

# The Relationship between Zinc and Human Health and How to Supplement Zinc Scientifically

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**Abstract.** Zinc is one of the essential trace elements in the human body. In recent years, Human society as a whole is increasingly aware of the nutritional role that zinc plays in human health. This paper mainly discusses the relationship between zinc and human health and how to supplement zinc scientifically and lists the various effects of zinc on human metabolism. In this paper, the trace element zinc was studied through literature analysis, case analysis, data analysis, and review methods. The research data mainly came from various types of zinc literature and newspapers and magazines. This paper finds that zinc is extremely important element for human growth and development, it can resist and eliminate pathogens in the body. Meanwhile, the relationship between zinc and the metabolism of our human body is very close. Only by obtaining enough zinc, can the cells in our various organs and tissues maintain a relatively high metabolic rate.

**Keywords:** Zinc, Zinc Deficiency, Zinc Metabolism, Zinc Status

## 1. Introduction

Zinc is a chemical element, its chemical symbol is Zn, and its atomic number is 30, in the periodic table of chemical elements in the fourth period, group IIB. Zinc is a light gray transition metal and the fourth most common. In modern industry, zinc is an irreplaceable and very important metal in battery manufacturing. In addition, zinc is also one of the essential trace elements for the human body and plays an extremely important role. This paper mainly discusses the relationship between zinc and human health and how to supplement zinc scientifically. The trace element zinc was studied through literature analysis, case analysis, data analysis, and review methods. Through the research on the collected literature and data about zinc, to explore the nature and status of zinc, and draw out the role of zinc in human health, and finally make a review. This paper can make the public have a preliminary understanding of the importance of zinc to the human body and its distribution in the human body, and at the same time, it can play a certain reference role for researchers who study zinc-related products.

## 2. Zinc and human health

### 2.1. Introduction to zinc

Zinc, whose name "zinc" comes from the Latin Zincum, meaning "white thin layer" or "white deposit". Its chemical symbol is Zn, its atomic number is 30, and its atomic weight is 65.38. Zinc is a silver-white metal with a bluish tinge, a density of 7.14 G/cm<sup>3</sup>, and a melting point of 419.5 ° C. At

room temperature, it is brittle; at 100 ~ 150 °C, it becomes soft; above 200 °C, it becomes dry again. The chemical property of zinc is active. In the air at room temperature, a thin and dense film of basic zinc carbonate is formed on the surface, which can prevent further oxidation. When the temperature reaches 225.degree. C., the zinc is strongly oxidized.

Zinc is one of the 25 essential elements in the human body and is a trace element in the body, but cannot be synthesised in the body and is only available from external food. It is a component of many important enzymes in the body and is also essential for the synthesis of insulin. It plays an important role in the synthesis of proteins and nucleic acids, in maintaining the integrity of red blood cells and in the process of haematopoiesis, and is a key element in promoting growth and development, especially for the development of the nervous system in children. To keep the flower of our life blooming, we should consume enough zinc[1].

## 2.2. *Physiological function of zinc*

2.2.1. *Catalytic function.* There are nearly 100 enzymes in our body that rely on zinc to catalyze, such as alcohol dehydrogenase EC1.1.1. Without zinc, the activity of this enzyme will disappear, and zinc supplementation can restore the activity.

2.2.2. *Structure function.* In the cell membrane, it mainly binds to the sulfur-containing and glossy ligand of the cell membrane, and a few binds to the oxygen-containing ligand to form a firm complex, which keeps the cell membrane fixed and has less toxin absorption and absorption. When food intake is low, an important surface is membrane diosporium. This is the cause of primordial pathology.

2.2.3. *Regulating function.* The regulatory effect of zinc on protein synthesis and metabolism is also manifested in the regulation of immune function, and the physiological level of zinc can control the secretion and production of immune regulatory factors.

Zinc, as a factor regulating gene expression, has a wide range of effects in vivo. Expression of metallothionein or metallothionein-like proteins through zinc binding to metal transport factors. Zinc is a component of the regulatory system of metal transport factors and metal responsive elements, and may control intracellular zinc levels by this mechanism[2].

Zinc has important biological significance in the regulation and influence of hormones. Zinc has been shown to be present in considerable amounts in crystalline insulin and to play a regulatory role in insulin release. Zinc is involved in the active secretion of prostaglandins, and inhibitors of prostaglandin synthesis are dependent on zinc regulation under physiological conditions.

