



# The Benefits and Importance of Vitamin D

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Vitamin D is an important fat-soluble vitamin to maintain human health, and it is also a hormone. The source of vitamin D in the human body is divided into food intake or self-synthesis in the body, and the synthesis method is generated by irradiating ultraviolet B in the sun through the skin. In general definition, serum 25(OH)D concentration below 20 ng/mL is defined as vitamin D deficiency, and concentration below 30 ng/mL is defined as vitamin D inadequacy. Insufficient vitamin D has an impact on the physiological functions of many organs; for example, bone health (osteoporosis), it has also been confirmed that vitamin D is closely related to the occurrence and development of many chronic diseases, such as cardiovascular diseases, autoimmune diseases (including regulation of immune function, stimulation of macrophage biosynthesis), malignant tumors (vitamin D inhibits cell proliferation, induces apoptosis or differentiation, and inhibits angiogenesis), metabolic diseases (maintains human blood calcium balance, inhibits renin production) and prevention infectious diseases (reduces respiratory tract infections), and kidney protection and prevention of metabolic syndrome, type 2 diabetes (stimulates insulin secretion). Vitamin D also acts on nerve cells, systemic blood vessels, prostate, breast and immune cell receptors, indirectly affects the physiological activity of human metabolic genes; even positively correlated with the mortality caused by the disease itself.

**Key words:** vitamin D deficiency, 25(OH)D, osteoporosis, frailty, sarcopenia

## Introduction

Vitamin D is a group of fat-soluble vitamins and is an important nutrient for maintaining normal growth and health of the human body. The human body can obtain vitamin D by ingesting food, and it can also synthesize vitamin D by itself when the skin is exposed to ultraviolet light.<sup>1-3</sup> Vitamin D deficiency is quite common around the world, especially in women (due to excessive sun

protection and poor dietary intake), and it is estimated that about 1 billion people worldwide fail to meet the standard recommended value; about 39% in the United States are extremely deficient (less than 20 ng/mL), another 25% were deficient, and 64% of the population lacked sufficient vitamin D to function well.<sup>4,5</sup> Asian countries also have high rates of vitamin D deficiency. Malaysia has 12% to 73%, India 91%, China 36%, South Korea 69 to 80% and Japan about 5% to 18%.<sup>6,7</sup> According to the Institute of Medicine, 4000 IU is the

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safe upper limit of daily vitamin D intake for adults; however, 40,000 to 100,000 IU (1,000 – 2,500 micrograms) per day for more than a month has been proven toxic to humans.<sup>8</sup> Age is an important factor affecting serum vitamin D concentration in Taiwan. The proportion of elderly people with vitamin D deficiency is higher than that of young people. Testosterone levels in the body decrease with aging, and vitamin D deficiency can lead to decreased libido, decreased bone density, decreased muscle mass, increased fat production, and decreased red blood cell production. Maternal vitamin D supplementation during pregnancy (alone, not in combination with other micronutrients) has positive effects on neonatal birth weight, height, and head circumference, as well as a reduction in low birth-weight and small-for-gestational-age infants risk. Vitamin D intake during pregnancy may help reduce offspring's chances of stridor and asthma.<sup>9</sup> Overweight and obesity are the result of an imbalance between daily energy intake and energy expenditure, and vitamin D supplementation reduces body mass index (BMI  $-0.32$  kg/m<sup>2</sup>) and waist circumference ( $-1.42$  cm), but not for body weight.<sup>10</sup> Significant effect, the mechanism may be related to vitamin D inhibition of parathyroid hormone, support of intestinal calcium absorption, stimulation of insulin receptors. Currently, there is no evidence that vitamin D supplementation can reduce the incidence of cardiovascular disease; hypertension is the most common cardiovascular disease in old-aged people.<sup>11</sup> Vascular and organ complications related to hypertension include: stroke, retinopathy, coronary heart disease/myocardial infarction and heart failure, proteinuria and renal failure, and atherosclerosis.<sup>12</sup> More than 800 IU and the group over 50 years old have the most antihypertensive effect (whether healthy or hypertensive); and vitamin D<sub>3</sub> supplementation may have the effect of lowering blood pressure for the middle-aged and older groups.<sup>13</sup> Vitamin

