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Review Article

Improving Vitamin D Status in the Deficient Obese Population

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Abstract

Normal serum levels of vitamin D are essential for bone health, immune, nervous and cardiovascular systems, and are suggested as a preventative measure for multiple forms of cancer. Vitamin D deficiency is extensive in the general population, with the obese population being especially susceptible. This review investigates literature for the association between vitamin D and obesity. A literature review found vitamin D deficiency was inversely related to obesity and BMI, and increasing serum 1,25D improved glucose handling and insulin resistance. The obese population is more deficient in vitamin D and has lower serum levels of 1,25D than the non-obese population. Possible causes include adiposity of vitamin D, volumetric dilution, decreased sun exposure and a diet lacking in foods rich in vitamin D. Solutions include correction of RDA of vitamin D for improved dosing recommendations, 15 minutes of sunlight without SPF, an increase in consumption of foods high in vitamin D, supplementation for obese and non-obese populations and education for the individual and family. Toxicity of high levels of vitamin D was found to be only relevant above 50,000 UI daily intakes and not of concern for the general population. Public health policy change and improvements in Vitamin D status in obese populations will improve health status for a significant portion of the population.

Keywords: 1,25D serum; Deficiency; Insulin resistance; Obesity; Vitamin D

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Introduction

The relationship between obesity and vitamin D has been more prevalent throughout research in recent years. Understanding the impact vitamin D has on the entire body has led to a better understanding of the micronutrient balance. Vitamin D is a fat-soluble micronutrient found in certain foods, is added to others, and can be synthesized by the skin. Vitamin D is important for maintenance of bone and teeth, the nervous system, regulation of insulin, lung and cardiovascular health, and has been suggested to reduce cancer development. Vitamin D is not a true vitamin; a vitamin is defined as essential substances obtained exclusively from the diet [1]. It is naturally synthesized in the skin with UV sun exposure and can be obtained from food as well as supplementation [2]. Low intake of this vitamin is of public concern because of known deficiencies in the general population and resulting health concerns [3]. Deficiencies in micronutrients, such as vitamin D have been steadily on the rise, and susceptible populations, such as the obese population, have been found to have greater deficiencies than the general population. Other populations that are uniquely susceptible to deficiency include breastfed infants, older adults, people with dark skin and people with malabsorption diseases [2].

In the United States obesity is at epidemic levels, 1 in 3 adults are obese and 1 in 6 children are obese. According to Healthy People 2020, the goal by the year 2020 is to reduce the number of obese adults to 30.5% (a 10% reduction) and children age 2-19 to 14.5% (a 10% reduction) [4]. Obesity has many factors, one of which is insulin resistance. Merriam-Webster defines insulin resistance as “reduced sensitivity to insulin by the body’s insulin-dependent processes (as glucose uptake, lipolysis and inhibition of glucose production by the liver) that results in decreased activity of these processes or an increase in insulin production” [5]. Incomplete or delayed sugar metabolism leads to various disease processes, including metabolic syndrome, hyperglycemia and diabetes mellitus. Insulin resistance is a key factor in the obese populations’ ability to lose weight and limit or resolve disease processes associated with sugar metabolism.

Sufficient serum vitamin D levels are 50-75 nmol/l and Recommended Daily Allowance (RDA) is 600 IU/day, with the recommended dosage for insufficiency and deficiency ranges from 1000-50,000 UI for up to 3 months [6]. Research has suggested optimal serum vitamin D levels have a positive impact on insulin resistance in the obese population [7]. Recent studies found the optimal level of vitamin D is significantly higher than was originally reported, well beyond 2000-4000 UI for non-deficient populations and current RDA is not meeting requirements for bone health and disease prevention [8,9]. Additionally the Endocrine Society recommends 2-3 times more vitamin D for obese populations [10]. Susceptible populations may require individualized dose recommendations to achieve optimal serum vitamin D levels [11]. In this review vitamin D deficiency in obese populations, current and recommended RDA guidelines and current solutions to the population deficiency will be discussed.

