30.2% had low levels of vitamin D. In conclusion, there is no relationship between vitamin D levels and muscle mass in obese children.

## 1. Introduction

Obesity is caused by an imbalance between energy intake and energy output. A study shows that the prevalence of obesity in Indonesia in children under 5 years reaches 8%. The highest prevalence of obesity is at the age of 5-12 years and 13-15 years. The prevalence of obesity in females is higher than in males. Obese children show a decrease in muscle mass and also a deficiency of vitamin D. The proportion of body fat is inversely proportional to the serum concentration of 25(OH)D. Other studies suggest that *a* higher BMI leads to a lower 25(OH)D. Each increase in BMI is associated with a 1.15% lower concentration of 25(OH)D. The nature of vitamin D deficiency in obesity is still debated and may be due to several mechanisms.[1,2]

Several studies studying the relationship between the effects of vitamin D on muscle mass have come to different conclusions**.** One study showed that, in elderly women, vitamin D supplementation (4000 IU/day) for 4 months was associated with a 30% increase in intramionuclear vitamin D receptor (VDR) concentration and a 10% increase in the cross-sectional area of muscle fibers. A randomized trial in 179 pre-pubertal women, ages 10–17, who received vitamin D3 1.400 IU/week, vitamin D3 14.000 IU/week, or placebo for 1 year, reported an increase in lean mass throughout the body (a marker of muscle

mass replacement) in pre-pubertal women who were given supplements. Another study showed that there is no relationship between vitamin D levels and the cross-sectional area of the muscles in the thighs.[3-5]

Obesity can result in the secretion of proinflammatory mediators, which can result in vitamin D deficiency and decreased muscle mass. Good muscle mass is necessary for a good quality of life in obese children.[6] This study aims to determine the relationship between vitamin D levels and muscle mass in obese children.

## 2. Methods

This study was an analytic observational study with a cross-sectional approach and used primary data. A total of 86 research subjects were included in this study. The inclusion criteria in the form of obese children aged 7-12 years at Pendrikan Kidul Elementary School, Bulustalan Elementary School, Petompom 2 Elementary School, HJ Isriarti Elementary School, Semarang, Central Java, Indonesia, and research subjects agreed to participate in the study after obtaining consent from the subject's parents. This study has received approval from the Health Research Ethics Committee, Faculty of Medicine, Universitas Diponegoro, Dr. Kariadi General Hospital, Semarang (No. 1170/EC/KEPK-RSDK/2022).

Nutritional status is determined from anthropometric data, which is then classified by body weight (BW)/body height (BH). Nutritional status is declared obese if the z-score ≥ 3SD (Standard Deviation). Measurement of serum vitamin D (25[OH]D) levels used the human vitamin D (VD) enzyme-linked immunosorbent assay (ELISA) (Elabscience biotechnology) method at the GAKI laboratory in Semarang. Vitamin D levels are considered low when ≤20 ng/mL. Muscle mass was measured with the Tanita BC 545 Inner Scan Body Composition, declared normal when ≥-2SD (Standard Deviation). Data analysis was performed using SPSS version 20. Data analysis was performed univariately to present the distribution of data frequencies for each test variable. Bivariate analysis was carried out to analyze the relationship between the test variables with a p-value <0.05.

## 3. Results and Discussion

Table 1 shows that the most obese subjects are in the age group 8-10 years (51.2%), followed by the age group 11-13 years (36.0%) and the age group 5-7 years (12.8%). In this study, there were more obese males (60.5%) than females (39.5%). Obese children's weight ranges from 27.3 kg to the highest at 97.5 kg. The body mass index ranges from 19.9 to 35.9. As many as 82.4% of subjects had sun exposure scores above the average. As many as 87.2% of the subjects wore daily clothes that covered more than 3 body parts in their daily lives. The clothes are in the form of shirts and pants for men and skirts for women. Most of the subjects did not wear hats or umbrellas in their daily lives (81.4%) and did not use sunscreen in their daily lives (80.2%). Most of the subjects had sufficient protein intake (75.6%). The level of protein intake is moderately marked at ≥ 90% of the recommended dietary allowance (RDA). None of the subjects had sufficient vitamin D intake. All subjects had a daily protein intake that was lower than the nutritional adequacy rate. The level of physical activity obtained from the CPAQ (Children Physical Activity Questionnaire) showed that 47.7% had sufficient physical activity, and 52.3% of subjects had insufficient physical activity. The average CPAQ score in obese children in this study was 2.72. The average muscle mass in obese children is 15.04 kg. As many as 24.4% of children have normal muscle mass levels, while 75.6% of obese children have low muscle mass. The average vitamin D level was 26.65 ng/mL. As many as 69.8% of obese children had normal vitamin D levels, while 30.2% had low levels of vitamin D. Table 2 shows that there is no relationship between vitamin D levels and muscle mass in obese children.

