



PharmaInterScience Publishers

A potential medicinal importance of zinc in human health and chronic disease

Debjit Bhowmik, Chiranjib,
K.P. Sampath Kumar*

Department of Pharmaceutical
Sciences, Coimbatore Medical College,
Coimbatore, Tamilnadu, India

***Correspondence:**

Mr. K.P. Sampath Kumar
Tel: +91 8623 243140
Email: debjit_cr@yahoo.com

Zinc is an essential nutrient for human health. Ensuring adequate levels of zinc intake should be a key component in efforts to reduce child illness, enhance physical growth and decrease mortality in developing countries. In spite of the proven benefits of adequate zinc nutrition, approximately 2 billion people still remain risk of zinc deficiency. Zinc is found in over 200 enzymes and hormones in mankind. It is a natural element found in all plants and animals, and is widely available in over-the-counter vitamin supplements. Zinc is essential to life. It is a natural element found in all plants and animals and plays a crucial part in the health of our skin, teeth, bones, hair, nails, muscles, nerves and brain function. Zinc is essential for growth. It is used to control the enzymes that operate and renew the cells in our bodies. The formation of DNA, the basis of all life on our planet, would not be possible without zinc. Zinc deficiency was a major etiological factor in the syndrome of adolescent nutritional dwarfism, that had been identified in mid-eastern countries. Zinc deficiency is an important public health problem, Nutritionists have been concerned that zinc deficiency affects large numbers of women and children in India and worldwide. In recent survey by WHO, zinc deficiency found most of the Indian population and Zinc supplement is used commonly to enhance wound healing and treatment of pneumonia. Zinc gluconate lozenges, taken at the first sign of a common cold, reduce duration and symptom severity by 42% according to a 1992 study. Trace element zinc is important in maintaining the healthy growth of the human body, especially for infants and young children's growth and development.

Key words: Zinc, Chronic diseases, human health, Zinc deficiency, Pregnancy

Received: 17 May 2010 / Revised: 28 May 2010 / Accepted: 06 Jun 2010 / Online publication: 09 Jun 2010

1. INTRODUCTION

Zinc is an essential trace element for all forms of life. The significance of zinc in human nutrition and public health was recognized relatively recently. Zinc deficiency has been recognized by a number of experts as an important public health issue, especially in developing countries. The prevalence and clinical consequences of zinc deficiency on growth delay, diarrhoea, pneumonia, disturbed neuropsychological performance and abnormalities of fetal development. Zinc is such a critical element in human health that even a small deficiency is a disaster. Zinc supplementation is a powerful therapeutic tool in managing a long list of illnesses. Zinc, an essential trace mineral, is required for the metabolic activity of 300 of the body's enzymes, and is considered essential for cell division and the synthesis of DNA and protein. These enzymes are involved with the metabolism of protein, carbohydrate, fat and alcohol. Zinc is also critical to tissue growth, wound

healing, taste acuity, connective tissue growth and maintenance, immune system function, prostaglandin production, bone mineralization, proper thyroid function, blood clotting, cognitive functions, fetal growth and sperm production. The distribution of zinc in the human body and its physiological function is multi-faceted. For example, it can promote protein synthesis and manufacture of insulin; maintenance of cells and enzyme systems to work; the composition of a variety of enzymes, and helps to enhance the activity of a variety of enzymes, synthetic DNA; regulating body fluid pH; promote the formation of collagen to make hair, skin, nails and other healthy growth; help to enhance memory and improve mental, especially for fetal brain development has an important role; to maintain the normal function of the prostate. There are experiments shows that zinc testosterone secretion in animals has important implications. The lack of zinc in the human body partial eclipse will appear anorexia, loss of appetite, smell and taste failure and other symptoms; caused decreased

immune system, triggering the disease arteriosclerosis and anemia. Pregnant women, the lack of zinc may lead to fetal brain cells decreases, and affect their mental development. Children's lack of zinc will hinder their normal growth and development, detrimental to intellectual development and reproductive system health. A zinc-deficient adult males, there may lead to prostatic hyperplasia, reducing the reproductive function of the system and affect fertility; and so on.

2. FUNCTIONS OF ZINC

On the cellular level, the function of zinc can be divided into three categories: Catalytical, Structural and Regulatory.

Catalytical: Nearly 100 different enzymes depend on zinc for their ability to catalyze vital chemical reactions. Zinc dependent enzymes can be found in all known classes of enzymes.