Methods

In this report, a review of possible links between vitamin D and obesity was evaluated. Databases used included EBSCO, ProQuest and Google Scholar. The types of studies accepted for review included controlled studies, reviews and statistical analysis of previous data. Quantitative and qualitative studies were included. Case studies were not included. Participants of the studies included adolescents and adults in the obese populations. Interventions included supplementation, sun exposure and diet. Outcome measures included post-intervention lab work including serum 1,25D levels, BMI and waist circumference. Keywords used included vitamin D, micronutrient, deficiency and obesity. The search was narrowed to articles from no later than 2013. Animal studies were excluded.

Results and Discussion

Solutions to vitamin D deficiency in the obese population include RDA correction, dietary changes, sun exposure, supplementation and education of the individual and family.

Correct RDA vitamin D

Deficiency of vitamin D status is an epidemic. The importance of proper vitamin D (1,25D) levels can be seen at the cellular level of disease prevention. Vitamin D is important for reducing chronic disease by upregulation and downregulation of gene expression that affects 160 difference metabolic pathways; highlighting the importance of vitamin D status worldwide [12]. Current RDA of 600 IU 25D was based on prevention of rickets and not levels of optimal functioning and prevention of disease for 97.5 % of the population [8,11]. Studies have found various intake levels to achieving 50 nmol/L 25D serum levels, which is shown to prevent disease, injury and promote bone health [8]. To achieve proper serum levels, one study recommended 1040 IU another 4000 IU, while a separate study used 75-100 nmol/L as proper serum levels and recommended 8895 IU [8,9,11]. These recommendations were for daily intake for non-deficient populations. Additionally the Endocrine Society has stated recommendations of 1000 IU under age 1, 1500 IU breastfed under age 1, 3000 IU children above age 1, and 8000 IU for all other populations to reach 50 nmol/L [11]. These recommendations do not address the 30% of the population that is considered obese. Studies have shown the obese patient does not have the same elevation in serum 1,25D as the non-obese patient with identical doses [13]. Obese populations are recommended to have an additional 40% in one study, 2-5 times non-obese population dose in another study, while the Endocrine recommends 2-3 times the non-obese dose to achieve the same 50 nmol/L serum 25D [10,12,13]. The concern of toxicity is not relevant at recommendations, as toxicity has been found to be rare at 10,000 IU per day and is more common at 50,000 IU per day or achieving 500 nmol/L serum 1,25D which is difficult to achieve [10]. Correction of RDA vitamin D intake must occur for the population to be educated, especially high risk populations such as the obese. With many conflicting findings, the RDA may not be decided with the current body of knowledge and a study that takes into account demographics and physical characteristics, such as BMI, may be indicated for.

Increase vitamin D in dietary sources

Approximately 20 % of vitamin D is meant to come from dietary sources [11]. Sources include oil-rich fish that are smoked or cooked, cod liver oil, dairy products, fortified cereals and juices, eggs, UV grown mushrooms, margarine, pork, non-dairy products like soy milk, almond milk and rice drink [3,14]. Additionally, correct adherence to the Mediterranean diet has shown to provide proper dietary intake of vitamin D [14]. Dietary sources of vitamin D are limited and not consumed in large amounts in the American diet. Education of natural vitamin D sources is recommended, with focus to improve foods that are consumed less often, such as vitamin-rich fish, mushrooms and eggs. To improve the consumption of vitamin D for the current limited American diet increased levels of fortification of milk, eggs, margarine and cereals may be essential, especially in products containing calcium.

