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Role of Zinc as a Micronutrient in Life and Human Health

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Abstract:

There are so many micronutrients which are important to human health and nutrition but amongst all the micrnutrients, Zinc is a vital constituent which is most significant and its importance for the health is increasing day by day and due to its deficiency, many diseases may appear. Zinc plays three major biological roles such as catalytic, structural and regulatory ion, hence it is an important trace element for the organisms. Zinc is critically affected in many aspects of human health such as in immune function, homeostasis, apoptosis, oxidative stress, aging and many disorders related to the health of human are also associated with the zinc deficiency. Zinc insufficiency may complex out the medical factors of various chronicor prolonged ailments or disorders like as malignancies, atherosclerosis, autoimmune diseases, neurological disorders, age-related degenerative diseases, aging, and Wilson's disease increases oxidative pressure and reaches to the generation of inflammatory cytokines and affects immunological status adversely. In this paper, the multipurpose of zinc is discussed and also discussed its biological significance in immunity and prolonged sicknesses including diabetes, cancer, HIV, Wilson's disease and other age and skin associated illnesses.

Keywords: *Zinc, Human Health, Health Benefits, Immune Responses, Zinc Deficiency*

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Introduction

Zinc (Zn) is one of the most essential trace element in the body and is ubiquitous. It is very essential for the progress and advancement of microorganism, animals and plants. In adults, the average amount of the zinc is about 1.4-2.3g. It is secreted in all tissues of the body, and it secretes with a high proportion in the muscles and bones with 85% of the whole body, in skin and liver, it is approximately 11% and higher concentration from other remaining secretes in the prostate and various parts of the eye. The minimum need for zinc in humans for their health, well-being and satisfactory growth, differs according to the nutrition taken, climatic situations, stress presence caused by the distress, infections and parasitic infestations.

Zinc and Immunity

Zinc plays a crucial part in the sustainance of immune functions like as humoral and cellular immunity and zinc deficit. Zinc may affect the aspects of immune systems and crucial for phagocytosis, cell-mediated immune systems also for the utility of natural killer cells, neutrophils, and macrophages. The growth of B and T cells may be harmfully influenced by the deficit of zinc and it may potentiate the apoptosis. It has been observed that the decrease in an absolute number of splenocytes, thymic atrophy, and decreased responses to both T-cell dependent (TD) and T cell independent (T1) antigens in young adult zinc-deficient mice. Animals establish a serious weakening in their capability to produce a cytotoxic T killer response to the tumor challenge and preserved on a zinc-deficit diet for as slight as 2 weeks.

Zinc and Its Health Benefits

Zinc deficiency causes reduce in the flowing luteinizing hormone and testosterone absorptions, modifies sex steroid hormone receptor levels along with the alterations in the hepatic steroid metabolism hence causing male reproductive dysfunction. For maintaining normal serum testosterone, Zn is very essential and the pituitary gland is prevented from secreting luteinizing and follicle stimulating hormone by the inadequate level of Zn. It also prevents the aromatase enzyme alters testosterone into extra estrogen. Augmented threat of heart disease, obesity and weight gain are caused by the higher estrogen activity. Zinc also helps to produce healthier sperm with increase sperm count and motility along with the other impacts on hormone levels. Zn deficiency leads to the enlargement of the prostate gland due to the infection.

1. Zinc as an antioxidant

Cytosolic Zinc/Cu superoxide dismutase stabilizes by the Zn which starts catalysis of superoxide elimination by feature of zinc –histidyl-Cu triad, which acts as a proton presenter while on the oxidation cycle. The NADPH oxidases which catalyze the making of superoxide O_2^- from O_2 and Cytotoxic cytokines TNF- α, IL-1β and IL-8 which produce free radicals are also repressed by the zinc element. Whereas, the generation of cysteine-rich metallothionein which is a brilliant scavenger of hydroxyl (OH-) radical induces by the zinc element.

2. Zinc and Central Nervous System

Abnormal excessive contact of beta-amyloid 42 (Aβ42) with zinc, copper and iron induce peptide aggregation and oxidation in Alzheimer's disease which results in a neocortical Aβ precipitation. Since zinc has the property of antagonist of the glutamate N-methyl-D-aspartate (NMDA) receptor, therefore it shows antidepressant-like movement in rodent models and also persuades the neurotrophic factors gene countenance derived from the brain. In psychopathy and therapy of depression, zinc homeostasis is relevant.

3. Zinc and diabetes

In patients with type II diabetes mellitus, just due to the compromised zinc absorption and hyperzincuria, zinc shortage occurs. Hyperzincuria correlates with the mean serum glucose concentration and is proportional to the proteinuria.