Structural: Zinc plays an important role in the structure of proteins and cell membrane. The structure of proteins and cell membrane. The structure and function of cell membranes are also affected by zinc. Loss of zinc from biological membranes increases their susceptibility to oxidative damage and impairs their functions.

Regulatory: Zinc finger proteins have been found to regulate gene expression by acting as transcription factors. Zinc also plays a role in cell signaling and has been found to influence hormone release and nerves impulse transmission.

3. ZINC DEFICIENCY

Up to one-fifth of the worlds people may lack sufficient zinc in their diet, while an estimated one-third live in countries considered at high risk of Zinc deficiency, warns a comprehensive new reports by an international group of medical researchers WHO Task force has recommended use of Zinc in the treatment of diarrhea (Table 1).

4. RISK GROUPS

1. Infants and children
2. Pregnant and Lactating women.
3. Patients receiving total parentals nutrition.
4. Older adults (65 years and older)
5. Individuals with alcoholic liver disease increased urinary zinc excretion and low liver zinc levels.
6. Individuals with inflammatory bowel disease, including crohn's disease and ulcerative colitis.
7. Individuals with severe or persistent diarrhea.

5. DIETARY SOURCES OF ZINC

Shellfish, beef and other red meats are rich sources of zinc. Nuts and legumes are relatively good plant sources. The Zinc content of some relatively Zinc-rich foods is listed in milligrams (mg) in the Table 2.

Table 1

Zinc deficiency has been implicated as a factor in

Birth Defects	Lack of Sexual Development in Females
Low Birth Weight	Infections
Delayed Sexual Development	Small Breasts in Females
Impaired learning	Growth Retardation
Loss of Smell and Taste Sensation	Dwarfism
Diminished Wound Healing	Delayed Puberty in Adolescents
Anorexia	Rough Skin
Loss of Appetite	Poor Appetite
Paranoia	Mental Lethargy
Depression	Short Stature
Strong Body Odor	Diarrhea
Benign Prostatic Hypertrophy	Pneumonia
Impotence	Stretch Marks
Some Hair, Nail and Joint Conditions	Poor Immune Function
Arthritic Problems	Reduced Collagen (connective tissue)
Cataracts	Cataracts
Optic Neuritis	Acne
Skin Conditions such as Acne and Dermatitis	Cross-linking in Collagen
defective bone mineralization	Macular Degeneration
Weight Loss	Myopia
Hypogonadism in Males	Retinal Detachment

Table 2

Zinc rich foods

Category of foods	Zinc contents in mg/100 calories
Fats and various non-nutritive foods	None to 0.2
Fish, fruits, cakes	0.1 to 0.5
Poultry, pork, diary products and whole grains cereals	0.4 to 1.2
Lamb, beef, leafy grains, root vegetables, shell fish and organ meats	> 1.2

Table 3

Zinc Requirements Daily Reference Intakes

Infants		Males	
0 - 6 months	2 Zinc(mg/day)	9 - 13 years	8 Zinc(mg/day)
7 - 12 months	3 Zinc(mg/day)	14 - 18 years	11 Zinc(mg/day)
		19 - 30 years	11 Zinc(mg/day)
Children		31 - 50 years	
1 - 3 years	3 Zinc(mg/day)	51 - 70 years	11 Zinc(mg/day)
4 - 8 years	5 Zinc(mg/day)	> 70 years	11 Zinc(mg/day)
Pregnancy		Females	
< 18 years	13 Zinc(mg/day)	9 - 13 years	8 Zinc(mg/day)
19 - 30 years	11 Zinc(mg/day)	14 - 18 years	9 Zinc(mg/day)
31 - 50 years	11 Zinc(mg/day)	19 - 30 years	8 Zinc(mg/day)
		31 - 50 years	8 Zinc(mg/day)
Lactation		51 - 70 years	
< 18 years	14 Zinc(mg/day)	> 70 years	8 Zinc(mg/day)
19 - 30 years	12 Zinc(mg/day)		
31 - 50 years	12 Zinc(mg/day)		

Zinc deficiency is a recognized health problem. The Recommended Daily Allowance (RDA) of zinc is 15 mg for a male adult, a figure that is easily met by a balanced diet containing meat and vegetables. However, certain people require more zinc than others; pregnant and lactating women for example, may need as much as 19 mg a day. The average elderly person's intake is only about 9 mg a day due to the fact that food consumption, especially of proteins, is often reduced and so that person may need to take a zinc

supplement. Zinc is essential for growth. It is used to control the enzymes that operate and renew the cells in our bodies. The formation of DNA, the basis of all life on our planet, would not be possible without zinc (Table 3).

