Zinc Is Essential for Immune Functions

by Lewis Chang, PhD

Introduction

this case, Pacific oysters; n= 16) to different noises emitted from underwater loudspeakers and recorded shell movements using sensors attached to the shells. Within a minute these shellfish would shut their shells, particularly when hearing low-frequency noises.[1]

Food fact: Oysters have the highest amount of the mineral zinc per serving in any food. According to the US Department of Agriculture's FoodData Central, one raw Pacific oyster contains 18.9 mg zinc, or 172% daily value for adults.

Intimately involved in immune responses

When it comes to improving immune health, many people think zinc immediately. Although zinc does not "work" alone, it is indeed vital for supporting virtually every stage of an immune response when our bodies encounter pathogens (e.g., virus and bacteria) or dangers (e.g., tissue damage caused by oxidative stress or toxins). For example:[2,3]

- Zinc helps maintain integrity of the physical and biochemical barriers such as skin and mucus membranes (mucosal cells) in the respiratory and gastrointestinal tract to block entry of pathogens.
- Zinc supports differentiation and proliferation of innate immune cells and enhances their functioning, such as monocyte phagocytic capacity and natural killer cell cytotoxic activity.
- Zinc has antioxidant properties that protect against reactive oxygen species (ROS).
- Zinc is important for the development and activation of T lymphocytes supporting adaptive immune responses.
- Zinc is involved in production of the antibody IgG.
- Zinc supports production of antimicrobial substances such as interferon gamma (IFNγ) that deter growth of microbes.

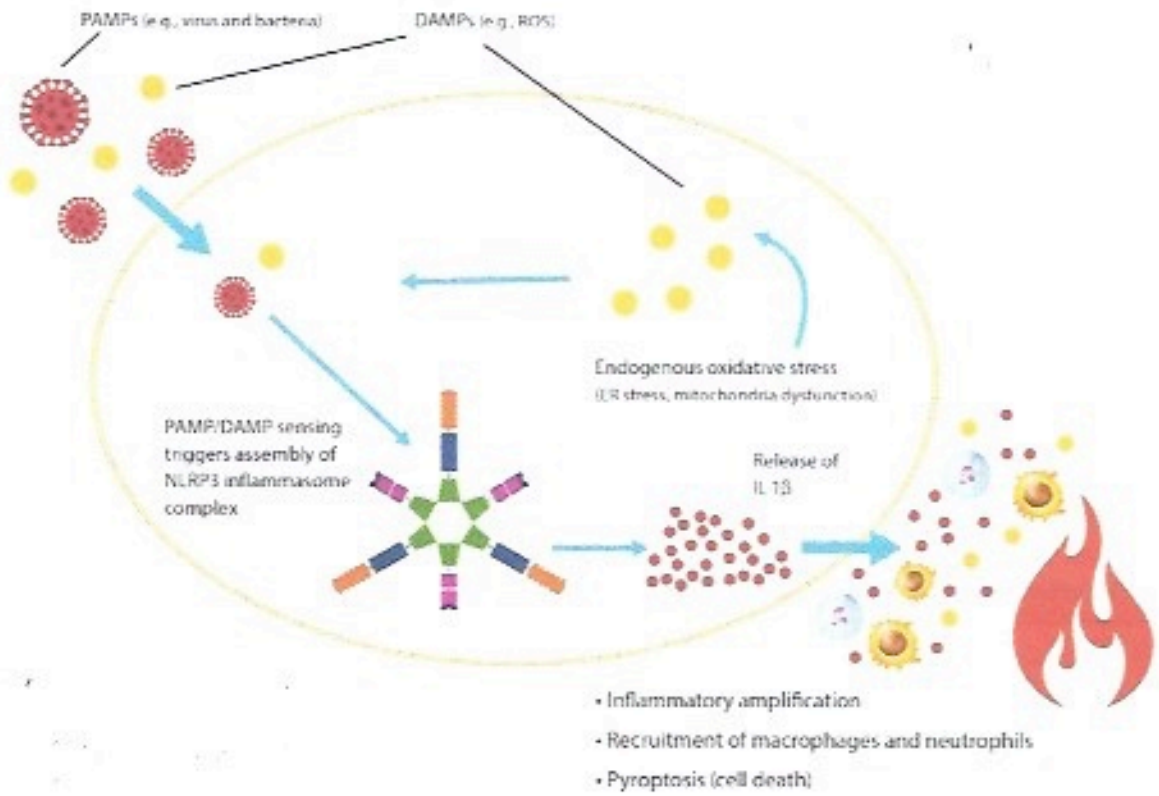
Deficiency negatively impacting health

The recommended dietary allowance (RDA) for men is 11mg/day and women is 8mg/day.[4] Unfortunately, dietary intake of zinc in the US has been inadequate. Older adults, vegetarians, and people with chronic inflammatory conditions or renal disease are especially at risk of deficiency.[5,6] Zinc deficiency has been linked to impaired immune functions, and its clinical impact can be detrimental, such as increased susceptibility to infections including viral infections of respiratory tract, increased diarrhea and pneumonia, impaired wound healing, and increased risk of inflammatory and autoimmune disorders.[7-10]

Modulation of NLRP3 inflammasome activity

Importantly, zinc has been shown to be involved in modulation of NLRP3 inflammasome activation, as well. Inflammasomes—of which there are several types, and the NLRP3 inflammasome is considered the most clinically relevant—are protein complexes in the cell that can sense signals from pathogens or dangers.[11] Activation of inflammasomes is part of the innate immune defenses that leads to amplification of downstream inflammatory and immune responses. However, inflammasome activation is a double edge sword; activations that are not well-regulated have been linked to not only tissue collateral damage during infections, but also immune and metabolic disorders such as autoimmune disease, type 2 diabetes, atherosclerosis, and even Alzheimer's disease.[12]

