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Essential Role of Zinc in Human Immunity: A Subject Review

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Abstract

The protection ability for mechanism defense against any foreign bodies like, fungi, bacteria, viruses or tumors cells inter in a process called immune system. There is an important correlation between the function of minerals and immune task. One of these substances is zinc it is fundamental mark element that play catalytic roles and regulatory structural in the body, also it is paramount for a number of immune roles. The zinc considered an aspect of inbred and remarkable in immunity, as well insufficient this element increased the vulnerability to wide types of inflammation. It will be partner to increased functions of T cell and B cell lymphocyte. Zinc likewise functions can stabilize membranes and as an antioxidant.

Key words: Zinc, Human Immunity, B lymphocytes, T lymphocytes

Introduction

Immune system is highly proliferative, complex network of cells, tissues and organs that work together designed to perform its important mission by posting (sentry) cells in all tissues to identify threats and issue early immune responses (Willem et al., 2014). Mobilizing a variety of white blood cells (leukocytes) thus can detect and destroy foreign invaders inside the body like bacteria and viruses, so can achieve the protection to the body from a variety of infections and diseases (Weidong et al., 2022). Leucocytes which comprise two sub-types, monocyte and lymphocyte, are evermore fight invading that causes sickness. Monocytes fight to prevent overrun menace, while lymphocytes let the body to remember and recognize previous invaders then assist to killing those (Christopher et al., 2022). Lymphocytes initiate in the stem cells of active red bone marrow and it have a basic two kinds: a cell that create in red bone marrow then after one day will be migrate to the thymus called T lymphocyte, while the another it consider mature cell and stay in active bone marrow, this cell is called B lymphocyte (Evanthia et al., 2021). In the blood stream the lymphocytes pass and become active in organs like tonsils, lymph nodes and spleen, also they are coated in their connective tissue (Puneet et al., 2021).

This system guide lymphocyte, therefore it directly contact with invaders, on the other hand, the lymphatic system is a grid of lymphatic vessels and lymph nodes throughout the body (Francesco et al., 2020).They load a liquid called lymph which have immune cells, waste products, and tissue fluid that pitfall the germs and other attackers including tumors cells, The immune responses can be split for three basic systems: (specialized) adaptive immunity, (general) as innate and passive immunity, they work closely together and take on different tasks

(Schmolke, 1989). The systemic innate immunity represents the onset line of defiance against germs. It acts a very speedily and has a limited power to fight the germs and stop their spreading. It consists from:

1. Protection offered by healthy skin and mucous membrane.

2. Protection offered by defiance cells (the killer cell in natural and macrophages) and proteins (enzymes). The adaptive immunity slower, more accurate than the innate immune system and can remember the invaders so the next time a known invaders are encountered hence, its response become faster, the passive immunity that build up temporarily from another source such as in case of newborn that get in breast milk mother's, antibodies which assist preserve them from illness (Tam et al., 2003).

Disorders of immune system

1. Primary immune deficiency: the weak immune system in individual may be occurring first in born with e.g. severe combined immunodeficiency (SCID).
2. Acquired immune deficiency: may be resulted from certain drugs e.g. chemotherapy also may be resulted from alcohol, smoking, poor nutrition and infections.
3. Over activity of immune system: The person born with definite genes and the immune reaction may attack to harmless substance called allergens e.g. dust, pollen, mold and food that presented in the environments and causing allergic reactions.

4. Auto immune disease: for unknown reasons, the body going to attack and destroy its own normal healthy tissues by auto antibodies. E.g. type 1 diabetes and rheumatoid arthritis (Haase & Rink, 2009).

The significance of tiny nutrients in nutrition and boosting immune system is unquestionable and between them zinc (Zn), which is a key micronutrient, an important trace element essential for normal functions and systems. It helps the cells to grow and divide and is necessary for the enzymes activity, DNA synthesis, normal cognitive function; proteins and carbohydrates metabolism also helps to produce the active form of vitamin A and transports it around the body. The body cannot synthetized zinc therefore, it must be obtained from food, Furthermore, it is temporarily stored in the muscle and bone and its concentration is second only to iron in the body (Bogden, 2004).