6. HEALTH BENEFITS OF ZINC

6.1. Zinc, Testosterone and Men's Health

Zinc is necessary to maintain normal serum testosterone. Inadequate zinc levels prevent the pituitary gland from releasing luteinizing and follicle stimulating hormones, which stimulate testosterone production. Zinc also inhibits the aromatase enzyme that converts testosterone into excess estrogen. The testosterone to estrogen ratio in men declines with aging from a high of about 50:1 to half of that, or even a low of 10:1. Higher estrogen activity results in increased risk of heart disease, weight gain, and obesity. One reason for the progressive weight gain with age is that fat cells contain aromatase. More fat cells mean more estrogen which means more fat deposition. This is further aggravated by alcohol consumption, which lowers zinc and increases estrogen, and so magnifies the problem. In addition to the impact on hormone levels, zinc also has been proven to help the body produce healthier sperm by increasing sperm count and motility. A USDA study found that semen volume dropped 30 percent when zinc intake was low. Research published in the *American Journal of Clinical Nutrition* found that male volunteers who consumed low amounts of zinc exhibited decreased semen volumes and serum testosterone concentrations.

Zinc deficiency has been found to have a severe impact on the male prostate gland. Zinc deficiency predisposes the prostate to infection (prostatitis) which may lead to enlargement of the prostate gland (prostatic hypertrophy).

6.2. Zinc Boosts the Immune System

The significance of zinc in the body's response to infection is well known. Zinc is a component in thymic hormone which controls and facilitates the maturation of lymphocytes. Zinc also plays a role in cell division and DNA replication, thereby aiding in the production of immune system cells.

6.3. Zinc Cuts Short the Common Cold

Zinc gluconate lozenges taken at the first sign of a cold reduce duration and symptom severity according to a 1992 study. Zinc, an antiviral agent and astringent, is released into the saliva, relieving cough, nasal drainage and congestion. Dr. Michael Macknin told CNN news. "It's the first thing I'm aware of that actually decreased the duration of cold symptoms to this extent." Researchers studied 100 patients

who had cold symptoms for less than 24 hours, giving half of the patients a zinc lozenge and the other half a placebo. There was nearly a 50 percent reduction in the duration of the symptoms of the common cold.

6.4. Zinc Boosts Brain Activity

Zinc is found in the vesicles of the mossy fiber system of the brain's hippocampus. These fibers play a role in enhancing memory and thinking skills. University of Texas researchers found that women deficient in zinc had a harder time on standard memory tests. USDA scientists found lower cognition in men experimentally deprived of zinc. Experiments have shown that accident victims who are given zinc supplements respond with improved cognitive function. Zinc is diverted to the healing tissues following injury or surgery and becomes less available for other essential functions.

6.5. Zinc Heals and Protects Skin

Zinc is essential for healthy skin. Topical zinc preparations (zinc oxide) have been used as an astringent to treat diaper rash, itching and chapped lips and skin. Zinc sulfate in a water based solution has been used for treating acne, cold sores and burns. Remember that zinc sulfate is a salt and can be quite caustic to raw tissue in high or moderate concentrations. Internally, zinc stimulates cell division, healing, proper connective tissue formation, and increases the transport of Vitamin A from the liver to the skin, helping to protect body tissue from damage and repair any damage present.

6.6. Zinc Stimulates Taste, Smell

Zinc activates areas of the brain that receive and process information from taste and smell sensors. Its importance to appetite was first demonstrated in 1972 when researchers showed taste disorders responded to zinc supplementation.

6.7. Zinc Improves Appetite

Levels of zinc in plasma were found to influence appetite and taste preference. Insufficient zinc has been linked to anorexia, which responds well to zinc replacement treatment.

6.8. Zinc Improves Mood

Zinc abnormalities also often exist in mood disorder patients. Zinc sulfate, taken as a supplement, appears effective in reducing fatigue, mood swings and changes in appetite.

6.9. Zinc and Pre-Menstrual Syndrome

Zinc may also help in the treatment of pre-menstrual syndrome (PMS). PMS affects 50 percent of all menstruating women. There is growing evidence that a deficiency of progesterone underlies PMS. Trace amounts of zinc regulate the secretion of many hormones, including progesterone.

