

Effect of Zinc deficiency on Growth and Morbidity in infants

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Abstract: Micro nutrients deficiency is a major problem in women of reproductive age and one of the most important micro nutrient deficiencies in many developing countries is Zinc deficiency. It is estimated that 82% of all pregnant women in the world have Zinc deficiency. Zinc is an important micro nutrient in fetal growth and development. The role of Zinc in pregnancy outcomes has been studied in past few decades and it was observed that serum level of zinc during and prior to pregnancy is crucial for health of mother, growth and development of fetus and optimal pregnancy outcomes. Low serum zinc status of mother is associated with growth retardation, poor congenital development, low birth weight, spontaneous abortion, abnormalities in gene replication, protein and DNA synthesis and also in translation and transcription of DNA. So it has many important roles in gestational and fetal life. The objective of this paper is to review the relationship of maternal serum zinc status and their newborns growth and development and to evaluate the public health importance of maternal zinc status since it is related to the fetal growth and development, health of mother and infants and complications of pregnancy, labor and delivery.

Key words: Micronutrients, congenital, replication, translation, transcription, DNA, synthesis.

I. Introduction

Zinc is an essential micronutrient, present naturally in some foods and also available as a dietary supplement. It involves in various activities of cellular metabolism and required for catalytic activity of approximately 100 enzymes (1) and play a vital role in immune function (2) and cell division (3). It is reported to support normal growth and development of fetus during pregnancy, childhood and adolescence (4). Pregnant women are at increased risk of developing zinc deficiency due to high fetal demand for zinc and likely to suffer health consequences due to zinc deficiency (5,6)

Dietary recommendations of Zinc- WHO has recommended that women should absorb 3 mg of elemental zinc / day, which will converts in to an intake of 15 mg/ day, assuming a bio availability of 20 %.

Studies showed that dietary intake of zinc by pregnant women in many developing countries was 8-14mg/ day (6.2-7 mg/day in Malawian and Brazilian women, United Kingdom 8-14 mg/day), which is below the recommendation for pregnant women that is 15 mg/ day. In adults normal level of serum zinc is considered to be between 10.7-15.3 µmol/litre.(7)

Bioavailability of zinc in the diet is influenced by the food sources as well as other components of the diet that inhibit or promote absorption of zinc in the body. The primary inhibitor of zinc absorption is phytic acid ,present naturally in staple food- cereals, corn and rice.

Risk of Zinc deficiency- Zinc deficiency usually occurs due to inadequate zinc intake or absorption, increased losses of zinc from the body and increased requirements for zinc. All these conditions are obvious to pregnant women. Hence It is most common to the pregnant women. Pregnant women are more susceptible to zinc deficiency, particularly in 2nd and 3rd trimesters. It is so because of increased volume of blood, poor bio-absorption and intake of zinc.(8). It is also associated with iron deficiency anemia.

II. Effects of zinc deficiency on growth and birth weight in LBW and preterm infants

Many observational studies (many in developing countries) showed an association between zinc deficiency and low birth weight.(9) Maternal serum zinc status during pregnancy directly effects fetal growth and infants birth weight. It influence infants growth and morbidity beyond the neonatal period due to its effects on intra uterine growth and development of immune system.(10) It is estimated that in less developed countries where diets low in zinc, are likely to results in zinc deficiency and where the prevalence of low birth weight is high , maternal zinc supplementation showed higher beneficial effects on pregnancy outcomes.

Zinc deficiency during pregnancy could retard fetal growth due to its effects on development of body's immune system. It regulates IGF-1(Immuno globulin F-1) activity in the formation of osteoblast (bone cells) and regulates bone growth.(11) There are about 100 specific enzymes and many hormones which require zinc during pregnancy to play a specific role in growth pathway, especially in last trimester (12) e.g. placental alkaline phosphatase, stimulating DNA synthesis and cell proliferation.(13)

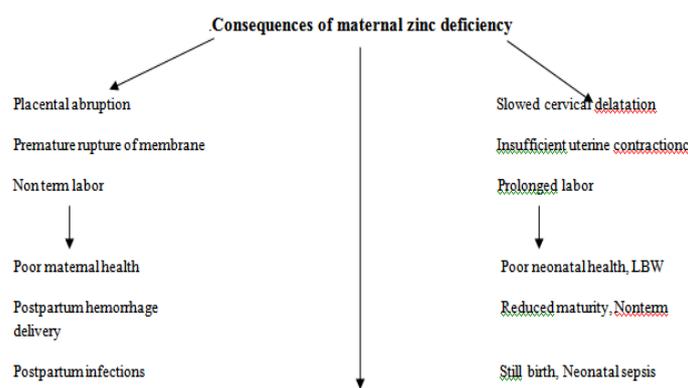
Therso,O.Scholl et.al.(14) reported that low serum status of zinc was associated with approximately two fold increase in risk of low birth weight and preterm birth (Due to rupture of membrane, which precede the onset of labor)

Prasad,A.S. et. al.(15) identified zinc deficiency as an underlying cause of stunting growth and delayed sexual maturation. He reported that zinc deficiency in infants and children was associated not only with reduced growth and development but also impaired immunity and increased morbidity due to infections.

