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ROLE OF ZINC DEFICIENCY IN COVID-19 INFECTION

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ABSTRACT

There is no doubt that zinc is one of the micro-minerals essential for the growth and healthy construction of the body.Besides, several studies have recorded that it is extremely important for the development of the immune system.Thus, people with deficient levels of zinc are more susceptible to infectious diseases, autoimmune disorders, and cancer.This study article aimed to provide an illustrative review of zincrole in alleviating potential symptoms of COVID-19 infection.Because zinc deficiency contributes to respiratory infections, it is considered a remarkableindicator of the relationship between zinc deficiency and susceptibility to COVID-19 infection.There is currently no approved antiviral treatment designed specifically for this infection, so practical guidelines have been developed that contribute to the treatment of COVID-19 patients, including the prevention of malnutrition and the need to obtain a sufficient amount of essential vitamins and minerals to prevent viral infections.Zinc is a promising, cost-effective and widely accessible treatment strategy for COVID-19 patients, with little or no adverse effects.It is recommended to establish a COVID-19 nutrition network that brings together diverse clinical and scientific expertise in the field of nutrition, in addition to those involved in critical care treatment, in order to prepare for future deadly infections and pandemics.

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INTRODUCTION

Zinc is critical for proper immune system development and function, due to the impact of zinc shortage on the quantity and functioning of immune cells, individuals with deficient zinc levels are more susceptible to infectious illnesses, autoimmune disorders, and cancer [1-4]. Aside from hunger, populations at risk of zinc deficiency encompass the elderly and individuals with diverse inflammatory and autoimmune disorders. Due to its predominantly asymptomatic nature, minor zinc insufficiency often goes unreported in the majority of individuals [5]. Nevertheless, the World Health Organization (WHO) estimates that a minimum of one-third of the global population suffers from zinc insufficiency [6]. Global prevalence of zinc deficiency contributing to 16% of lower respiratory infections serves as a significant indication of the link between zinc deficiency and the susceptibility to infection and severe progression of COVID-19, this finding also highlights the possible advantages of zinc supplementation [7,8]. It is known thatCOVID-19 is a worldwide health crisis, characterized by millions of infections and numerous fatalities on a global scale [9-11]. In December 2019, he became the initial individual to be officially documented as afflicted in Wuhan, China [10,11]. This is the seventh strain of the coronavirus that has the ability to infect people and can lead to numerous infections in various organs of the body [12,13]. This outbreak has been classified by the World Health Organization (WHO) as a pandemic [14]. The initial documented instance of COVID-19 infection in Iraq occurred on February 22, 2020, when an Iranian student in the city of Najaf was identified as the first patient. Subsequently, the number of reported cases increased to encompass nearly all of the governorates in Iraq [15,16]. Several individuals experienced the onset of severe pneumonia, pulmonary edema, acute respiratory distress syndrome, or multi-organ failure [17,18]. Various factors, including age, gender, ethnicity, and underlying comorbidities, can influence the severity of COVID-19 disease [19]. Despite numerous potential treatments, there is currently no authorized antiviral treatment specifically designed for COVID-19[20]. The European Society for Clinical Nutrition and Metabolism recently put out practical guidelines for the treatment of COVID-19 patients. Suggestions involve the prevention of malnutrition through the provision of sufficient quantities of nutrients to sustain energy levels and counteract diseases [21]. Furthermore, it is crucial to have a sufficient amount of vitamins and minerals to prevent viral infections. A recent study on the nutritional status of COVID-19 patients revealed that those with pneumonia had notable shortages in essential micronutrients [22]. The objective of this study is to review these symptoms and clarify how zinc can prevent or alleviate those symptoms.

Role of zinc in health and disease: Zinc, one of the micro-minerals along with iron, copper, selenium, manganese, iodine, chromium and molybdenum, is essential in the body for a wide range of physiological functions, as well as for normal growth and development.It is an intracellular mineral involved in many metabolic processes, as a catalyst, structural element or regulatory ion [23,24].Zinc deficiency leads to several broad and nonspecific changes in metabolism and function, such as reduced growth, heightened inflammation, and the development of skin lesions. The general and generic response of zinc deficiency to metabolic and clinical alterations classifies it as a type II nutrient [25]. It does not have any identifiable indications or symptoms. The main effects of zinc deficiency are poor growth, stunting, and wasting. On the other hand, type I nutrients are mainly necessary for specific metabolic functions of the body rather than overall metabolism. Deficiencies in Type I nutrients are characterized by specific signs and metabolic or clinical changes, such as iron deficiency resulting in low hemoglobin, iodine deficiency leading to goiter, or vitamin A deficiency causing bitot spots[26,27]. Zinc shortages have a significant impact on various bodily processes due to their crucial role in regulating cellular function and metabolism. These functions include physical growth, immunological competence, reproductive function, and neurobehavioral development. Stunted growth, heightened susceptibility to childhood illness and death, and premature deliveries frequently accompany these functional impairments in low-income nations with insufficient zinc consumption [28,29].

