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IMPORTANCE OF TRACE ELEMENTS IN FOETUS DEVELOPMENT AND POSITIVE OUTCOME OF PREGNANCY

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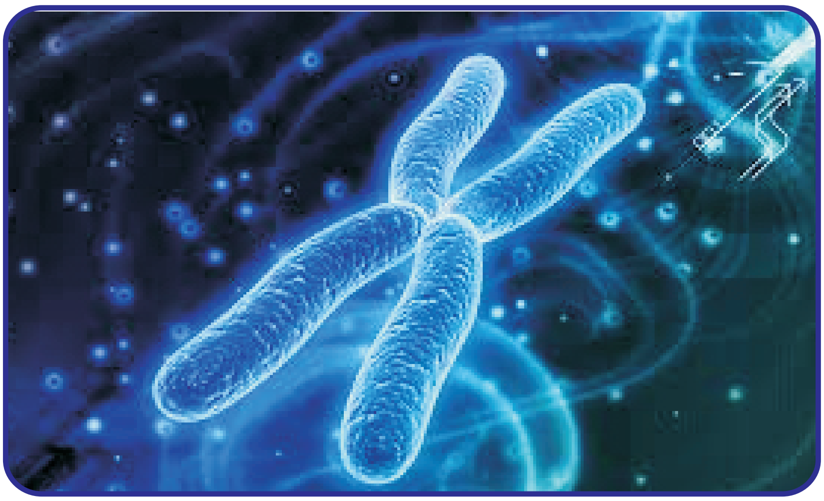
ABSTRACT

Trace elements viz. zinc, selenium, choline and DHA were found to have very important function in the growth and development of the foetus. Zinc is specifically required for the production of rapid cell growth, implantation of the embryo and organ formation, repair and functioning of the immune system and heal wounds in the time of pregnancy. Selenium has the most important role in conception and fertility. It is a constituent of selenoproteins exhibits anti-inflammatory activities. It stimulates the immune system and acts antagonistically to such heavy metals. Lower selenium concentration in the follicular fluid of women may develop infertility. It also has antioxidative activity in the follicular micro environment which play a certain role in the process of gametogenesis and fertilization. Choline is a nutrient precursor to a neurotransmitter Acetyl-choline, which plays an important role in memory, in methylation and stress management. Consumption of choline during pregnancy may also protect the baby later in life from mental health conditions, high blood pressure and type 2 diabetes. During this time, the demand is high for sphingomyelin which is made from choline, it is used to insulate nerve fibres. So it is especially useful for Neural Tube Defects (NTD) prevention. DHA (Docosahexaenoic Acid) also reduces the level of maternal depression , helps in foetus brain growth and better visual acuity. Deficiency of these nutrients during pregnancy has been associated with risk of premature birth and a very low birth weight baby. Trace elements play a crucial role for healthy foetus development and therefore they should be given sufficient emphasis while planning the diet during pregnancy.



KEY WORDS: Trace elements, zinc, selenium, choline, DHA, foetus development

INTRODUCTION:

Pregnancy is a physiological condition of enhanced demand for various nutrients. It is a period of increased metabolic demands with changes in a women's physiology and the requirements of a growing foetus (Pipkin, 2007). The importance of proper nutrition prior to and throughout pregnancy has long been known for optimising the health and well-being of both mother and baby (Allen, 2005). Insufficient supplies of essential vitamins and micronutrients can lead to a state of biological competition between the mother and foetus, which can be detrimental to the health status of both (King, 2003). Trace element deficiencies have been played an important role in determination of the foetal as well as mother health. Trace elements are well known to play an important role in the maintenance of health of both the mother and foetus. Alterations in maternal–foetal disposition of some essential trace elements could be a potential health risk for the mother as well as the foetus. Vitamins, minerals and essential fatty acid derived from fat (DHA) collectively referred to as micronutrients have important influence on the health of pregnant women and the growing foetus. Deficiencies of trace elements like zinc, selenium, choline and DHA have been implicated in various reproductive events like infertility, pregnancy wastage, congenital anomalies, placental abruption, premature rupture of membranes, still births and low birth weight (Priyali, 2004). Deficiency of trace elements during pregnancy is closely related to mortality and morbidity in the new born (Srivastava et.al, 2002). Deficiencies can exist because of losses or malabsorption associated with disease or inadequate intakes, lack of knowledge about adequate prenatal nutrition, or dietary taboos associated with pregnancy (Thapa, 1997). Deficiencies of mineral elements and vitamins in this period may contribute to the occurrence of prenatal complications, foetus necrobiosis, congenital organ defects in the child and impairment of the immune system functioning in a foetus (Black, 2001) .Thus, the demand for both energy and nutrients is increased during pregnancy (Picciano, 1996).