Gerg et.al.(16)reported that after zinc supplementation serum zinc level increased significantly in women and also the birth weight of their children were significantly higher than birth weight of children of women in control group. But this difference is being greater when supplementation was started in 3rd trimester of pregnancy. Also the infants of mothers in zinc treated group had higher gestational age then those in control group.

Ross et.al.(17)reported that women who receives zinc supplements 4-13mg/day delivered babies with low birth weight then control group

Goldenberg et.al(18)reported 126 grams increase in birth weight, 0.6cms in height and 0.4cms in head circumference of infants of mothers who received 25 mg zinc /day. He also reported 37% reduction in incidences of very low birth weight after zinc supplementation.



Effect of zinc status on gestation-

Zinc supplementation during pregnancy may be associated with increase in birth weight in infants and it is reported that it lengthened the average duration of pregnancy by 0.3- 1.0 weeks. Studies reported 18-36% reduction in the incidences of preterm delivery. Kynast and Saling (19) reported an 80 % decrease in incidences of preterm delivery as a result of zinc supplementation.

Effect of zinc deficiency on pregnancy-

Zinc deficiency in pregnancy causes abnormal labor, retarded fetal growth and abnormalities. Findings of some randomized controlled trials indicated potential benefits with regards to neonatal immune system, early neonatal morbidity and infant infection. However data about labor, delivery complications, gestational age at birth and fetal neurodevelopment are conflicting and require more research. A placebo controlled randomized trial showed that infants of mothers who received zinc during pregnancy had reduced risk of diarrhea, dysentery and impetigo. Evidences suggests the enhancing effect of zinc on bioconversion of β - carotene in to vitamin A, thus improving vitamin A status. Addition of zinc to the iron supplements leads to increased zinc concentration in women but did not affect hemoglobin concentration. Multi- vitamin and mineral supplementation in 1st and 2nd trimesters of pregnancy is believed to be associated with two fold reduced risk of low birth weight and preterm delivery but some studies have reported that addition of zinc with Iron/ folate supplements blocked the beneficial effect of these micronutrients on birth weight. However the prenatal supplementation with micro nutrients is proved to be associated with reduced risk of congenital abnormalities , low birth weight, preterm delivery and also with increase concentration of serum micronutrients. Maternal zinc status also effects in utero acquisition of antibodies , determining the role of zinc in placental transport of immune globulins .

Effect of zinc on neuro development

Since zinc is important for enzymatic activity ,involved in replication of cells in brain growth, zinc finger protein in brain structure and neuro transmission, it is an important element for neuro development of fetus and it is also involved in many metabolic activities like hormone transport, receptor binding and production of neuro transmitter precursor.(20)

Effect on labor and delivery complications

Zinc deficiency has been reported to be associated with many complication of labor and delivery like hemorrhage, placental abruption, respiratory distress and prolonged labor. Findings of some studies suggested an impairment in the estrogen dependent gene expression by interfering its function. Since zinc play a role in the production of uterine protein necessary for the conversion of normal uterus for enough contractions so that it expel the fetus. Zinc status of mother also involved in hormonal control of cervical maturation, dilatation and maintenance of fetal and amniotic membrane.(21) Kynast and saling(19) reported a 60% reduction in vaginal bleeding, placental abruption and maternal hemorrhage as a result of zinc supplementation. McMichael et. al.(22) reported a 2 fold increase in the risk of perinatal morbidities due to maternal zinc deficiency.

Effect of zinc on post natal outcomes

Problems occurred due to maternal zinc deficiency not only limited to the fetal life but also occurs in postnatal period since it is important for the transfer of many immunologic substances and vitamin A. Perinatal zinc deficiency may lead to poor development of natural immunity and decreased acquisition of antibodies from mother and adversely affect the proper development of many tissues and organ systems in the fetus(23). It suppress the immune responses and also reported to decrease the size of spleen and thymus, impaired lymphocytic mitogenic responses, plaque forming activities and decreases immunoglobulin M and immunoglobulin A concentration. Since zinc is required as a cofactor for immunoglobulin transport across the placental barrier, the deficiency of zinc during pregnancy may diminish utero acquisition of antibodies by the fetus. Hence zinc deficiency may be a cause of impaired disease resistance, poor immunity and decreased efficiency for vaccine in fetus.

III. Conclusion

The prominent role of zinc in immune system and host defense mechanism reflected from the beneficial effects of zinc supplementation on both prevalence and incidences of diseases in infants and children.

Maternal zinc deficiency during and prior to pregnancy has been related to adverse pregnancy outcomes and maternal zinc supplementation has a beneficial effect on neonatal immune status, early neonatal morbidity and infections. It is therefore concluded that reduction in morbidity observed in supplementation trials is the result of improved immunity, developed during gestation. However early zinc supplementation in low birth weight or SGA(small for gestational age) infants reveals an effective improvement in growth, which indicate a prenatal insufficiency of zinc and suggest zinc intake to support and catch up growth postnatally. There is a need to carry out more researches to determine the benefits of large scale introduction of zinc supplementation to pregnant women. It was concluded that Maternal zinc supplementation not only stimulate intra uterine growth alone but statistically significant effects of zinc on growth, height and weight increase is also expected to make a substantial contribution to infants growth.

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