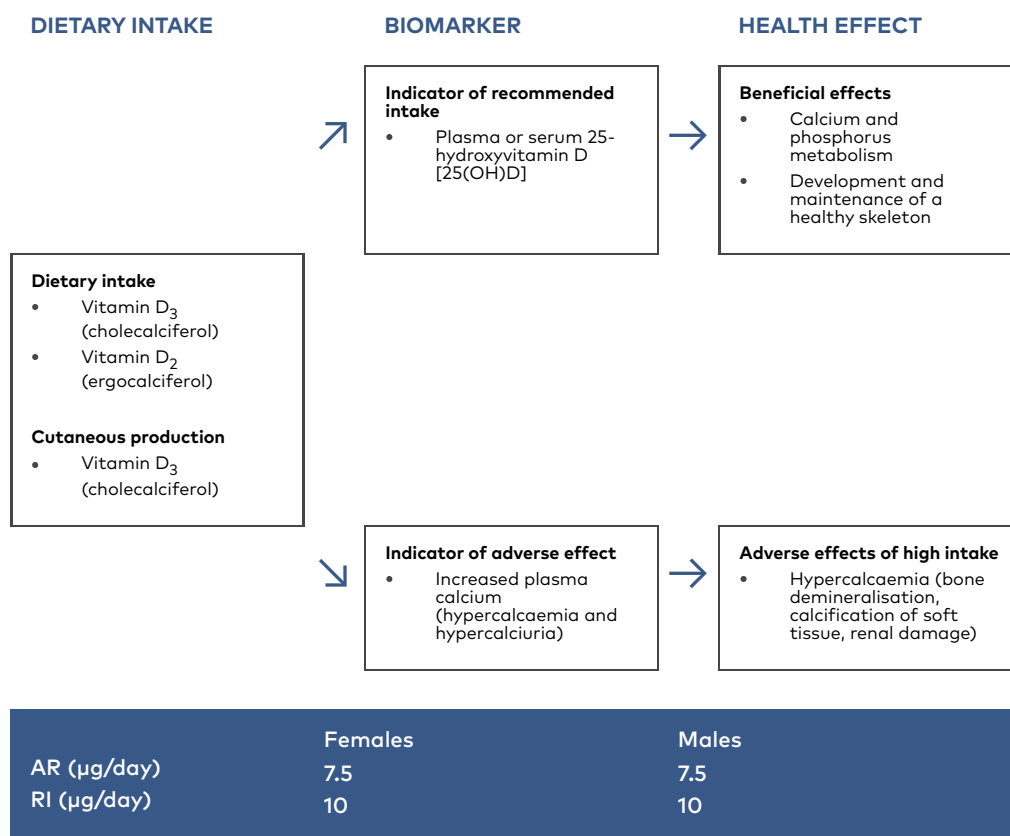


Vitamin D



For more information about the health effects, please refer to the background paper by Magritt Brustad and Haakon Meyer (Brustad & Meyer, 2023).

Dietary intake. Vitamin D₃ (cholecalciferol) is a steroid-like molecule synthesised from 7-dehydro-cholesterol in the skin by ultraviolet B (UVB) light from the sun (wavelength 290-315 nm). The Nordic and Baltic countries are situated at latitudes (54–71°N) where the sun radiation is insufficient for part of the year for vitamin D₃ production in skin to occur. Food sources of vitamin D₃ are fish, especially fatty fish like salmon, trout, mackerel, and herring, and egg yolk. Some products (including milk products, butter and margarine) are fortified to varying degrees in most of the Nordic countries (Brustad & Meyer, 2023). The average vitamin D intake (not including dietary supplements) ranged from 4.3 to 13 µg /d, partly reflecting differences in fortification practices between the countries (Lemming & Pitsi, 2022).

Main functions. Vitamin D is an essential nutrient and a pro-hormone. It is first hydroxylated to 25-hydroxyvitamin D [25(OH)D] in the liver. Thereafter it is further hydroxylated to the active form of vitamin D, 1,25-dihydroxyvitamin D (calcitriol), predominantly in the kidneys but also in other tissues. The active form of vitamin D exerts its mechanism of action through the vitamin D receptor on cellular functions such as proliferation, differentiation, and immunity. Its roles in calcium and phosphorus metabolism, and in the development and maintenance of a healthy skeleton, are well documented.

Indicator for recommended intake. Circulating 25(OH)D is considered as the most reliable biomarker for vitamin D status in humans as it captures both dietary intake and cutaneous vitamin D-production. Based on available evidence there is a growing agreement that circulating 25(OH)D above 50 nmol/l corresponds to sufficient concentrations, and that less than 25–30 nmol/l indicates deficiency (Brustad & Meyer, 2023). Factors like UV exposure, skin pigmentation and clothing habits are some of the determinants of 25(OH)D concentration. Over the years, different approaches have been used to analyse the dose-response relationship between vitamin D intake and 25(OH)D concentration. The different approaches are described in the Appendix 7.

Main data gaps. Despite the growing number of RCTs, the interpretation of some RCTs regarding the health effects of vitamin D is complicated by the fact that they often involve other co-treatments such as calcium, besides, few studies are conducted on participants with deficient 25(OH)D concentrations, and there is a lack of well-designed RCTs on some suggested vitamin D related health outcomes. More knowledge on vitamin D status being a *result of*, more than a *cause of*, diseases and ill health, could have methodological implications for future study designs (Brustad & Meyer, 2023).

Deficiency and risk groups. Vitamin D deficiency leads to impaired mineralisation of bone due to an inefficient absorption of dietary calcium and phosphorus, and is associated with an increase in serum parathyroid hormone (PTH) concentration. Clinical symptoms of vitamin D deficiency manifest as rickets in children, and osteomalacia in adults. Skin pigmentation attenuates vitamin D production (Brustad & Meyer, 2023). Frail older adults, people with low sun exposure (e.g., due to institutionalisation) and people with dark skin pigmentation are at risk of vitamin D deficiency. People with restriction of fish products in their diets, such as vegans, are at risk of becoming vitamin D deficient unless consuming supplements or fortified foods.

Dietary reference values. There is convincing evidence for recommendations to be set to prevent the population from being vitamin D deficient defined as circulating 25(OH)D <30 nmol/l. There is an increasing body of evidence

showing that there is no additional health benefit from increasing the 25(OH)D concentration above the suggested sufficient concentration at 50 nmol/l. Based on the totality of present available scientific evidence on vitamin D and health, the overall picture is in line with what was described in NNR2012. The body of evidence has increased due to the large research activity within this field. Thus, there is stronger certainty now to conclude that increasing the recommendations will not reduce disease risks in the population (Brustad & Meyer, 2023).

RI for adult females and males: 10 µg/day (≥75 years: 20 µg/day). AR is unchanged from NNR2012 (7.5 µg/day). The RI considers some contribution of vitamin D from outdoor activities during the summer season (late spring to early autumn), and this is compatible with normal, everyday life and is also in line with recommendations on physical activity. For people with little or no sun exposure, an intake of 20 µg/d is recommended. The UL of vitamin D is 100 µg/day (Lamberg-Allardt et al. 2023a).