Zinc

Zinc is an essential micronutrient of over 200 metalloenzymes that participate in carbohydrate and protein metabolism, nucleic acid synthesis and other vital functions like required for cellular division and differentiation, and is an essential nutrient for normal embryogenesis (Izquierdo, 2007). Zinc is a trace element with a great importance for intrauterine growth and it is used during pregnancy in order to improve foetal growth. During pregnancy, zinc is used to assist the foetus to develop the brain and also to be an aid to the mother in labour (Uriu-Adams, 2010). It has been estimated that the total amount of zinc retained during pregnancy is ~ 100mg (Swanson, 1987). Since all these are involved in cell division and growth, zinc is believed to be important for foetal growth and development. It has recently been shown to play an essential role in p~l~nucleotide transcription and translation and thus in the processes of genetic expression. Its involvement in such fundamental activities probably accounts for the essentiality of zinc for all forms of life (WHO, 1996).

The total amount of zinc retained during pregnancy in the foetus, placental tissue, amniotic fluid, uterine and mammary tissue and maternal blood has been estimated to be 100 mg (Geigy, 1984 and Swanson, 1987). Zinc is also well-known for its benefits to the immune system, helping to protect against infections and heal wounds (Wellinghausen, 2001) and aids in the metabolising of other vital nutrients. Zinc helps in keeping the foetus brain healthy. An adequate supply of zinc during pregnancy has various benefits for your baby, besides normal growth. High concentrations of zinc in the brain, is important for normal brain function, which contributes to all future learning and development in the foetus (Blackwell, 2013). It also helps to build a robust immune system by helping to maintain a healthy amount of antibodies (Wellinghausen, 2001).

Wholegrain bread, fortified cereals, Well-cooked oysters and shellfish, red meat such as beef as well as poultry, especially turkey, oatmeal, nuts, beans and soya, dairy products and eggs and corn also provide zinc, but the phytates they contain can inhibit the absorption of zinc from other foods. To maximise your intake from other sources, avoid eating these foods at the same time. Preliminary human data suggest a beneficial effect of prenatal zinc supplementation trials in particular on infant's neurobehavioral development. In the light of the currently available information, zinc supplementation at therapeutic load (30 mg/day) as it is proposed for the treatment of hormonal skin disorders to adolescents, cannot be toxic (Favier, 2005).

Selenium

Selenium is an essential trace element of importance to human biology and health. It is also a constituent of the active centre of glutathione peroxidase that protects cellular membranes against the adverse effects of H_2O_2 lipid peroxides. This mineral plays an important role in normal growth and reproduction in humans. Selenium has the most important role in conception and fertility. It is a constituent of selenoproteins exhibits anti-inflammatory activities. It stimulates the immune system and acts antagonistically to such heavy metals. Lower selenium concentration in the follicular fluid of women may develop infertility. It also has antioxidative activity in the follicular micro environment which plays a certain role in the process of gametogenesis and fertilization. Selenium plays a significant role in the undisturbed functioning of the reproductive system. It has addressed correlations between its intake and fertility as well as disorders of procreation processes. Selenium deficiencies may lead to gestational complications, miscarriages and the damaging of the nervous and immune systems of the foetus. A low concentration of selenium in blood serum in the early stage of pregnancy has been proved to be a predictor of low birth weight of a newborn(Pieczyńska and Grajeta , 2015).Selenium functions as a redox centre, for instance when the selenoenzyme, thioredoxin reductase reduces nucleotides in DNA synthesis and helps control the intracellular redox state,(Allan,1999) this helps to maintain membrane integrity(Nève ,1996) protects prostacyclin production and reduces the likelihood of propagation of further oxidative damage to biomolecules such as lipids, lipoproteins and DNA (Diplock and ,1994).