Early research at Baylor College of Medicine in Houston found significantly lower levels of zinc among women with PMS during the luteal phase of menstruation, the 13 days preceding menstruation. This reduction could lead to a decrease in secretions of progesterone and endorphins. Endorphins are the natural painkillers our bodies produce. While research is ongoing, it suggests that some women's PMS symptoms may be improved by zinc supplementation.

6.10. Zinc in Pregnancy and Lactation

It is critical that a pregnant woman satisfy her body's need for zinc. The official RDI for pregnant women is 19 milligrams per day. A report in the October 1992 American Journal of Epidemiology indicated that low zinc intake was associated with approximately a two-fold increase in risk of low birth weight, and low zinc intake earlier in pregnancy was associated with more than a trebling of pre-term delivery.

Research reported in the British medical journal, *The Lancet*, September 1992, notes that by the sixth month of lactation even a well-nourished mother may provide less zinc than is necessary for her child. Breastfed babies who received zinc supplements grew significantly in length and weight over those given a placebo.

6.11. Zinc in Post-Menopausal Health

As a woman ages, her zinc status may decline for several reasons. Excess estrogen can lower serum zinc levels. Women using estrogen replacement therapy should check to be sure their zinc intake is adequate. Zinc deficiency appears to be common in older women. This may be in part because they eat less and in part because the food they consume is deficient in zinc. It is well known that the immune system weakens with age, and zinc deficiency may be partly to blame. Zinc is needed for night vision and may also slow the progression of macular degeneration. Macular Degeneration is a disorder of the retina that is the leading cause of severe loss of vision in older women.

6.12. Zinc Deficiency Linked To Anorexia and Bulimia

A wide variety of health researchers, nutritionists and physicians are finding that zinc is a sustaining factor in

abnormal eating behavior. Dr. Laurie Humphries of the University of Kentucky has found that while patients may develop eating disorders for psychological reasons, they are sustained and complicated by the zinc deficiency that results from decreased food intake. Diminished Zinc levels may result in a diminished desire to eat because zinc is critical to the senses of taste and smell. In a 1994 summary publication appearing in the *Journal for Medical Research*, Dr. Alex Schauss reports that studies at Stanford, University of Kentucky, and University of California at Davis found most anorexics and many bulimics were zinc deficient. A five-year study showed an astounding 85 percent remission rate of anorexia nervosa in patients given a zinc supplement. Using zinc supplements resulted in weight gain, better body function and improved mental outlook.

6.13. Pregnancy and Infertility

- Because of zinc's role in generating cells, it is essential for the developing fetus where cells are rapidly dividing.
- Adequate zinc in the pregnant mother's diet also reduces the risk of premature birth and other complications and has been shown to improve neonatal survival.
- There is believed to be a link between zinc deficiency during pregnancy and learning difficulties.
- Research has been undertaken into the possibility of treating male infertility with zinc therapy to increase sperm count and motility.

6.14. Immune System

Zinc plays an important role in regulating the production of cells in the body's immune system, which protects against infection and disease. As we get older immunity often decreases. It has been shown that providing adequate zinc and a balanced diet helps decrease the rate of infectious diseases in older people.

6.15. Brain Functions

- Zinc interacts with other chemicals to send messages to the sensory brain centre, enhancing memory and thinking skills.
- In the weeks following a head injury patients tend to have lower zinc levels which, when boosted by zinc supplements, are thought to give improved cognitive function.
- Zinc activates areas of the brain that receive and process information from taste and smell sensors.
- Insufficient zinc has been linked to anorexia, which responds well to zinc replacement treatment.
- Zinc deficiency is often found in mood disorder patients. Zinc sulphate, taken as a supplement, appears effective in reducing fatigue, mood swings and changes in appetite.

6.16. Skin Healing and Protection

Zinc and zinc compounds are of major importance in skin care. Some of its vital uses are:

- To soothe nappy rash and itching thanks to its astringent and drying properties.
- As a sun-block to protect the skin from the sun's harmful rays.
- As an effective treatment for acne.
- In the relief of cold sore symptoms.
- To aid the healing of wounds, like surgical incisions, burns and other skin irritations. Many adhesive plasters contain zinc oxide for this reason.
- As an anti-inflammatory to relieve the discomfort from sunburn, blisters and gum disease.
- As an insect repellent.
- Helping to protect body tissue from damage by stimulating the transport of Vitamin A from the liver to the skin,
- As bactericides in high quality cosmetics and toiletries.
- To help heal leg ulcers through addition to the diet.

