The miracle cure is exercise, not vitamin D

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Credit: AI-generated image

In residents of northern latitudes, the content of vitamin D in the body varies naturally throughout the year. This coincides with varying exposure to sunlight, which typically is high in summer and low in winter. Our most important source of vitamin D is self-production in the body, induced by UV-rays, ongoing in the deep-laying cells of our skin, beneath a filter of pigments.

Accordingly, vitamin D levels vary between people, partly because we have varying degrees of skin pigmentation. The pigments prevent the UVB rays from reaching the vitamin D-producing cells. The greater the degree of pigmentation, the less self-production.

The levels also vary with the food we eat. While some food sources are rich in vitamin D, others are scarce. Marine products are particularly rich.

In Norway we are therefore encouraged to ingest cod liver oil in the winter months. This provides access to vitamin D throughout the year and is believed to ensure proper physiological functions.

Are vitamin D supplements necessary for most people?

Despite all this, we know surprisingly little about the significance of winter intake of vitamin D, although researchers have tried to shed light on the issue for decades. The uncertainty has two possible explanations: either the quality of the research has not been sufficient, or we are chasing a vitamin D ghost.

In 2015, we therefore initiated the research project The Granheim COPD Study. The main purpose was to map the importance of vitamin D supplements for muscular adaptation to strength training in older people with and without Chronic obstructive pulmonary disease (COPD), and at the same time to map its effects on a bunch of health variables. The study was conducted as a so-called placebo-controlled randomized double-blind clinical trial; the very gold standard of clinical research. Half of the seventy-two participants ingested vitamin D for 25 weeks, while the other half ingested placebo. Both groups conducted weekly strength training sessions during the last 13 weeks of the study, with focus on the legs. The study was of course conducted in the winter.

Muscle as research model

Muscle tissue is particularly well-suited as a model for studying vitamin D and its effects on cellular functions and biology in humans. Partly because muscle cells are easy to study and share their basic properties with the rest of our cells, hence providing insights that are transferable to other cell types. And partly because muscle cells are crucial for our mobility, especially in old age, hence providing insights that are important for ensuring appropriate functionality and health in a lifelong perspective.

However, muscle tissue is particularly well-suites first and foremost because they are prone to change—they show a high degree of plasticity. They change in a negative sense when they are inactive. Then they enter sleep mode, whereby they shrink and become less usable. And in a positive sense they change when they are active. Then they become bigger and more enduring. In other words, muscle cells adapt constantly to the perceived physiological stress.

Intriguingly, this coincides with our expectations to vitamin D-dependent cellular processes. We believe vitamin D is important for managing physiological stress and we believe it provides the necessary conditions for energy extraction and growth.

It is therefore not surprising that low vitamin D levels have been associated with negative changes in muscle functions, including impaired abilities to respond to strength training. Indeed, low vitamin D levels appear to be a plausible explanation for the complete failure to respond to such training seen in many individuals, evident as a lack of increases in muscle strength and mass. Despite this general belief, this phenomenon has not been adequately studied.

So, what did we learn from The Granheim COPD Study?

High-quality data set

Let us first examine the quality of the outcomes of the study: that is, whether vitamin D supplementation led to the expected changes in vitamin D levels in the participants and whether the strength training led to changes in muscle functions and biology. These are prerequisites for further analyses and conclusions.

In line with our expectations, vitamin D intake led to a 44 percent increase in vitamin D levels, while placebo intake led to an 11 percent decrease. Accordingly, at the start of the training period, all participants in the vitamin D group showed adequate vitamin D levels, defined as blood levels above a lower limit, while as many as 12 of the 43 participants in the placebo group showed insufficient levels. The vitamin D supplement was clearly effective.

The same was true for the strength training. It led to significant increases in muscle strength, performance and muscle mass in both the vitamin D and the placebo group, and at the same time led to marked changes in muscle biology, as well as improvements in important health markers such as blood cholesterol levels and body visceral fat mass.

Vitamin D supplementation and training responses

However, the effects of vitamin D supplement on training responses were disappointing. Contrary to our hypothesis, vitamin D intake did not have positive effects for any of the outcome measures. As simple as that. Participants in vitamin D and placebo groups responded similarly to exercise, both in terms of functionality and biology.

The muscle biological data gives particular credibility to this conclusion. In muscle samples retrieved from the participants, we investigated the expression of all genes using so-called sequencing technologies. This

provides an almost complete overview of cellular properties and how they change over time. Indeed, this was precisely where we believed vitamin D would work its magic. We believed vitamin D would lead to changes in gene expression that would make the cells better suited for handling the stress of the strength training, thus providing beneficial conditions for growth. Despite this: not so much as a gene was affected by concomitant vitamin D intake and strength training. Although training led to major changes, these were just as pronounced in the placebo group.

One can always discuss whether the participants had too "normal" vitamin D levels in the first place, or whether the groups were too diverse in their composition (e.g. they included individuals with and without COPD), or whether other outcome variables would have given other conclusions. It is also possible that responses to vitamin D intake varies in the population: What is true for one person is not necessarily true for another. We currently know little about this. The fact is, however, that the lack of effects prevailed regardless of vitamin D level before onset, sex or disease status.

However, when the gene expression data were analyzed in a different way, an interesting observation emerged. When each gene was grouped together with genes of similar functions, effects of vitamin D appeared. These were related to the functions of blood vessels, and not muscle cell biology per se.

Could there be something here? Does vitamin D affect cardiovascular responses to strength training? If so, this would be an important insight for preventive and rehabilitative measures aimed at improving circulatory health of the circulator. The data does not say much about this perspective, but it finds support in previous research.

Winter sun

Nevertheless, the overall conclusion of the study was indisputable. Vitamin D supplementation offered no measurable benefits for adaptations of strength training.

In many ways this takes us back to square one. Vitamin D is undoubtedly important for human health. And while it does not appear to have a significance for muscle responses to strength training, it does appear to affect markers of cardiovascular function. It is therefore still important to maintain adequate vitamin D levels throughout the winter. We just don't know exactly why.

However, one thing we do know. Exercise is a miracle cure. And it works. Almost every time.

So, while researchers continue to puzzle the pieces of the body puzzle, you should continue to pursue an active lifestyle. All you need is your own body and an exercise machine.

Strength training should be your winter sun.

More information: Knut Sindre Mølmen et al. Vitamin D 3 supplementation does not enhance the effects of resistance training in older adults, *Journal of Cachexia, Sarcopenia and Muscle* (2021). DOI: 10.1002/jcsm.12688