D also plays an important role in other cardiovascular disease-related risk factors such as hyperlipidemia, insulin resistance, diabetes, and obesity. With these multiple effects, vitamin D can protect the cardiovascular system through direct and indirect effects. Compared to subjects with serum concentration of 25(OH) D less than 20 ng/mL (vitamin D deficient), 25(OH)D greater than 40 ng/mL reduced the risk of cancer by 67%.<sup>14</sup> Vitamin D supplementation alone does not reduce cancer incidence or cancer mortality. Multiple sclerosis (MS) is a chronic inflammatory demyelinating disease of the central nervous system, and the risk of women is higher than that of men (male to female 2.5:1), and it is considered an autoimmune neurological disease; all neural functions can be compromised if acquired.<sup>15</sup> Neuroprotection includes reducing nerve damage, neurotoxicity and neuroplasticity, through which vitamin D can maintain good brain and neurological function; a population survey in Asia found that the concentration of vitamin D in the blood was insufficient positively associated with cognitive impairment.<sup>16</sup> Vitamin D supplementation (average daily dose of 3,500 IU for 6 months) improves glycemic control (HbA1c and fasting blood glucose) and reduces insulin resistance in pre-diabetic patients or those at high risk of diabetes.<sup>17</sup> For patients with type 2 diabetes, vitamin D supplementation can significantly improve serum 25(OH) D level and insulin resistance (HOMA-IR), and the improvement is especially in non-obese people, middle eastern people, vitamin D deficient, and better blood sugar control, the patients who took large doses (2,000 IU daily) in a short period of time were most significantly.<sup>18</sup> The concentration of 25(OH) D in the blood was significantly related to the walking speed of the elderly, and the walking speed of the subjects with severe vitamin D deficiency, deficiency and insufficiency was significantly slower than that of the subjects with normal values.<sup>19</sup> Vitamin D supplementa-

tion has a potentially important role in improving the symptoms of atopic dermatitis and can be considered as a safe and acceptable treatment method; the underlying mechanism may be related to the immunomodulatory effect of vitamin D, for the formation and restoration of the skin barrier, with atopic dermatitis who are deficient in vitamin D, additional supplementation may help relieve symptoms.<sup>20</sup> Vitamin D deficiency has a mortality rate of up to 45% (compared to 16% of normal values), showing that vitamin D deficiency can triple the overall mortality rate of acute hospitalized patients; studies of patients in intensive care units have found that if vitamin D concentrations are less than 12 ng/mL, there is a 32.2% risk of death, while those higher than this value are only 13.2%, a nearly 2.5-fold difference between the two.<sup>21</sup> Nevertheless, some studies have pointed out that high-dose vitamin D supplementation during hospitalization cannot bring immediate protective effect, which means that to achieve the above-mentioned mortality reduction effect, it must be established on a continuous basis; that is, it is necessary to maintain vitamin D concentration in the body at ordinary times.<sup>22</sup>

## Discussion

Vitamin D is a hormone with multiple physiological functions, its traditional function is to maintain calcium and phosphorus balance and bone health; it is found in many different organs, tissues and cells, so many non-traditional functions, are gradually understood, including the function of kidney protection, the function of cardiovascular protection, the function of immune modulation, the function of cancer prevention, etc.; When the sun exposure is sufficient, the human body can synthesize vitamin D<sub>3</sub> by itself, but if the sun exposure is insufficient, it needs to be taken from food. The food source of vitamin D<sub>2</sub> is mainly plants, while the food source of D<sub>3</sub> is mainly meat. Nutritional deficiencies also include oral and

dental problems in the elderly. It is mentioned in the literature that the vitamin D content in the elderly is related to cardiovascular events, osteoporosis, and mortality during hospitalization showing a nonlinear U-shaped curve. If oral supplementation is used, the daily dose is around 800 IU for the most protective effect.

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## Data Availability Statement

Not applicable.

## Conflicts of Interest

The authors declare no conflict of interest.

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