6.17. Eyesight

Zinc is found in high concentrations in the retina of the eye. Evidence exists linking zinc deficiency with the deteriorating vision that comes with ageing.

6.18. Zinc in children

Zinc deficiency is common in children from developing countries due to lack of intake of animal foods, high dietary phylate content, inadequate food intake and increased faecal losses during diarrhea. The Nutrition Collaborative Research support program (CRSP) sponsored by the US agency for International Development, the predicted prevalence of preschoolers with intakes of Zinc inadequate to meet basal requirements (ie. To prevent deficiency symptoms) was 57% in Kenya, 25% in Mexico and 10% in Egypt.

6.19. Zinc and Athletic Performance

Endurance athletes may develop a zinc deficiency because of dietary deficiencies and increased zinc demands and losses. A high carbohydrate diet has been used by endurance athletes in an attempt to enhance their performance. High carbohydrate diets are low in zinc. If zinc supplements are not being taken, low zinc levels are likely. Poor appetite is one potential sign of zinc deficiency. Because zinc is involved in the growth and development of taste buds, deficiency reduces taste and a poor appetite. Zinc deficient individuals also tend to find protein disagreeable, compounding their problem. In female athletes zinc deficiency can result in menstrual cycle irregularities, amenorrhoea and osteoporosis. Zinc

deficiency in athletes can lead to anorexia, weight loss, decreased endurance, fatigue and an increased risk of osteoporosis. Strenuous exercise may contribute to the zinc deficiency by increasing sweat loss and zinc redistribution between blood plasma and red blood cells.

6.20. Zinc Monomethionine

Zinc Monomethionine is a 1:1 chelated complex of the antioxidants zinc and methionine. Human and animal studies have demonstrated that zinc monomethionine is absorbed better, retained longer and is more effective than other zinc supplements tested. Zinc monomethionine has been shown to enhance immunity, improve male sexual function, nourish the skin, and fight free radical damage.

6.21. Recommendations on Zinc Supplements

Remember that the RDI (Recommended Daily Intake) and RDA (Recommended Daily Allowance) numbers are a statistical estimate of the amounts that prevent individuals from demonstrating deficiency signs and symptoms. The optimum nutrition level is generally higher than the RDI numbers, sometimes much higher. Unfortunately, we do not know what those numbers are. Furthermore, individual needs vary with age, sex, health status and individual genetic makeup. The simplest estimate of optimum zinc intake is assume that it is between the RDI numbers and the maximum tolerance numbers from the table above. It is also likely that foods are deficient in zinc in general, therefore, zinc supplementation is appropriate. In general, the sum of the zinc from foods and supplements should not exceed the maximum tolerance estimates, at least for long periods of time. Because zinc competes with iron and copper, those taking high doses of zinc supplements may develop deficiencies of these minerals. One way to avoid this is to take a good broad spectrum multi-mineral supplement. It is best to take these at different times to avoid conflict over the absorption channels. Zinc is water soluble and is not stored effectively in body tissues. Therefore, for maximum absorption and utilization

6.22. Zinc Supplements and Zinc Monomethionine

The health benefits of Zinc include proper functioning of immune system, digestion, control of diabetes, improves stress level, energy metabolism, acne and wounds healing. Also, pregnancy, hair care, eczema, weight loss, night blindness, cold, eye care, appetite loss and many other factors are included as health benefits of zinc. Zinc, being an important mineral plays a vital role for the protein synthesis and helps in regulation of the cells production in the immune system of the human body. Zinc is mostly found in the strong muscles of the body and especially in high concentrations in the white and red blood cells, eye retina,

skin, liver, kidneys, bones and pancreas. The semen and prostate gland in men constitutes large zinc amount. In a human body, even 300 enzymes or more than that requires zinc for the normal functioning. The researchers believe that 3000 proteins out of 100,000 are involved in human body consisting of Zinc. A normal human body consists of two to three grams of Zinc. There are organs of the human body, which secrete Zinc such as salivary gland, prostate gland and pancreas. Even the immune cells secrete Zinc.

7. DEFICIENCY SYMPTOMS

The deficiency symptoms of zinc include

- Growth retardation
- Low blood pressure
- Retarded bones
- Loss of appetite
- Loss of sense of smell and taste
- Weight loss
- Pale skin
- Diarrhea
- Hair loss
- Fatigue
- White spots under finger nails.