Improve insulin resistance in obese population

Obese patients have decreased insulin sensitivity, low-vitamin D-binding protein, poor absorption and greater volume of distribution [13]. Some studies have found there is an inverse relationship between 25D and insulin resistance, however after correction of BMI, this relationship became nonsignificant. The more accurate inverse relationship was found to be between vitamin D and BMI or possible adiposity. Studies also differed based on type and populations studied and found results of the inverse relationship between vitamin D and diabetes mellitus and glucose handling [1]. An additional study found when participants were provided 2000 IU D3 for 6 months, this resulted in significant changes in fasting plasma insulin and leptin: adiponectin ratio. This ratio is found to increase glucose uptake and may help with insulin resistance. It was found that supplementing 4000 IU vitamin D impaired glucose metabolism and insulin resistance, possibly due to reducing inflammation, enhancing peripheral uptake and decreasing circulating insulin concentrations [7]. Correlations were additionally found between increased vitamin D and calcium intake and body fat and weight gain, suggesting this combination as a chemoprevention and treatment of obesity [15]. As compared to other medications for insulin resistance like metaformin, vitamin D correction in the obese population gave similar results of attenuation of insulin resistance without the side effects associated with metaformin [6]. It is unclear if there is a direct link between insulin resistance and vitamin D, however improvements have been shown in multiple studies of decreased insulin resistance and body fat and modest improvements cannot be ignored and must be studied further as an additional resource for decreasing obesity.

15 minutes a day of sunshine and no SPF

Heliotherapy is the healing power of the sun. The body has the ability to synthesize its own vitamin D and vitamin D receptors are in every tissue in the body [16]. It is recommended to receive 80% of vitamin D from sun exposure [11]. Casual sun exposure is recommended, where appropriate vitamin D synthesis requires exposure to arms and legs for one half the time it takes to burn 2-3 times each week, and face exposure is not required. Other sources such as tanning beds and UV lamps may also be effective [12]. SPF 15 has been found to decrease or completely inhibit vitamin D synthesis, and casual exposure is not meeting RDA needs due to less time outside, SPF 15 or greater sunscreen use and protective clothing use [17]. Obese populations have vitamin D deficiencies in part due to decreased sun exposure despite greater surface area for vitamin D synthesis [14]. Research has found 19 of the 30 top diseases linked to vitamin D status can be reduced significantly with an increase in serum 1,25D to

40 ng/mL. This is contrary to current recommendations of sun exposure to prevent skin cancer, even though the leading type of skin cancer has been found to not being linked to sun exposure and it is suggested the sun protection may be promoting melanoma skin cancer instead of protecting against it [16,17]. The many factors of sun exposure and vitamin D synthesis appear to be compounding the deficiency in obese populations.

Vitamin D supplementation

Supplementation may be a necessity in the adolescent and adult obese populations as a result of inadequate dietary sources and sun exposure. Extra adipose tissue results in storage of vitamin D and volumetric dilution results in lower serum 25D levels for the same dose in obese and non-obese populations, indicating required levels far above that of the non-obese population [13,14]. The Endocrine Society and various studies recommend 2-3 times more vitamin D in obese populations [10]. Of the two recommended types of vitamin D supplementation, vitamin D2 and D3 appear to have similar bioavailability and raise 1,25D serum levels as comparable rates. One study recommends doses for deficiency at 50,000 IU D2 every two weeks for 8 weeks and insufficiency at 50,000 IU D3 every two weeks for 3 months. Supplements can be administered daily, weekly, monthly, or quarterly and initial doses for severe deficiency can reach 300,000 IU [12].

Alternatively, severe deficiencies may require intramuscular injections of 100,000 IU weekly [14].

Toxicity is rare at 10,000 IU/day and recommendations in males have been found safe and higher levels are safe as long as serum 1,25D does not exceed 200 ng/mL [12]. The range of toxic levels varies in studies from 20,000 - 50,000 IU but is generally not seen unless serum levels reach 500 nmol/L [6,10].

Education

Treatments focus on behavioral changes and increased physical activity. Diet therapy provides short term results. Counseling to change individual and family behaviors with diet, exercise, sun intake and decreased screen time have been used. There are medications that decrease fat absorption and appetite [18]. Education of individual and family is essential for long-term success, habits must be changed to stop the results of vitamin deficiency and obesity.

