The Relationship of Vitamin D with Cardiorespiratory Fitness and Muscular Strength in Japanese Adults

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Introduction

Vitamin D plays not only an important role in maintaining metabolism and growth of bone, but also accumulating evidence indicates that it has a protective role against many diseases, including cancer, cardiovascular diseases, diabetes, and infectious diseases. Human gets vitamin D largely from exposure to sunlight which induces vitamin D production in the skin, and also a few from diet. However, causes of variety of factors, such as limited to geographical latitude, season and supplement use, vitamin D deficiency is spread in the world. In Japan, there were few studies about vitamin D status. However, data collection from youth and male was scant in Japan, and the range of subjects' age was small. Therefore, in this study, we investigated vitamin D status both female and male with larger range of age in Japan.

Cardiorespiratory fitness has been proved that it was benefited to reduce the risk of heart disease, lung cancer, type 2 diabetes, stroke, and other disease. And muscular strength was also evidenced to be inversely associated with metabolic syndrome incidence. Recently, the effect of vitamin D on skeletal muscle structure and function is receiving a great deal of attention. Several experimental studies have revealed VDR (vitamin D receptor) in skeletal muscle, and vitamin D have been found affect muscle metabolism by stimulating de novo protein synthesis, increasing the proportion of type II muscle fibers and improving muscle function. And, vitamin D is also effect on other organs, including brain, heart, skin, and immune system, via VDRs which are expressed by cells. Therefore, it is maybe that serum 25(OH)D concentration was related to cardiorespiratory fitness and muscular strength.

In Western, few human studies have been evidenced that higher serum 25(OH)D concentration was positively associated with better cardiorespiratory fitness. And several observational studies showed a positive association between vitamin D status and muscular strength among older, younger and adults. However, vitamin D and physical fitness were influenced by race and environment. Thus, we cannot know that the relationship of vitamin D with physical fitness existing in Westerners is also existed in Japanese.

In the present study, the first aim was to investigate vitamin D status in Japanese. And the second aim was to ascertain the association between vitamin D level and physical fitness, including cardiorespiratory fitness and muscular strength, in Japanese adults.

Methods

A total of 96 Japanese (age 43.6 ± 14.14 years, BMI 22.1 ± 3.01 kg/m^2) participated in our study. Fasting blood samples were collected in morning and analyzed for serum 25(OH)D and serum PTH by using an enzyme-linked immunosorbent assay. Maximal oxygen uptake VO(2max) was measured with a maximal incremental test on a bicycle ergometer. Hand grip strength was measured using a hand grip dynamometer and leg extension power was measured using a leg extension power measurement system. Moderate to vigorous PA (MVPA) was measured using accelerometer-based activity monitors worn at the waist for seven consecutive days.

Results

Of the 96 Japanese, 78% of subjects were vitamin D deficiency, 20% of them were vitamin D insufficiency, and merely 3% of them were sufficiency. There was a significant relationship between serum 25(OH)D concentration and $\dot{V}O_2$max in all participants and the relationship remained after adjusted by gender, age. And there was a borderline statistically significant relationship after further adjusted by BMI. But this relationship was disappeared after further adjustment for physical activity. Moreover, there was a positive relation between serum 25(OH)D concentration and hand grip strength, leg extension power, and the relationship remained after adjusted by gender, age, BMI, MVPA and $\dot{V}O_2$max.

Conclusion

The high prevalence of vitamin D deficiency was found in our studies. We found that serum 25(OH)D concentration was related to cardiorespiratory fitness, but the relationship was affected by BMI and MVPA. Moreover, the present study also demonstrated that serum 25(OH)D are independently and positively associated with muscle strength, including hand grip strength and leg extension power in Japanese adults.