4. Zinc in wound healing

During the repair of the wound, auto debridement and keratinocyte migration are increased by the Zinc-dependent matrix metalloproteinase. With cytoprotection in contrast to reactive oxygen species and bacterial toxins, zinc discusses resistance to epithelial apoptosis through the antioxidant activity of the cysteine-rich metallothioneins. Zinc deficit decreases the nuclear factor-kB activation due to which wound healing delays. During the early stages of wound healing, its deficiency may cause decreased neutrophil infiltration. The appearance of proinflammatory cytokines such as interleukin (IL)-1β and tumor necrosis factor (TNF-α) are reduced by the deficit of zinc element. In the treatment of zinc-

deficient leg ulcer patients, oral zinc supplementation is beneficial but the therapeutic role of zinc in surgical patients remains to be seen.

5. Zinc and aging

Zinc prevents the neoplastic cell growth, therefore, the role of zinc is very crucial in healthy aging and also engaged in mitotic cell division, DNA and RNA mending. Even marginal zinc deprivation may contribute to immunosenescence, although most of these studies which confirmed declination of zinc levels with age do not categorize most of the aged as zinc deficit. The probability to develop immunity and competently control chronic inflammatory responses amongst the seniors is demonstrated by the physiological oral zinc supplementation.

6. Zinc and Cancer

In the metabolism and contact of malicious cells predominantly in apoptosis, zinc has been qualified roles. The structural stabilization and activation of a significant constituent of the apoptotic process i.e., cytochrome P53 are done by the zinc element and also inactivation of some fellows of the caspase family of proteases. It offers an operative dietetic chemopreventive tactic to the illness in a susceptible segment of the population having a medical history of carcinoma and also applies a positive advantageous outcome contrary to chemically persuaded preneoplastic progression in rats.

7. Zinc and liver disorders

There is so many acute and chronic liver disease which are associated with the zinc deficiency. Zinc supplementation is used as a treatment for hepatic encephalopathy in patient's refractory to typical dealing and prevents against toxin-induced liver injury. It also decreases hepatic encephalopathy and blood ammonia stages and reduces gastrointestinal disorders, weight loss, hair loss and mild anemia in prolonged Hepatitis-C-Virus infected patients.

8. Zinc and HIV

The immunological failure and diarrhea in HIV-infected patients have been reported to decrease by the long-term zinc supplementations of 12-15 mg/days with poor viral control. More advanced disease and increased mortality in HIV patients is associated with the decreased serum zinc level.

9. Zinc in Skin diseases

Minor to reasonable facial acne vulgaris can be cured by giving Oral APC (methionine-based zinc complex with antioxidants) thrice daily for 12 weeks to the patient and it is found to be effective and well tolerated. Scalp seborrheic dermatitis can be treated by using shampoos containing zinc pyrithione as it provides clinical benefits. The patient suffering from alopecia areata can be treated by using oral zinc sulfate supplementation as it is useful adjuvant therapy with encouraging results. Treatment of plane warts can be done by using the topical 10% zinc sulfate solution 3 times daily for 4 weeks.

10. Zinc and Wilson's disease

Introduction of intestinal and hepatic MTs production is the main function of the zinc compounds in Wilson's disease. Decreased protein degradation accumulates the hepatic MTs in a mouse model of Wilson's disease and this seems to deliver some defense from the excess hepatic Cu levels. In Wilson's disease, the clinical signs and laboratory findings of the patient do not aggravate by the zinc treatment but recover some medical indications of the patients.

Therapeutic Effects of Zinc Supplementation in Humans

There are so many health benefits of the zinc supplementations in humans shown by several studies. Some of which are discussed as follows:

Parasitic Infections:

The plasma zinc levels remain lower in patients with visceral, cutaneous, and mucosal leishmaniasis. The reduction in erythema and dimension of induration is associated with the zinc supplementation and causes an upsurge in treatment frequency.

Bacterial Infections:

In developing countries, the length, sternness, and occurrence of diarrhea can be reduced by zinc. Fulfilling of the zinc deficit requirement recovers the absorption of water and electrolytes by the intestine which promotes the growth of levels of electrolyte brush border enzyme and results to a quicker rebirth of the gut epithelium. Zinc deficiency may cause the immune dysfunction which can be treated or cured by the zinc supplementations. Zinc is very beneficial in the treatment of shigellosis and leprosy patients according to several previous types of research. An upsurge in plasma retinol concentration, previously

sputum transfiguration, and determination of x-ray lesions occurs by giving zinc supplementation to the patient with Mycobacterium tuberculosis. Zinc insufficiency is categorized by a lessening of IL-2 and IFN-γ in humans and zinc persuades the group of both IL-2 and IFN-γ. Polaprezinc (zinc-L-carnosine) with antimicrobial triple therapy promotes the improved cure rate in the treatment of ulcer.

Viral Infections:

Since 1984, so many studies have been observed that the impact of zinc lozenges on the extent or strictness of common cold indications. Zinc acetate and gluconate as zinc ions are unconfined at biological pH as it is suitable salts. Zinc lozenges must be happening within 24 hours of the onset of common cold and the daily total dose of elemental zinc should be at least 75 mg are these two important factors. Zinc supplementation is used as a subsidiary therapeutic interference in contagion with the human immunodeficiency virus (HIV) leads into the acquired immune deficiency syndrome (AIDS) disease. The results of zinc supplementation in AIDS varies greatly i.e., and its explanation is that the patients with deficiency of zinc only respond to zinc supplementation and exhibit beneficial effects but zinc sufficient patients do not respond.