Sources of Zinc

Zinc taken by mouth, found in many foods such as fish, red meat, poultry, dairy foods, oysters and fortified cereals, zinc must be consumed regularly as part of the diet and the amount of zinc needed by the body depend on the age, sex and stage of human life, the absorption of zinc may be affected by the present of protein in the diet therefore, vegetarian people and vegans may suffer from zinc deficiency (Markell & Siddiqi, 2022). Unfortunately, the human body does not store excess zinc.

Recommended amount of zinc according to (Institute of Medicine, Food and Nutrition Board)

Life stage	**Recommended amount**
Birth –6 months	2mg
Infents7—12monthes	3mg
Children1—3years	3mg
Children4—8 years	5mg
Children9—13years	8mg
Teens14—18years(boys)	11mg
Teens14—18years(girls)	9mg
Adults(men)	11mg
Adults(women)	8mg

Excessive zinc administration may lead to headaches, nausea, vomiting, abdominal cramps, diarrhea and copper deficiency accordantly; zinc should not be taken more than 40mg /day unless necessary or described by the doctor. On the other hand, some people may need to administrate more zinc including people susceptible to have zinc deficiencies such as old ages, pregnant females, strict vegetarians, alcohol abusers, those who have poor diet and those with digestive problems. Furthermore, topical zinc recommended treating skin irritations, diaper rash, ulcers, acne and many other conditions (Evanmayo et al., 2014). In this subject display, we try to visualize the complementary role of zinc in human immune functions.

Complementary Roles of Zinc

An effective immune response to different external or internal invaders can be achieved only when all the sophisticated components of immune system work normally and properly together, zinc is the micronutrients that play a basic part in promotion, maintenance and ensure proper both innate and adaptive immune functions, its crucial for normal functions and growth of T and B immune cells (Fraker & King, 2004). Studies in previous show that zinc is significant in all quarters of the immune system:

It assist cells in skin and lining cells our organs prohibit invaders to enter and also keeps the bone marrow and thymus, which are important for immune cells generating, functioning adequately and normally ,therefore, the deficiency of zinc is participated with raised receptivity to infections and increase risk of autoimmune diseases due to niggled tolerance, The low zinc in plasma and serum has been discovered in autoimmune patients underlining either an pathological or etiological in this illness (Shankar, & Prasad, 1998). Thymine is a thymus-specific hormone that binds to specific receptors on T - cells, requires for its normal activity of the zinc biology to induce several T cells scores and elevates their functions including interleukin-2 production, allogeneic cytotoxicity, and suppressor functions (Dardenne, 2002). Zinc required for ordinary development and functions of cells mediating nonspecific immunity including killer cells in natural and neutrophils for promotes chemotaxis of phagocytic cells and the cohesion of myelomonocytic cells accordingly, can enhance oxidative burst of neutrophils, monocytes and phagocytosis, as well as promote the activity of natural killer cells (Wolfgang & Harold, 2006).

Furthermore, zinc is the key player for the process that causes stem cells to form lymphocytes in the bone marrow, production of anti-bodies from B-lymphocytes, proper and efficient interaction between B and T- lymphocytes and for the sequent differentiation into B and T lymphocytes but does not have an effect on the circulating level of WBCs.

Studies suggest zinc may slow the ability of viruses to make copies of themselves, Moreover, its functions as an antioxidant provide protection to exogenously and endogenously generated (Maria & Hajo, 2016). Zinc is famous to motivate the making of metallothionein, which is very wealthy in cysteine, and is an excellent clean out of (OH). Copper and iron ions stimulate the manufacture of (OH) from H2O2. Zinc is known to vie with those ions for connection to receptor in cell membrane, thus leading to limited for production of (OH) so it can stabilize membranes, reduce the risk of infections and can support immune functions (Hiroyuki, 2004). The function of zinc according to catalytic mineral or structural of more than 300 enzymes, as well, it is participated at all scales of transduction to the single cellular. In this way, can regulates and enhance the immune cells communication, proliferation, differentiation and survival, many studies have shown that zinc may exert anti-cancer properties, mostly through protecting and repairing DNA strands (Liang et al., 2019).

