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# Editorial
# The relationship between vitamin D and obesity

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## Abstract

Currently, vitamin D deficiency and obesity are pandemic diseases and they are associated with cardiovascular (CV) disease, metabolic syndrome and type 2 diabetes mellitus (T2DM) and other diseases. Concentrations of 25-hydroxyvitamin D (25(OH)D) (25D) are considered as the best indicator of total body vitamin D stores. An association between reduced circulating 25D concentrations and obesity is well known, but the mechanisms are not totally clear. The role of vitamin D supplementation is still uncertain and prospective interventions will establish its influence, if any, in the treatment of obesity. Vitamin D deficiency is associated with the presence of a cardiometabolic risk profile in the obese. Future trials may establish a role for Vitamin D supplementation in individuals at increased CV risk.

The increase in obesity rates presents a major public health concern. In Europe, its prevalence is in the range of 10–25% in men and 10–30% in women[1,2]. Obesity is associated with a number of co-morbidities such as cardiovascular (CV) disease, hypertension, stroke, type 2 diabetes mellitus (T2DM), dyslipidemia, osteoarthritis and some cancers[3,4].

The role of vitamin D in calcium and bone metabolism is well established. Today, vitamin D deficiency is a pandemic and has been implicated in several diseases including CV morbidity and mortality[5–8], metabolic syndrome[9–11] and T2DM[12–14].

Which proteins link vitamin D to obesity has been investigated in genetic studies[15]. There is also evidence that non-genomic mechanisms including protein expression, oxidative stress, inflammation and cellular metabolism are involved[15]. However, it is unlikely that vitamin D can cause weight loss although supplements may be associated with a small improvement in cardiovascular risk[16–19]. After absorption vitamin D is sequestered and stored in tissues (e.g. adipose and muscle)[20]. Radio-labeled vitamin $D_3$ has been injected into individuals and the highest levels of activity and radioactivity has been shown in adipose tissue[21].

Serum concentrations of 25-hydroxyvitamin D (25(OH)D) (25D) are considered as the best indicator of total body vitamin D stores, and their value reflects the total dietary intake and exposure to ultraviolet radiation[22]. The association between reduced 25D concentrations and obesity is well known, but the mechanisms are not fully understood. The question still remains as to what the health consequences of these reduced 25D levels are, especially in obesity with dysfunctional adipose tissue and insulin resistance.

An inverse association between 25D levels and insulin resistance has been reported and lower vitamin D status was accompanied by higher glucose concentrations[23–25]. In patients with T2DM, it has been reported that glucose intolerance improves after vitamin D supplementation[25,26]. There is also an inverse association between 25D concentration and body mass index (BMI)[27–30]. The mechanisms involved in lower 25D concentrations in obese individuals are not fully described, but it is possible that sequestration of vitamin D metabolites in fat compartments decreases their bioavailability[29].

 

Several clinical and epidemiological studies reported that obese subjects have lower serum concentrations of 25D with a negative correlation of vitamin D concentrations with BMI and waist circumference[31,32]. Additionally, fat mass is inversely associated with 25D levels[33–38]. Another explanation is that obese people have vitamin D deficiency because of less sun exposure due to a sedentary lifestyle[37]. A study involving 243 adults reported a decrease of 0.74 nmol/l of serum 25D per 1 kg/m$^2$ increase in BMI[38].

The role of vitamin D supplementation is still uncertain. In Norway, 334 overweight/obese participants were treated with calcium plus vitamin D or placebo during 1 year; no change in weight was observed[17].

Botella-Carretero *et al.* reported a negative correlation between serum 25D concentrations and serum triglycerides, as well as a positive association between serum 25D concentrations and serum high density lipoprotein cholesterol (HDL-C) concentrations[39,40]. Another study failed to find any effect of raising 25D levels on plasma lipids[41] while a similar study found that calcium and vitamin D supplementation resulted in decreased serum low density lipoprotein cholesterol levels[42]. As dyslipidemia is an important CV risk factor, there is a need for randomized controlled trials to clarify the possible effects of vitamin D on atherogenic dyslipidemia, especially in obese persons.

Several studies have proposed a relationship between vitamin D status and insulin resistance[23,24,43]. Pancreatic β-cells express vitamin D receptors, so a possible explanation is that vitamin D acts on these receptors[44] and in that way can indirectly influence calcium entering the β-cells[45]; thus vitamin D may affect insulin secretion.

There is evidence suggesting that vitamin D deficiency is a potential risk factor for CV disease[46–49]. Giovannucci *et al.* in a 10 year follow up clinical study found that men with vitamin D deficiency were at higher risk for myocardial infarction[50]. Wang *et al.* reported that vitamin D deficiency among participants with hypertension is related with a two-fold increased CV risk[51].

Recently, Alhamad *et al.*[52] reported the findings of a study related to the vitamin D deficiency among the elderly. They found that in elderly people, lower serum vitamin D levels were inversely correlated with values of $HbA_{1c}$ (an index of glycemic control) and HDL-C. In addition, they show that after supplementation, improvement in vitamin D deficiency was small but significant.

In conclusion, vitamin D deficiency seems to promote the development of a more proatherogenic cardiometabolic risk profile in the obese as well in persons with increased fat mass. Future research may show that measurement of vitamin D levels can help to identify individuals at greater CV risk. This could be the basis for the design of future intervention trials in the obese.

## Transparency

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