The important food sources of zinc include meat based products. The source of a wide range of trace elements zinc, especially the most abundant meat, such as chicken, lamb, beef, rabbit meat, oysters, scallops, blackfish and animal liver, and so on. Good sources of its mushrooms, mushrooms, day lily flowers, edible fungus, rape, cabbage, black sesame, black rice, dates, hazelnuts, ebony and other vegetables, food crops and fruit.

8. APPLICATION OF ZINC IN HEALTH AND CHRONIC DISEASE

The most important health benefits of zinc are as follows:

- **Skin Care:** Studies have shown zinc to be an effective home remedy for curing pimples or acne. It is even more powerful than placebo and consumption of antibiotic medication is still considered to be more effective.
- **Eczema:** Also called as atopic dermatitis, is an inflammatory and chronic disorder of skin. It is mainly caused by deficiency of zinc in the body. Zinc plays an important role in healing chronic infection and assists the body in restoring its ability to heal properly.
- **Acne:** This mineral is important for erasing acne from skin. It regulates in controlling the amount of testosterone in the body which plays a dominant role in causing acne. In addition to it, zinc is also concerned with collagen synthesis. This further aids in normalizing the amount of skin oils and maintenance of a healthy skin.

- **Wound healing:** Deficiency in zinc causes delayed healing of wounds. Human body has several zinc dependent enzymes, which promote the synthesis of collagen that thereby aids in wound healing.
- **Prostate disorder:** Zinc is very important in dealing with prostate disorders. Zinc deficiency causes enlargement of the prostate gland and makes it vulnerable to cancer. It is advisable to take 15mg of zinc everyday, under close medical observation, when suffering from prostate disorder.
- **Cold:** Zinc supplements help in decreasing the severity and duration of cold illness. It reduces the amount of proinflammatory cytokines, which is aggravated during the cold infections.
- **Weight loss:** Zinc plays a leading role in weight loss and in controlling the appetite of the person.
- **Pregnancy:** It is essential for the repair and functioning of DNA. It is hence, necessary for quick growth of cells and building of major constituents of the cell during the course of pregnancy.
- **Reproduction:** In males, zinc assists in spermatogenesis and development of the sex organs. While in females, it aids in all the reproductive phases, including parturition and lactation stages.
- **Biological Functions:** Zinc plays a vital role in many biological functions such as reproduction, diabetes control, stress level, immune resistance, smell and taste, physical growth, appetite and digestion.
- **Infection:** Zinc helps a person to sense the taste and smell, provides an aid to wound healing, boosts immunity and helps in promoting the fetus growth. Zinc helps in protecting against the infectious disorders and fungal infections, which includes pneumonia and conjunctivitis.
- **Antioxidant:** Zinc acts as an antioxidant and is basically involved in some of the biochemical decisive reactions, which includes protein synthesis, enzymatic function and carbohydrate metabolism.
- **Enzymes regulation:** Zinc is a component of a number of enzymes, which help in regulation of cell growth, protein synthesis, hormonal level, DNA, regulating the gene transcription, energy metabolism and other related health benefits of zinc.
- **Cancer:** In males, zinc plays a vital role in the prostate gland and prevents the early damage, which can lead to problems like cancer.
- **Chronic Fatigue:** People suffering from chronic fatigue are suggested to consume fish, as it is rich in zinc. The doctors suggest no other medications are required for curing chronic fatigue except the intake of fish oil rich in zinc content.
- **Alopecia:** Alopecia causes loss of hair in both children and adults. Remedies suggested by the doctors to the people suffering from it, should intake a diet rich in zinc

content. There are various capsules that are rich in zinc, so the medicines rich in zinc will help preventing hair loss.

- Bone loss: It is a disease when the bones become weak and fragile. Zinc is a component of hydroxyapatite, which is a salt and makes the bone matrix strong and hard. Due to this reason, zinc content should be added in your dietary plan to avoid bone loss.
- Night blindness: Consuming Zinc in about 150-450 mg will improve the vision. So it is always suggested to consume food like beef, lamb, oysters, buckwheat and crabs as they are rich in zinc content and will improve the vision of the eye.

9. CONCLUSIONS

Zinc is an essential micronutrient and plays an essential role in growth, immune functions, and resistance to infections in children. Zinc deficiency places children in many low-income countries at increased risk of illness and death from infectious diseases. Mild to moderate Zinc deficiency may be common in the developing world but the public health importance of this degree of zinc deficiency is not well defined.