Figure: NLRP3 inflammasome activation



inflammation.[13] Fortunately, deficiency in zinc can be corrected by eating foods rich in zinc or via supplementation of zinc. In a cell model of an inflammatory condition, zinc treatment inhibited NLRP3 inflammasome activation. It was achieved via activation of the Nrf2 antioxidant pathway and reduced production of reactive oxygen species.[14]

Supplementation markedly improving various health outcomes

There is strong clinical evidence demonstrating the benefits of zinc supplementation on immune health. Here are only some of the examples:

- Zinc supplementation at 30 mg/day for 3 months effectively increased serum zinc concentration in elderly (65 y/o or older living in nursing home), which improved T cell proliferation.[15]
- Zinc supplementation at 45 mg/day for 1 year significantly reduced the incidence of infection, levels of inflammatory cytokines, and markers of oxidative stress in elderly subjects.[16]
- In a meta-analysis involving common cold patients, zinc (as lozenges) use led to reduction in common cold duration by nearly 3 days.[17]
- Zinc supplementation reduced the incidence of otitis media (inflammation of the middle ear caused by infection) in young children without causing serious adverse events.[18]
- A meta-analysis demonstrated that zinc supplementation significantly reduced the frequency and severity of diarrhea and respiratory tract infections in children.[19]

Summary

There is very strong evidence supporting the role of zinc in immune functions, but the benefits of zinc go beyond supporting immune health. Many studies have demonstrated the role of zinc in the management of type 2 diabetes,[20] age-related macular degeneration,[21] depression,[22] and more. Therefore, it is important to maintain adequate dietary intakes of zinc. So next time you see oysters in a restaurant (after measures of social distancing have been lifted, or course), be sure to thank them. Or better yet, eat them!

Citations

1. Charifi M et al. The sense of hearing in the Pacific oyster, Magallana gigas. *PLoS One*. 2017;12:e0185353.
2. Gombart AF et al. A review of micronutrients and the immune system working in harmony to reduce the risk of infection. *Nutrients*. 2020;12:pii. E236.
3. Wessels I et al. Zinc as a gatekeeper of immune function. *Nutrients*. 2017;9:pii. E1286.
4. Gibson RS et al. A review of dietary zinc recommendations. *Food Nutr Bull*. 2016;37:443-460.

6. International Zinc Nutrition Consultative Group. International Zinc Nutrition Consultative Group (IZiNCG) technical document #1. Assessment of the risk of zinc deficiency in populations and options for its control. *Food Nutr Bull.* 2004;25:S99 203.
7. Prentice S. They are what you eat: can nutritional factors during gestation and early infancy modulate the neonatal immune response? *Front Immunol.* 2017;8:1641.
8. Maywald M et al. Zinc signals and immunity. *Int J Mol Sci.* 2017;18:2222.
9. Savino W et al. Nutritional imbalances and infections affect the thymus: consequences on T-cell mediated immune responses. *Proc Nutr Soc.* 2010;69:636-643.
10. Sanna A et al. Zinc status and autoimmunity: a systematic review and meta-analysis. *Nutrients.* 2018;10:pii:E68.
11. Abderrazak A et al. NLRP3 inflammasome: from a danger signal sensor to a regulatory node of oxidative stress and inflammatory diseases. *Redox Biol.* 2015;4:296-307.
12. Yang Y et al. Recent advances in the mechanisms of NLRP3 inflammasome activation and its inhibitors. *Cell Death Dis.* 2019;10:128.
13. Summersgill H et al. Zinc depletion regulates the processing and secretion of IL-1beta. *Cell Death Dis.* 2014;5:e1040.
14. Fan Y et al. Zinc inhibits high glucose-induced NLRP3 inflammasome activation in human peritoneal mesothelial cells. *Mol Med Rep.* 2017;16:5195-5202.
15. Barnett JB et al. Effect of zinc supplementation on serum zinc concentration and T cell proliferation in nursing home elderly: a randomized, double blind, placebo-controlled trial. *Am J Clin Nutr.* 2016;103:942-951.
16. Prasad AS et al. Zinc supplementation decreases incidence of infections in the elderly: effect of zinc on generation of cytokines and oxidative stress. *Am J Clin Nutr.* 2007;85:837-844.
17. Hemila H et al. Zinc acetate lozenges for treating the common cold: an individual patient data meta-analysis. *Br J Clin Pharmacol.* 2016;82:1393-1398.
18. Gulani A et al. Zinc supplements for preventing otitis media. *Cochrane Database Syst Rev.* 2014:CD006639.
19. Aggarwal R et al. Role of zinc administration in prevention of childhood diarrhea and respiratory illnesses: a meta analysis. *Pediatrics.* 2007;119:1120-1130.
20. Wang X et al. Zinc supplementation improves glycemic control for diabetes prevention and management: a systematic review and meta-analysis of randomized controlled trials. *Am J Clin Nutr.* 2019;110:76-90.
21. Evans JR et al. Antioxidant vitamin and mineral supplements for slowing the progression of age-related macular degeneration. *Cochrane Database Syst Rev.* 2017;7:CD000254.
22. Swardfager W et al. Zinc in depression: a meta-analysis. *Biol Psychiatry.* 2013;74:872 878.

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