Office for Health Improvement & Disparities

Independent report

Fortifying foods and drinks with vitamin D: summary

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Applies to England

Contents

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Introduction

Current government advice on vitamin D (https://www.nhs.uk/conditions/vitamins-and-minerals/vitamin-d/) relates to the protection of musculoskeletal health and is based on recommendations of the Scientific Advisory Committee on Nutrition (SACN), following publication of its Vitamin D and health report (https://www.gov.uk/government/publications/sacn-vitamin-d-and-health-report) in 2016.

In spring 2022, the Department of Health and Social Care (DHSC) launched a review to promote the importance of vitamin D and identify ways to improve vitamin D intake across the population. This included the potential option of fortifying foods and drinks with vitamin D.

As part of this review, DHSC asked SACN to provide scientific advice on the potential of mandatory vitamin D fortification for the UK population to meet the dietary recommendations for vitamin D.

SACN's rapid review considers 2 aspects of the potential impact of mandatory fortification of foods with vitamin D, which are:

- experiences of countries with existing vitamin D fortification programmes, and their impact on vitamin D intakes and vitamin D status
- the efficacy of different forms of vitamin D to fortify food

Background

Vitamin D

Vitamin D is produced in the skin when it is exposed to sunlight containing ultraviolet B (UVB) radiation. This is the main source of vitamin D for most people. It can also be obtained from foods and dietary vitamin supplements. Dietary sources are essential when skin exposure to sunlight containing UVB radiation is limited (for example, during the autumn and winter, when habitually wearing clothing that covers most of the skin outdoors, or when confined indoors).

There are 2 major forms of vitamin D, which are:

- vitamin D3, which is produced in skin and can also be obtained from the diet

- vitamin D2, which can be obtained only from the diet

Sources of vitamin D in the diet include:

- foods of animal origin, such as fish, meat and eggs
- voluntarily fortified foods, such as breakfast cereals
- vitamin supplements

There are few naturally rich food sources of vitamin D. Foods that contain significant amounts (such as oily fish, fish liver oil or egg yolk) or small amounts (such as meat) contain vitamin D3. Vitamin D2 is present in low amounts in people's diet. It can be obtained from mushrooms or yeast exposed to UVB sunlight or in foods fortified with vitamin D2.

Assessment of vitamin D exposure

The main indicator of total exposure to vitamin D (from skin production and dietary intake) is blood 25-hydroxyvitamin D (25(OH)D) concentration. This is used as a measure of vitamin D status (the amount of vitamin D in the body).

A variety of methods are available to determine blood 25(OH)D concentration and the method used can affect measurements.

Vitamin D fortification

In the UK, vitamin D fortification of food is voluntary for food producers. Foods commonly fortified with vitamin D include fat spreads (such as margarines and fat spreads made from plant oils) and breakfast cereals.

Randomised controlled trials (RCTs) have clearly demonstrated that consuming foods fortified with vitamin D increases blood 25(OH)D concentrations.

Current vitamin D recommendations in the UK

In the 2016 Vitamin D and health report, SACN concluded that the risk of poor musculoskeletal health is increased at blood 25(OH)D concentrations below 25

nanomoles (nmol) per litre and set the reference nutrient intake (RNI) for vitamin D at 10 micrograms (µg) (400 international units (IU)) per day for the UK population aged 4 years and over. This is the amount of vitamin D needed for most of the population to maintain a blood 25(OH)D concentration at or above 25nmol per litre when UVB sunshine exposure is minimal.

The UK government advises that, from late March and early April to the end of September, most people should be able to synthesise all the vitamin D they need from skin exposure to sunlight. During October to late March or early April, when skin production is minimal, everyone is advised to consider taking a daily vitamin D supplement, since it is difficult to meet the recommendation of 10µg (400 IU) per day from consuming foods containing vitamin D.

Population groups who are at an increased risk of having blood 25(OH)D concentrations below 25nmol per litre include those:

- with dark skin
- with minimal sunshine exposure due to not spending time outdoors (for example, if they are housebound or have limited outdoor access)
- who cover almost all their skin when outdoors

These population groups are advised to consider taking a daily vitamin D supplement (10µg or 400 IU) all year round.