Table 1. Baseline characteristic.

| Variable | Frequency | Percentage % | Mean ± SD | Median (minimum-maximum) |
|---|---|---|---|---|
| Age | | | 9,76 ± 1,67 | 10 (7 – 13) |
| 5 – 7 years | 11 | 12,8 | | |
| 8 – 10 years | 44 | 51,2 | | |
| 11 – 13 years | 31 | 36,0 | | |
| Gender | | | | |
| Male | 52 | 60,5 | | |
| Female | 34 | 39,5 | | |
| BW (Body weight) | | | 52,21 ± 12,82 | 52,7 (27,3 – 97,5) |
| BH (Body height) | | | 140,70 ± 10,35 | 140,75 (116 – 167) |
| BMI (Body mass index) | | | 26,06 ± 3,60 | 25,7 (19,9 – 35,9) |
| Sun exposure score | | | | |
| Above average | 70 | 82,4 | | |
| Below average | 15 | 17,6 | | |
| Body parts covered with clothes | | | | |
| > 3 | 75 | 87,2 | | |
| ≤ 3 | 11 | 12,8 | | |
| Umbrella/cap protector | | | | |
| Yes | 16 | 18,6 | | |
| No | 70 | 81,4 | | |
| Sunscreen | | | | |
| Yes | 17 | 19,8 | | |
| No | 69 | 80,2 | | |
| Protein intake rate | | | 134,67 ± 62,23 | 125,95 (64,0 – 368,30) |
| Enough | 65 | 75,6 | | |
| Less | 21 | 24,4 | | |
| Vitamin D intake levels | | | 19,25 ± 17,33 | 15 (1,3 – 86) |
| Enough | 0 | 0 | | |
| Less | 86 | 100 | | |
| Physical activity level | | | 2,72 ± 0,79 | 2,6 (1,12 - 5,04) |
| Moderately active | 41 | 47,7 | | |
| Less active | 45 | 52,3 | | |
| Muscle mass | | | 15,04 ± 3,34 | 14,92 (6,23 – 24,84) |
| Normal | 21 | 24,4 | | |
| Low | 65 | 75,6 | | |
| Vitamin D levels | | | 26,65 ± 9,87 | 25,30 (9,90 – 74,60) |
| Normal | 60 | 69,8 | | |
| Less | 26 | 30,2 | | |

Table 2. Relationship between vitamin D levels and muscle mass.

| Vitamin D levels | Muscle mass | | p | PR (95% CI) |
|---|---|---|---|---|
| | Low | Normal | | |
| **Low** | 19 (29,2%) | 7 (33,3%) | 0,722* | 0,95 (0,73 – 1,25) |
| **Normal** | 46 (70,8%) | 14 (66,7%) | | |

*Chi-square.

The relationship between vitamin D levels and muscle mass has mixed research results. Another study in a population of postpubertal women found no relationship between vitamin D levels and muscle mass. Vitamin D supplementation increases muscle strength without adding muscle mass. Another study in young women aged 16-22 years found no consistent

relationship between vitamin D and muscle mass and muscle function.

The study conducted in Asia on 69 males (average age 33.9 years) and 67 females (age 32.9 years) found that there was no relationship between 25(OH)D2 levels and muscle strength. A long-term study among healthy elderly males and females on serum levels *25* (OH)D <75 nmol/L given 800 IU of vitamin D3 and 1000 mg of calcium daily for 12–20 months significantly improved physical performance tests compared to the elderly who only got calcium supplementation alone over a period of 12-20 months. A randomized trial in 179 pre-menarche women, ages 10-17, who received 1.400 IU/week of vitamin D3 showed an increase in lean mass. A study shows that vitamin D supplementation improves physical activity function and reduces the risk of falling among elderly people. This is because vitamin D is proven to have more influence on the function of muscle coordination which is mediated by nerve performance. Supplementation of 1.25(OH)D2 has more effect on physical activity, balance, and posture stability but has less effect on strength and muscle mass.[7-13]

Obesity results in increased levels of proinflammatory cytokines resulting in chronic inflammation. Chronic inflammation results in increased oxidative stress and decreased IGF-1. Increased inflammatory cytokines are a risk factor for decreased muscle mass in obese children. In this study, there was no measurement of inflammatory cytokine levels that could affect muscle mass. In obesity, there is an accumulation of fat, including in skeletal muscle tissue. Fat infiltration in skeletal muscle tissue can be identified by performing a CT scan in the thigh area and calculating tissue density with an external phantom. Fat infiltration in muscle tissue results in a decrease in muscle function and strength but does not affect muscle mass. Fat cell infiltration results in decreased mitochondrial phosphorylation and causes insulin resistance at the tissue level. These conditions result in impaired glucose uptake and ATP formation in muscle tissue resulting in a decrease in muscle strength and function.[14-20]

## 4. Conclusion

There is no relationship between vitamin D levels and muscle mass in obese children.

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