Conclusion

The element zinc is important to play an essential role in defense immunity system and influence multiple rules of both adaptive and innate immune response therefore; zinc deficient subjects may exhibit high susceptibility to a variety of infections.

References

1. Bogden, J.D. (2004). Influence of zinc on immunity in the elderly. Nutr Health Aging. 8 (1): 48- 54. The Influence of Nutritional Factors
2. Christopher, C. Karsten, K. Peter, P. and Lindy, C .(2022). The Role of Minerals in the Optimal Functioning of the Immune System. Nutriants. 14(3): pp. 644.
3. Dardenne, M. .(2002). Zink and immune function. European Journal of Clinical Nutrition. 56,520-523.
4. Evanmayo,W. Jean, A. Junior, A. Imdad, S. and Dean, E.(2014). Zink supplementation for preventing mortality, morbidity, and growth failure in children aged 6 months to 12years of age. The Cochrane Library, DOL:10.1002/14651858.CDoo9384.pub 2.
5. Evanthia T, Christos T and Athanasia M .(2021). The Influence of Nutritional Factors on Immunological Outcomes. Nutrition and Immunity. vol. (12) Article 666968.
6. Fraker P.J and King L.E. (2004). Reprogramming of immune system during zinc deficiency. Annu Rev Nutr. 24:277-298.
7. Francesco, P. Federica, P. Alberto, A. and Cosimo, N. (2020). The Role of Micronutrients in Support of the Immune Response against Viral Infections. Nutrients. 12, 3198.
8. Haase H, and Rink L.(2009). The immune system and the impact of zinc during aging. lmmune Ageing. 12;6:9.
9. Hiroyuki, Y. (2004). Zinc Deficiency and Clinical Practice. JMAJ. 47(8):359-364.
   Immune system. Eur J Clin Nutr. 57(10): 1193-7.
10. Institute of Medicine. Food and Nutrition Board. (2019). Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc: a Report of the Panel on Micronutrients. Washington, DC: National Academy Press; 2001. https://www.ncbi.nlm.nih.gov/books/NBK222317/ Accessed 10/17.

11. Liang, H. Xi Li, Wence Wang and Lin Yang. (2019).The Role of Zinc in Poultry Breeder and Hen Nutrition: an Update. Biological Trace Element Research. 192,308-318.
12. Maria, M. and Hajo, H. (2016). Zinc and immunity: An essential interrelation. Archives of Biochemistry and Biophysics. Science Direct. vol 611,pp: 58-65.
13. Markell M and Siddiqi H.A.(2022).Vitamins and trace elements. In: McPherson RA, Pincus MR,eds.Henyrys Clinical Diagnosis and Management Methods.24th ed. Philadelphia, PA: Elsevier: chap27.
14. Puneet, K. Mandeep, K. Onkar, B. and Manisha, G .(2021). Role of Vitamins and Minerals as immunity booster in COVID-19. Inflammopharmacology. 29:1001-1016.
15. Schmolke B. (1989). Organization and function of the immune system. Z Lymphol. 13(1):1 18.
16. Shankar, A.H and Prasad, A.S. (1998). Zinc and immune function: the biological basis of altered resistance to infection. Am J Clin Nutr, 68 (2 Suppl) 4475-4635.dol:10.1093/ ajcn /68.2.4475.
17. Tam M, Gomez S, Gonzalex-Gross M, and Marcos, A. (2003). Possible roles of magnesium on the
18. Weidong, Qiang Zhan, Hongwei Wang, and Wei Rao .(2022). Hypoxia Promotes Glioma Stem Cell Proliferation by enhancing the 14-3-3 βExpression via the PI3K pathway. Journal of Immunology Research. Article ID5799776, 11pages.
19. Willem B, Van Muiswinkel and Miki Nakao .(2014). A short history of research on immunity to infectious disease in fish. ELSEVIER (Developmental& Comparative Immunity). Vol 43 (2):pp130-150.
20. Wolfgang, M. and Harold H. (2006). Zinc requirements and the risk and benefits of zinc supplementation. Journal of Trace Elements in Medicine and Biology. 20: 3-18.