Influence of Zinc on Vaccination:

An investigation of a research is that if the vibriocidal antibody in children is affected by the micronutrients supplementation to an executed oral cholera vaccine or not. Only zinc supplementations can improve seroconversion to vibriocidal antibody and therefore has the capacity to advance the effectiveness of oral cholera vaccine amongst kids.

Review of Literature

Brown, Wuehler, and Peerson, (2001) summarized the study on the significance of zinc for human health and also reviewed the obtainable literature for the evaluation of zinc status in individuals and populations. Their analysis results as the indication of approximately half of the world's populace are at threat for insufficient zinc consumption and suggested the public health program is required for controlling the zinc deficit.

Frassinetti, (2006) summarized the role and manifestation of zinc in the setting and its prominence for human health and metabolism. Zinc has an important position in biological processes. Zinc is required for DNA synthesis, protein synthesis and cell division. It is evidentially found that zinc finger proteins are engaged in the appearance of several development issues and steroid receptors. They found that the zinc is needed for the standard progress and maintenance of immune functions. They also found that zinc salts were neither toxic nor mutagen.

Imtiyaz *et al*., (2010) worked on the part of micronutrients in crop manufacture and human health. To cover up the micronutrients issues in soil and for the enhancement in human health, the development of micronutrient efficient genotypes can be a successive tool. They said for ensuring the role of preventable deficiency on crop productivity and quality not give adverse effect is checked by the available micronutrients status of arable soils. The farmers and agronomist need to always think about Zn as the deficiency of zinc are widespread in our country. They mentioned that the repeated spraying of ferrous sulfate or chelated iron can cure the chlorosis and also improves the quality of foodstuff.

Chasapis *et al*., (2011) reviewed the zinc as versatile trace elements, its place in homeostasis, propagation and apoptosis and its position in immunity and prolonged disorders. Zinc has three chief biological parts which are as a structural, regulatory and catalyst ion hence it is an important element. There are so many micronutrients which are important to human health and nutrition amongst them, Zinc is an important element which is most significant and its importance for the health is increasing day by day and due to its deficiency, many diseases may appear. Therefore zinc is very necessary to cure many diseases as it has many therapeutic effects on the health.

Akhtar, (2013) highlighted the occurrence of zinc insufficiency and its health and financial significances in South Asian emerging nations and also enlightened the probable methods to fighting zinc shortage. This study is separated on the basis of population groups, sex, age, pregnancy, and location. Pregnant and lactating women, preschool and school children are included in this study and it revealed by the investigation that zinc deficit is maximum amongst kids, pregnant and lactating woman in India, Pakistan, Bangladesh, Sri Lanka and Nepal. Clearly, progress of consciousness amongst the susceptible inhabitants has displayed assurance to

diminish the distressing effect of this nutritive insufficiency.

Devi *et al*., (2014) discussed on the zinc with relation to the human health. Zinc deficiency is becoming the world problem which is affecting increasingly to the women and children in India and all over the world. It is impossible the formation of DNA which is the basis of life on the earth, without zinc. Deficiency of zinc is the fifth prominent threat issue for sickness in the emerging world. This element is very important in human especially in infants and young children's health. They suggested that the status of zinc should be assessed in relevant clinical situations. There are still opportunities for further research mostly controlled clinical trials for establishing the potential use of zinc as a precautionary and beneficial means for an extensive series of sicknesses in human.

Rajeshwari and Swaminathan, (2015) studied the role of zinc and copper in infertility. This study is the outcome of the extensive literature search and compiling of key finding during the last 15 years. They suggested this review as an eye opener for the more research in this field. This study covers a simple disease to the advanced cancer depicting the role of zinc and copper in human health and disease. They found the zinc as predominated that of copper as it discussed many important roles of zinc and copper in a variety of human disorders especially in reproductive health of both the genders.

Wieringa *et al*., (2015) showed the estimations of the occurrence of zinc insufficiency using these diverse displays can diverge extensively by using data from a current national micronutrient study in Vietnam leading to inconsistencies. They found that zinc insufficiency among children is four times more predominant than iron insufficiency and 2.3 times more than restricting occurrence for example. They suggested that the efforts should be made for the identification of most appropriate pointer to assess the influence of programs intended at refining zinc status and health of populations.

Conclusion

As zinc has three chief biological role, such as catalytic, operational and supervisory, it is very important micronutrient for the organisms. It involves in the proper functioning of the immune system to its role in cellulat growth, cell proliferation, and cell apoptosis and in the activity of numerous zinc binding protiens hence plays an important role in human physiology and essential for the structure and functioning of various proteins and cellular components. It is also very crucial for various chronic diseases such as cancer, aging, diabetes, Wilson's disease, HIV, liver disorders and central nervous system disorders. Therefore it is very important to overcome the problem of zinc deficiency. There are so many opportunies to further research in this field.

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