Consuming too much vitamin D can lead to hypercalcaemia (above normal concentrations of calcium in the blood), which can weaken bones and damage the kidneys and heart. The recommended upper levels per day for vitamin D, set by the European Food Safety Authority based on its scientific opinion on the tolerable upper intake level for vitamin D (and endorsed by the UK Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment), are:

- 100µg (4,000 IU) for ages 11 years and over
- 50µg (2,000 IU) for ages 1 to 10 years
- 35µg (1,400 IU) for ages 7 to 11 months
- 25µg for ages 0 to 6 months

Dietary vitamin D intakes and vitamin D status in the UK

Data from the National Diet and Nutrition Survey rolling programme for years 9 to 11 combined (https://www.gov.uk/government/statistics/ndns-results-from-years-9-to-11-2016-to-2017-and-2018-to-2019) (2016 to 2017 and 2018 to 2019) shows that mean

vitamin D intakes from dietary sources were below the RNI (10µg or 400 IU per day) in all age groups.

The proportion of adults that reported taking vitamin D supplements was:

- 17% for ages 19 to 64 years
- 34% for ages 65 to 74 years
- 28% for ages 75 years and over

The low uptake of vitamin D supplements in the UK suggests that recommendations for vitamin D supplement intake are not reaching the UK population.

The proportions in each age group with plasma 25(OH)D concentrations below 25nmol per litre (taking account of seasonal variation) were:

- 2% of children aged 4 to 10 years
- 19% of children aged 11 to 18 years
- 16% of adults aged 19 to 64 years
- 13% of adults aged 65 years and over

The proportions with plasma 25(OH)D concentrations below 25nmol per litre were higher during January to March and were:

- 19% of children aged 4 to 10 years
- 37% of children aged 11 to 18 years
- 29% of adults

Experiences from countries with existing vitamin D fortification policies

The purpose of this part of the review was to assess the likely effectiveness of a national vitamin D fortification programme in the UK.

We obtained information on international vitamin D fortification policies and practices from:

- peer-reviewed journal articles
- government publications

- grey literature (information produced outside of traditional publishing and distribution channels)
- national survey data

Countries with fortification policies

We identified vitamin D fortification policies in 6 countries.

Policies were mandatory in:

- Australia
- Canada
- Sweden

Policies were voluntary in:

- Finland
- Norway
- USA

We considered the vitamin D fortification policies in these countries in detail.

We subsequently identified vitamin D fortification policies in 4 additional countries (Belgium, Chile, Ethiopia and Pakistan), but information about the policies in these countries was limited and we could not make a detailed assessment.

Foods fortified with vitamin D

The most common foods or drinks fortified with vitamin D in other countries were:

- milk
- breakfast cereals
- yogurts
- fat spreads

Three countries specified the form of vitamin D to use for fortification. They were:

- Canada, which specifies vitamin D2 or D3

- Finland, which specifies vitamin D3
- USA, which specifies vitamin D2 or D3 in milk, breakfast cereals and margarines, and vitamin D2 in plant-based beverages and yogurt alternatives

We assumed that both vitamin D2 and D3 are permitted in the countries that did not specify the form of vitamin D to use for fortification. They were:

- Australia
- Norway
- Sweden

Effectiveness and impact of fortification

Evidence was limited on the effectiveness and impact of the vitamin D fortification policies that we identified. Only one country (Finland) assessed the impact of its vitamin D fortification policy on vitamin D intakes and vitamin D status of the population. Findings from this assessment suggest that vitamin D fortification (together with an increase in the uptake of vitamin D supplements) has improved the vitamin D status of the Finnish population.

Evidence from countries that have collected data on intakes of vitamin D-fortified foods and blood 25(OH)D concentrations suggests that consumers have both higher intakes and status compared with non-consumers.

It was difficult to compare data between countries because they differed in:

- definitions of low vitamin D status
- food products that were fortified
- amount of vitamin D added to foods

We also obtained information on vitamin D intakes and vitamin D status from national survey data from countries with fortification policies. Since dietary surveys rely on self-reported measures of intake, misreporting of food consumption may have affected estimates of vitamin D intakes.

Blood 25(OH)D concentrations are influenced by several factors including those that affect the amount produced in the skin (such as the time of year the blood sample was taken or a person’s genetics) and the method used for measurement. The national surveys considered in this review were not designed to assess these factors, so it was not possible to consider how they might have affected blood 25(OH)D concentrations reported in the surveys.

A potential barrier to consumption of vitamin D-fortified foods is the choice of food or drink used for fortification. Data from the USA suggests consumption of foods and drinks fortified with vitamin D (such as milk and breakfast cereals) varies by population group.

Evidence was limited on the impact of national fortification policies on population groups at greater risk of vitamin D deficiency, such as those with dark skin and those with minimal sunshine exposure.

Studies generally did not consider the proportion of the population with intakes of vitamin D above recommended upper limits, or any potential adverse effects of fortification.

Relative efficacy of vitamin D2 and vitamin D3

We conducted the rapid review because the form of vitamin D (D2 or D3) used to fortify foods might influence the effectiveness of fortification in raising blood 25(OH)D concentrations of the UK population.