Zinc deficiency is an important public health problem; Nutritionists have been concerned that zinc deficiency affects large numbers of women and children worldwide. Zinc affects multiple aspects of the immune systems, from the barriers of the skin to gene regulation within lymphocytes. Zinc is used in preventive trials of Zinc supplementation a significant impact has been shown on the incidence of acute lower respiratory infections. Zinc is used treatment of Pneumonia, common cold and respiratory infections. Zinc supplementation may reduce the incidence of clinical attacks of malaria in children. Sufficient zinc is essential in maintaining immune system function and HIV infected individuals are particularly susceptible to Zinc deficiency. Decreased serum Zinc levels have been associated with more advanced disease and increased mortality in HIV patients. Zinc supplementation is used commonly in wound healing. Zinc has many actions that may promote debridement and wound healing in patients suffering from burns.

REFERENCES

- [1] Prasad AS. Discovery of human zinc deficiency and studies in an experimental model. *Am J Clin Nutr* 1991, 53, 403.
- [2] Brown KH, Peerson JM, Allen LH, Rivera J. Effect of supplemental zinc on the growth and serum zinc concentrations of pre-pubertal children: a meta-analysis of randomized, controlled trials. *Am J Clin Nutr* 2002, 75, 1062.
- [3] Cousins RI. Zinc. In: Present knowledge in nutrition. Eds. Zeigler EE, Filer LJ. Washington DC. ILSI Press 1996.
- [4] Van Wouwe JP. Clinical and laboratory diagnosis of acrodermatitis enteropathica. *Eur J Pediatr* 1989, 149, 2.
- [5] Duchateau J, Delepesse G, Vrijens R, Collet H. Beneficial effects of oral zinc supplementation on the immune response of old people. *Am J Med* 1981, 70, 1001.
- [6] Sandstead HH, Prasad AS, Schulert AR, Farid Z, Miale A, Bassily S et al. Serum thymulin in human zinc deficiency. *J Clin Invest* 1988, 82, 1202.
- [7] WHO, FAO, IAEA. Trace elements in human health and nutrition. WHO, Geneva 2002.
- [8] Food and Nutrition Board, IOM. Dietary reference intakes of vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon and zinc. Washington DC. National Academy Press, 2002.
- [9] Hotz C, Brown KH. Assessment of the risk of zinc deficiency in populations and options for its control. *Food Nutr Bull* 2004, 25, 99S.
- [10] Lonnerdal B. Dietary factors influencing zinc absorption. *J Nutr* 2000, 130, 1378 S.
- [11] Fosmire GJ. Zinc toxicity. *Am J Clin Nutr* 1990, 51, 225.
- [12] Prasad AS, Brewer GJ, Schoemaker EB, Rabbini P. Hypocupremia induced by zinc therapy in adults. *JAMA* 1978, 240, 2166.
- [13] Chandra RK. Excessive intake of zinc impairs immune responses. *JAMA* 1984, 252, 1443.
- [14] Yadrick MK, Kenney MA, Winterfeldt EA. Iron, copper and zinc status: response to supplementation with zinc or zinc and iron in adult females. *Am J Clin Nutr* 1989, 49, 145.
- [15] Freeland-Graves JH, Friedman BJ, Han WH, Shorey RL, Young R. Effect of zinc supplementation on plasma high-density lipoprotein cholesterol and zinc. *Am J Clin Nutr* 1982, 35, 988.
- [16] Walgravens PA, Hambidge KM. Growth of infants fed a zinc supplemented formula. *Am J Clin Nutr* 1976, 29, 1114.
- [17] Briefel RR, Bialostosky K, Kennedy-Stephenson J, McDowell MA, Ervin RB, Wright JD. Zinc intake of US population: findings from the third National Health and Nutrition Survey 1988-1994. *J Nutr* 2000, 130, 1367S.
- [18] Bhandari N, Mazumder S, Bahl R, Martinez J, Black RE, Bhan MK. Substantial reduction in severe diarrheal morbidity by daily zinc supplementation in young north Indian children. *Pediatrics* 2002, 109, e86.
- [19] Lind T, Lönnerdal B, Stenlund H, Ismail D, Deswandhana R, Ekström EC et al. Community based randomized controlled trial of iron and zinc supplementation in Indonesian infants: interactions between iron and zinc. *Am J Clin Nutr* 2003, 77, 883.