## 2.3. *Zinc, human health and metabolism*

2.3.1. *Zinc and human health.* Zinc is found in various organs of the human body, including bone, muscle, retina and liver. Zinc is the most widely metabolized element in the human body and is a component of more than 200 enzymes and deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) in the body. The physiological functions of zinc in the human body are mainly reflected in the protection of the health of the brain and nervous system, especially in the developing fetus, and the regulation of the secretion of hormones from the reproductive system organs[3]. In addition, zinc is helpful for the formation of bones and teeth, the healing of traumatic wounds, the relief of stress, and the growth of hair. Because zinc plays an important role in human growth and development, reproductive heredity, immunity, endocrine and other physiological processes, it is called "the flower of life" and "the source of intelligence". Zinc deficiency in the human body can lead to a decline in physical function, and even lead to a variety of diseases, such as insensitivity to taste and smell, white spots on fingernails, susceptibility to infection, pale skin, low fertility, etc. Teenagers and children are prone to depression, lack of appetite and other symptoms, while brain retardation, diabetes, and nervous system disorders are also related to zinc deficiency.

a. Zinc Deficiency

Signs of zinc deficiency in humans are the result of a reduction in the biological function of one or more forms of zinc. Severe congenital zinc malabsorption has been documented in humans as acrodermatitis enteropathica[4]. Skin damage and immune function damage caused by severe zinc deficiency are not common at present. The common manifestations of zinc deficiency in humans are slow growth, poor healing of skin wounds, taste disorders, gastrointestinal disorders, and decreased immune function.

b. Zinc Poisoning

Zinc poisoning occurs when adults ingest more than 2 G of zinc at one time, which is characterized by the direct effect of zinc on the gastrointestinal tract, leading to epigastric pain, diarrhea, nausea and vomiting. Long-term supplementation of 100 mg of zinc per day can lead to anemia, decreased immune function, and decreased high-density lipoprotein cholesterol[5]. Long-term administration of 25 mg zinc per day can cause secondary copper deficiency, damage immune organs and immune function, affect the activity of neutrophils and macrophages, inhibit their chemotaxis and phagocytosis, and weaken the killing ability of cells[6].

*2.3.2. Zinc intake of human body.* The function of zinc in the human body can not be replaced, and it can not be synthesized in the human body, so it must be ingested from food. WHO recommends that the daily intake of dietary zinc for adults is 12 to 16 mg. The American Food and Nutrition Board recommends a daily intake of 15 mg of zinc for adults, 20 mg during pregnancy, and 25 mg during lactation. The daily intake of zinc for infants under 6 months of age and weighing less than 6 kg is 3 mg, for infants under 1 year of age and weighing less than 10 kg is 5 mg, for infants between 1 and 6 years of age is 10 mg, and the intake for infants over 7 years of age should be the same as that for adults.

The order of zinc content in different foods is animal foods > legumes > cereals > fruits > vegetables. Therefore, people who mainly eat cereals and do not eat meat and legumes, especially those who eat refined rice and flour products for a long time, are prone to zinc deficiency. Especially in developing countries, people's dietary habits are mostly based on cereal grains, and the content of trace elements in cereal crops is low, and there are many losses in the process of food processing[7]. In order to improve zinc nutrition and the health of the human body, people have been actively looking for various feasible measures. At present, the main strategies adopted are as follows: (1) drug prevention and control; (2) dietary diversification; (3) food defense engineering, that is, adding zinc to food; and (4) biofortification engineering, that is, improving the content and bioavailability of trace elements in the grain of grain crops through breeding and cultivation. And the zinc content of the edible part of the crops is improved, and the zinc required by the human body is provided through the staple food. Measures such as drug control, food defense engineering and dietary diversification have been widely applied in developed countries and achieved good results.

### **3. The content, distribution and function of zinc in human body and how to supplement zinc scientifically**

*3.1. The content, distribution and function of zinc in human body*

The zinc content in normal human body is 2 ~ 3 G, and there is a very small amount of zinc distribution in most tissues, among which the content in liver, muscle and bone is higher. The zinc intake of human body mainly comes from the food chain, and the zinc content of meat is higher than that of vegetables[8]. Zinc is mainly distributed in cells. The concentration of zinc in plasma is 10-20 mol/L, of which 60% is bound to serum albumin, 30% -40% is tightly bound to 2-macroglobulin, and a small amount is bound to amino acids.

Zinc is a functional component or activator of many enzymes. Zinc is a component or activator of more than 160 enzymes, such as carbonic anhydrase, pancreatic carboxypeptidase, RNA polymerase, DNA polymerase, lactate dehydrogenase, alkaline phosphatase, pyruvate oxidase, etc.

Zinc can promote growth and development. Zinc is an essential component for regulating DNA replication and nucleic acid metabolism, is closely related to protein synthesis, participates in the synthesis of growth hormone, plays an important role in promoting the growth and development of the body, affects the division and regeneration of cells, and accelerates the healing of wound tissues[9]. Zinc also affects the efficiency of hormone receptors, the response of target organs, the production, storage and secretion of hormones, and sexual development, and plays an important role in the development of reproductive organs and secondary sexual characteristics and the maintenance of reproductive capacity.