In conclusion, the deficiency of vitamin D in the obese population is worse than the non-obese populations. Solutions of RDA update, dietary changes, supplementation, increased sun exposure and education are possible solutions to improve vitamin D serum status. Improvement of serum vitamin D will result in decreased BMI and improved insulin resistance which both have positive impacts in reducing obesity. These steps will improve health outcomes of the obese population and decrease prevalent disease processes.

Declarations of Interest

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References

1. Girgis CM, Clifton-Bligh RJ, Hamrick MW, Holick MF, Gunton JE (2013) The Roles of Vitamin D in Skeletal Muscle: Form, Function, and Metabolism. Endocr Rev 34: 33-83.
2. National Institutes of Health (2016) Vitamin D Fact Sheet for Consumers. National Institutes of Health, Bethesda, Maryland, USA.
3. US Department of Health and Human Services (2018) 2015-2020 Dietary Guidelines for Americans. US Department of Health and Human Services, Washington, DC, USA.
4. Office of Disease Prevention and Health Promotion (2018) Nutrition, Physical Activity, and Obesity. Healthy People.gov, office of Disease Prevention and Health Promotion, Washington, DC, USA.
5. Mariam-Webster (2018) Insulin resistance. Mariam-Webster, Springfield, USA.
6. Peterson CA, Tosh AK, Belenchia AM (2014) Vitamin D insufficiency and insulin resistance in obese adolescents. Ther Adv Endocrinol Metab 5: 166-189.
7. Belenchia AM, Tosh AK, Hillman LS, Peterson CA (2013) Correcting vitamin D insufficiency improves insulin sensitivity in obese adolescents: a randomized controlled trial. Am J Clin Nutr 97: 774-781.
8. Veugelers PJ, Ekwaru JP (2014) A statistical error in the estimation of the recommended dietary allowance for vitamin D. Nutrients 6: 4472-4475.
9. Cashman KD, Ritz C, Kiely M, ODIN Collaborators (2017) Improved dietary guidelines for vitamin D: application of Individual Participant Data (IPD)-level meta-regression analyses. Nutrients 9: 469.
10. Ekwaru JP, Zwicker JD, Holick MF, Giovannucci E, Veugelers PJ (2014) The importance of body weight for the dose response relationship of oral vitamin D supplementation and serum 25-hydroxyvitamin D in healthy volunteers. PLoS One 9: 111265.
11. Papadimitriou DT (2017) The Big Vitamin D Mistake. J Prev Med Public Health 50: 278-281.
12. Hossein-nezhad A, Holick MF (2013) Vitamin D for Health: A Global Perspective. Mayo Clin Proc 88: 720-755.
13. Dhaliwal R, Mikhail M, Feuerman M, Aloia JF (2014) The Vitamin D Dose Response in Obesity. Endocr Pract 20: 1258-1264.
14. Savastano S, Barrea L, Savanelli MC, Nappi F, Di Somma C, et al. (2017) Low vitamin D status and obesity: Role of nutritionist. Rev Endocr Metab Disord 18: 215-225.
15. Christakos S, Hewison M, Gardner DG, Wagner CL, Sergeev IN, et al. (2013) Vitamin D: beyond bone. Ann N Y Acad Sci 1287: 45-58.
16. Baggerly CA, Cuomo RE, French CB, Garland CF, Gorham ED, et al. (2015) Sunlight and vitamin D: necessary for public health. J Am Coll Nutr 34: 359-365.
17. Godar DE, Pope SJ, Grant WB, Holick MF (2012) Solar UV Doses of Young Americans and Vitamin D3 Production. Environ Health Perspect 120: 139-143.
18. Huang JS, Barlow SE, Quiros-Tejeira RE, Scheimann A, Skelton J, et al. (2013) Childhood Obesity for Pediatric Gastroenterologists. J Pediatr Gastroenterol Nutr 56: 99-109.