Selenium has long been recognised as being essential for successful reproduction (Underwood, 1997). Idiopathic miscarriage has been shown to be associated with Se deficiency in veterinary practice (Stuart, 1982). While in sheep, administration of Se supplements has been shown to prevent early pregnancy loss (Hidiroglou, 1979). Investigating whether this could also be relevant to humans, it was found significantly lower serum Se in women who suffered either first-trimester or recurrent miscarriages (Barrington, 1997). The early pregnancy loss may be linked to reduced antioxidant protection of biological membranes and DNA by relatively low levels of the Se-dependent glutathione peroxidase. A subsequent study found lower Se levels in non-pregnant women suffering recurrent miscarriage than in controls, but the difference did not reach significance (Nicoll, 1999).However, the choice of control group can be criticised in this study as it did not exclude women who had suffered a miscarriage.

In both humans and animals, final selenium status of the offspring reflects that of the mother (Lombeck, et al. and Mitchell,1996). Selenium absorption in the diet is high (about 70%), so there is little scope for regulation at gut level and consequently, the developing foetus is very dependent on dietary supply or maternal stores. The dietary supply may be the more important factor. In women with a high selenium status, there was an increase in blood glutathione peroxidase activity during pregnancy of about 25% (glutathione peroxidase is a seleno-enzyme). In contrast, in women from a low selenium environment, there was a decrease in glutathione peroxidase levels (Whanger,1998).

Choline

Choline is an essential nutrient that is required to make phosphatidylcholine, a component of all cell membranes. It is an important nutrient that helps brain cells develop properly and particularly important during the neonatal period because it changes brain development. The brain function changed, resulting in lifelong enhancement of memory and attention . It is critical during foetal development, when it influences stem cell proliferation and apoptosis, thereby altering brain and spinal cord structure and function and influencing risk for neural tube defects and lifelong memory function(Zeisel, 1994). Choline is a nutrient precursor to a neurotransmitter Acetyl-choline, which plays an important role in memory, in methylation and stress management. Consumption of choline during pregnancy may also protect the baby later in life from mental health conditions, high blood pressure and type 2 diabetes. During this time, the demand is high for sphingomyelin which is made from choline, it is used to insulate nerve fibres. So it is especially useful for Neural Tube Defects (NTD) prevention.

Choline or its metabolites, are needed for the structural integrity and signalling functions of cell membranes; it is the major source of methyl-groups in the diet (one of choline's metabolites, betaine, participates in the methylation of homocysteine to form methionine), and it directly affects cholinergic neurotransmission, transmembrane signalling and lipid transport/metabolism (Zeisel, 1994).

Pregnancy and lactation are times when demand for choline is especially high; transport of choline from mother to foetus (Sweiry, 1986) depletes maternal plasma choline in humans (McMahon, 1985). During pregnancy and lactation mothers export large amounts of choline to the foetus or baby. This depletes maternal stores of choline (Sweiry, 1986) as reflected by maternal plasma choline concentrations(McMahon,1985). Thus, despite enhanced capacity to synthesize choline, the demand for this nutrient is so high that stores are depleted. But, it is fortunate that estrogens induces the capacity to form choline in liver as even with this extra capacity maternal choline stores are depleted.0 Genetic variations that increase susceptibility to choline deficiency (and that occur in half the population) might be important for identifying women who need more dietary choline during pregnancy and lactation (Shaw,et.al,2004).