Zinc deficiency: Generally, zinc serves three main roles: as an enzyme catalyst, a structural component, and in the regulation of gene expression.Because there is no functional reserve or body store of available zinc, a regular and adequate dietary supply is required.Nutritional deficiencies may arise from low zinc intake or mal-absorption of dietary zinc and may be exacerbated by the physiological condition with increasingly high zinc requirements [30-32]. In low-income countries where diets are predominantly vegetarian, plant foods, especially cereals, are rich in phytate, which inhibits the absorption of zinc and other minerals. Young children and women during childbearing and pregnancy years are most at risk for zinc deficiency. Many conditions involving zinc malabsorption, excessive losses, or poor utilization increase the risk of zinc deficient [33]. There are several conditions associated with an increased risk of zinc deficiency, including:digestive and metabolic disorders, vegetarian diet, pregnancy and breastfeeding, and hemoglobinopathies [34,35]. There are a wide range of pathological signs of zinc deficiency. These signs vary depending on the severity of the condition. It is known that various body systems are clinically affected by zinc deficiency, including the skin, digestive system, central nervous system, immune system, skeletal system, and reproductive system [36].

Role of zinc in preventing Covid-19 infection: The entry of infectious agents into the human body is prevented by tissue barriers equipped with cilia, mucus, and antimicrobial peptides such as lysosomes and interferon.In relation to SARS-CoV2, the enzyme angiotensin-converting enzyme 2 (ACE2) and the enzymethe cellular protease TMPRSS2 are the main mechanism for cell entry [37].

- Mucosal clearance of viruses is affected by zinc. Coronavirus infection is accompanied by damage to the cilia epithelium and cilia dyskinesia, which respectively impairs mucosal clearance. Physiological concentrations of zinc have also been shown to increase the frequency of cilia pulsation [38].
- Zinc is essential for maintaining tissue barriers. Disturbances in the integrity of the respiratory epithelium facilitate the entry of the virus as well as pathogens co-infecting and can lead to the entry of pathogens into the bloodstream. In addition, the inhibitory effect of zinc on LFA-1/ICAM-1 interaction attenuates inflammation in the respiratory tract by reducing leukocyte recruitment. Furthermore, higher zinc levels improved lung tolerance to damage caused by mechanical ventilation [39].
- Zinc-dependent changes in gene expression can affect entry of virus through pneumocytesACE-2, expressed primarily on pneumocytes type 2, is zinc metalloenzyme. Zinc binding may affect the molecular structure of ACE-2 and thus its binding to the virus remains to be tested [40]. However, this is likely because zinc is important for stabilizing protein structures and changing the substrate affinity of different metalloproteinases. Finally, zinc homeostasis may influence ACE-2 expression, as zinc-dependent expression of other zinc metalloenzymes such as metallothionein matrix metalloproteinases has been confirmed [41].
- Cases of a deficiency in the secretion of type 1 and 2 interferon have been recorded and confirmed in COVID-19 patients. For interferon alpha (IFN-a), it has been shown that zinc supplementation can remodel [42]. Its expression is expressed by leukocytes and potentiates its antiviral effect via JAK/STAT1 signaling as observed for rhinovirus-infected cells [43].
- Zinc has the ability to hinder the merging of the virus with the host membrane, diminish the activity of the viral polymerase, hinder the translation and processing of proteins, impede the discharge of viral particles, and destabilize the protective outer layer of the virus. The production of RNA went down when low doses of zinc were added along with small amounts of zinc ionophores like pyrithione or hinokitol [44]. This reduction in RNA synthesis was observed in several viruses, including influenza, polio virus, picoRNA virus, and SARS virus. This inhibition was caused by direct inhibition of the viral RNA polymerase [45].
- Zinc deficiency has been linked to higher amounts of pro-inflammatory substances and increased levels of reactive oxygen species (ROS). Regarding systemic inflammatory illnesses, there is a growing body of research demonstrating the advantages of preventive zinc supplementation. The role and significance of zinc in controlling intracellular signals have also been elucidated [46]. Overall, the ability of zinc to restore equilibrium in immune cell populations and enhance their functionality has the potential to be highly advantageous in the treatment of COVID-19 infection [47, 48].

CONCLUSIONS

Zinc is not referred to as "essential" nutrient arbitrarily. While the impact of zinc shortage on different cells in the human body may be minimal and the symptoms of mild to moderate deficiency are rather inconspicuous, having a pre-existing zinc deficiency along with a virus like COVID-19 can be detrimental and potentially fatal. Research has demonstrated that those who are prone to zinc deficiency are also more susceptible to acquiring severe cases of COVID-19. The unpredictable nature of combining a pre-existing zinc shortage with a virus like COVID-19, which manifests many symptoms and problems, makes it extremely challenging to anticipate the specific results. Insufficient levels of zinc increase the likelihood of experiencing severe symptoms and a higher death rate from COVID-19. Due to its affordability and safety, it is strongly advised that those at risk of zinc insufficiency consider using zinc supplements. Greater emphasis should be placed on the surveillance of nutritional status, as minerals and trace elements are inherently connected to a proficient immune response. It is desirable to establish a COVID-19 Nutrition Network that brings together diverse clinical and scientific expertise in the field of nutrition, as well as those involved in critical care therapy.

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