Both vitamin D2 and vitamin D3 increase blood 25(OH)D concentrations, and both forms prevent and treat vitamin D deficiency. However, there is ongoing debate about their relative efficacy, since some studies have reported lower increases in blood 25(OH)D concentrations following consumption of vitamin D2 compared with vitamin D3.

Studies comparing relative efficacy of vitamins D2 and D3

We searched for systematic reviews and meta-analyses of RCTs, published since the 2016 SACN report on vitamin D, that compared the relative efficacy of vitamins D2 and D3 in raising blood 25(OH)D concentration.

We identified one systematic review with meta-analysis: Relative efficacy of vitamin D2 and vitamin D3 in improving vitamin D status (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8538717/). The meta-analysis included data from 21 studies (1,277 participants with an age range of 18 to over 90 years) from 12 countries. Sample sizes of the studies ranged from 18 to 270 participants and included:

- healthy adults or children (19 studies)
- women living in a nursing home (1 study)
- hospital inpatients with hip fractures (1 study)

Limitations

Limitations of the systematic review with meta-analysis included differences in:

- the amount of vitamin D given (daily doses ranged from 5 to 100µg (200 to 4,000 IU) and single doses ranged from 1,250 to 15,000µg (50,000 to 600,000 IU))
- how often the vitamin D doses were given (single dose, daily, weekly, monthly or other)
- the methods used to measure blood 25(OH)D concentrations
- the duration of the vitamin D intervention (ranging between 14 days and one year) or the follow-up time in studies that gave a single dose (ranging between 4 and 24 weeks)

Most effective form of vitamin D

Overall, the systematic review with meta-analysis suggests that vitamin D3 is slightly more effective than vitamin D2 for increasing blood 25(OH)D concentrations. However, due to the limitations, the difference in estimated effect between the 2 forms may not be reliable.

We observed greater consistency in studies that administered vitamin D daily at doses between 5 and 25µg (200 and 1,000 IU), which are more representative of the vitamin D intakes that are likely to be achieved through food fortification. Taken together, these studies indicate an advantage of vitamin D3 over D2 in raising blood 25(OH)D concentration of about 8nmol per litre. Although concentrations were generally higher in the vitamin D3-supplemented groups, these studies confirm that both vitamins D2 and D3 are effective in raising blood 25(OH)D concentrations.

Conclusions

The need to improve vitamin D status

In its 2016 Vitamin D and health report, SACN concluded that the risk of poor musculoskeletal health was increased at blood 25(OH)D concentrations below 25nmol per litre. SACN set the RNI for vitamin D at 10µg (400 IU) per day for the UK population. This is the average amount needed by most people to maintain a blood 25(OH)D concentration of 25nmol per litre or above when UVB sunlight exposure is minimal.

Since it is difficult to achieve the RNI from natural food sources alone, SACN advised the government to consider strategies for the UK population to achieve the recommended intakes of vitamin D. Subsequent government advice, that everyone should consider taking a daily supplement of vitamin D (10µg or 400 IU) during the autumn and winter months, has had limited impact since substantial proportions of the UK population still have poor vitamin D status. This suggests that other strategies may be necessary for the UK population to achieve the recommended intakes of vitamin D.

Vitamin D fortification

One potential public health strategy to increase vitamin D intakes in the UK is fortification of foods with vitamin D. Evidence from countries with existing vitamin D fortification policies suggest that an appropriately designed and well-implemented vitamin D fortification policy has the potential to improve the vitamin D status of the UK population.

To be effective, a vitamin D fortification policy should ensure that most of the population meets recommendations for vitamin D intake, with few or no individuals exceeding upper limits. This would require:

- determining suitable levels of vitamin D for fortification
- identifying appropriate categories of foods and drinks that would reach all populations groups in the UK, including those consumed by groups at risk of vitamin D deficiency

To reach diverse population groups, foods fortified with vitamin D would need to be affordable and widely available.

The choice of which form of vitamin D (vitamin D2 or D3) to use for fortification would need to take account of different food consumption patterns across the UK (for example, adding vitamin D3 derived from animal sources to foods would not be suitable for people following a vegan diet).

Although the evidence suggests vitamin D3 may be more effective than vitamin D2, both forms prevent risk of vitamin D deficiency (blood 25(OH)D concentration below 25nmol per litre).

Further consideration of a potential vitamin D fortification policy in the UK would require a modelling exercise to:

- identify suitable foods for fortification that would reach all population groups in the UK
- assess safe levels of fortification (taking account of the amounts of vitamin D currently in fortified foods and supplement use)

The impact of any fortification policy on population blood 25(OH)D concentrations would need to be carefully monitored and evaluated.

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