Zinc can maintain cell structure and physiological function. Zinc can inhibit lipid peroxidation and sulfhydryl group oxidation on biological membranes, and play a synergistic role with ceruloplasmin, catalase and vitamin E in the protection of cell membranes. It participates in the synthesis of vitamin A reductase and retinol binding protein in the liver and retina, promotes the synthesis and allosterism of retinal, and is related to the activity of retinol deaminase. Zinc can promote the mobilization of vitamin A in the liver, maintain the normal concentration and metabolism of plasma vitamin A, and play an important role in maintaining human dark adaptation.

It is involved in the regulation of immune function. Zinc is closely related to immune function. It is an essential substance for the differentiation and maturation of T lymphocytes[10]. It mediates cellular immune function, induces T cells to synthesize cytokines such as interleukin-1, IL-6 and TNF- $\alpha$ , and strengthens the interaction between immune cells.

### 3.2. *How to supplement zinc scientifically*

3.2.1. *A balanced diet.* The content of zinc in meat is about 20 ~ 60mg/kg, in general, the content of zinc in fish is more than 15mg/kg, and the highest zinc content in oysters is up to 1000mg/kg. Other foods with more zinc are egg yolk, beans, sesame, walnuts and other nuts. Breastfeeding should be advocated for infants and young children, and supplementary foods such as egg yolk rich in zinc should be gradually added from 4 months. Children should mix coarse and fine grains to develop good eating habits of not being partial to food and not being picky about food. For adults, in terms of diet, they can regularly eat animal foods rich in zinc, including red meat and animal liver, and plant foods rich in zinc, including dried fruits, cereal germ and wheat bran, which are good sources of zinc. If the zinc extraction of middle-aged and elderly people is insufficient, they should also start adjusting their diet[11]. Food should be coarse and fine, soft and easy to digest and absorb. Increase your intake of foods rich in zinc.

3.2.2. *Zinc fortified food.* Zinc fortification is an effective, safe and economical way to supplement zinc in food. Zinc in fortified foods is easily absorbed by the human body. Nutritional supplements and fortified foods can also be provided for middle-aged and elderly people who have difficulty eating or eat less.

3.2.3. *Zinc preparation.* Zinc sulfate is the earliest zinc supplement drug, but it is seldom used at present because of its side effects such as nausea and vomiting caused by irritation to gastrointestinal mucosa[12-13]. Zinc gluconate oral liquid has become one of the most commonly used zinc preparations for children because of its soft taste and low price. Other zinc preparations such as zinc glycylrhizinate and zinc arginine have few side effects and good curative effects.

## 4. **Effect of Zinc on Human Metabolism**

### 4.1. *Promote physiological metabolism*

In some enzymes, zinc is not only a component but also their activator. Zinc is involved in the metabolism of glucose [14] and can also be found in insulin. A number of insulin activities are also

inextricably linked to zinc. Zinc can also be found in red blood cells, which are important to the body, and is included in the enzymes responsible for transporting oxygen and carbon dioxide.

#### 4.2. *Promote development and metabolism*

Zinc is involved in the synthesis of nucleic acids and proteins and contributes to cell growth. You can find zinc in the growth of bones. Zinc is also essential for the normal growth of the skin. If zinc is lacking, the hair on people's bodies may become pigmented and white spots may appear on the nails [15].

#### 4.3. *Promote sexual function and metabolism*

Zinc plays a vital role in promoting the development of secondary sexual characteristics. A chronic lack of zinc intake may cause a decrease in the function of male secondary sexual characteristics, especially during puberty. More severe and serious zinc deficiency can also cause male infertility. In women, zinc deficiency may cause erratic menstruation or even amenorrhoea. On the other hand, zinc deficiency in pregnant women may have an impact on the growth and development of the foetus. Children and adolescents are very active in their growth and a deficiency in zinc may stunt their growth.

#### 4.4. *Promote cell metabolism*

For wounds or deep folds, zinc oxide ointment is often used in surgery, and the therapeutic effect is better. After the operation, the patient takes a moderate amount of zinc-containing drugs, and the wound heals faster. This is because zinc can maintain the normal adhesion of epithelial mucosal tissue, so the wound heals quickly.

### 5. Conclusion

This paper mainly discusses the relationship between zinc and human health and how to supplement zinc scientifically and lists the various effects of zinc on human metabolism. The conclusion is that zinc is an indispensable element for the human body and a very important contributor to human growth and development. Zinc is not only able to deal with pathogens that invade the body, but also works in conjunction with other trace elements in the body to balance the health of the body. At the same time, the relationship between zinc and the metabolism of our human body is very close. Only by obtaining enough zinc, can the cells in our various organs and tissues maintain a relatively high metabolic rate. The deficiency of this paper is that it does not discuss the future direction of zinc utilization, future research should focus more on the development and optimization of zinc supplements.

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