Choline is critical during foetal development, when it influences brain stem cell proliferation and apoptosis (cell suicide), thereby altering brain and spinal cord structure and function. Choline availability to the foetus also permanently influences memory function. At least in part, this effect of choline on brain development is mediated by altering the on-off switches that control genes (epigenetic changes involving DNA methylation). In adults deprived of dietary choline, fatty liver, liver cell death and muscle cell death (rhabdomyolysis) ensues (Zeisel, 1994).

Finally, the benefits of choline are not restricted to just pregnant women. Brain development continues in humans from 25 weeks gestation through years after birth. Stem cells are even dividing in middle-aged brains. Though there is a critical period in early development in which lack of choline cannot be made up, choline intake may have some (though smaller) effect on brain throughout a person's lifetime. In addition, adults need choline for normal liver and muscle function. Therefore, everyone should aim for a diet with great variety that includes foods rich in choline. (Zeisel, 1994).

Decosahexaenoic acid (DHA)

The most biologically active omega-3 fatty acids are eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Both have been shown to have multiple beneficial effects, including improving childhood development when ingested during pregnancy (Jensen, 2006). DHA accumulates both prenatal and postnatal in infant brain, eye and nervous system tissue. Developing infants cannot efficiently produce their own DHA and must obtain this vital nutrient through the placenta during pregnancy and from breast milk following birth. DHA is important throughout pregnancy, particularly in the third trimester when major brain optimal infant brain and eye development occurs. Increasing DHA intake during pregnancy and nursing significantly enhances the level of DHA available to the foetus and infant. Supplementation of DHA in the mother's diet improves infant developmental outcomes, such as eye-hand coordination, motor skills and attention span. DHA has also been shown to play a part in maternal well-being and can increase the length of pregnancy by six days helping mothers carry to a healthy or full term.

As awareness of the importance of DHA grows, more attention is being paid to the fact that pregnant and breastfeeding women may benefit from getting more DHA in their diets. In fact, the EFSA Scientific Panel recommends that pregnant and nursing women should consume an additional 100-200 mg DHA daily in addition to the 250 mg omega-3 intake recommended by EFSA for adults.

To optimize pregnancy outcomes and foetal health, consensus guidelines have recommended that pregnant women consume at least 200 mg of DHA per day (Koletzko, 2008). A woman can achieve this threshold by consuming 1 to 2 servings of seafood per week, dietary intake that is consistent with the current US Food and Drug Administration (FDA) and Environmental Protection Agency (EPA) advisory (US Food and Drug Administration, 2010). The best sources of DHA are: seafood, algae, salmon, sardines, and tuna, Eggs and organ meats. The healthiest source of dietary DHA is seafood. Besides fish oils, vegetable oils (primarily flaxseed, soy, and canola) are also rich sources of omega 3 fatty acids, with flaxseed oil being the best. The two F's, fish and flax, are the top brain-building foods for growing children, and adults. Those who eat little or no fish each day should take a DHA supplement, especially during pregnancy and lactation.

DHA is important throughout pregnancy, particularly in the third trimester when major brain growth occurs. DHA has also been shown to play a part in maternal well-being. Studies show that supplementation of DHA in the mother's diet can increase the length of pregnancy by six days helping mothers carry to a healthy or full term.

Inadequate DHA during early development decreases DHA in the brain and retina, impairs neurogenesis and visual function, and results in long-term deficits in neurotransmitter metabolism and visual function in animals (Chalon, 2006). More recently, it has become clear that maternal to foetal transfer of DHA during gestation is influenced by the maternal circulating and dietary intake of DHA (Innis , 2005). Thus, attention has turned to consider whether low DHA intakes in pregnant women may contribute to poor infant CNS development (Hibbeln, 2007). However, the extent of DHA deficiency, if present, biochemical cut-offs for circulating DHA, dietary intakes, or infant visual or other developmental scores indicative of inadequate maternal DHA status to support optimal infant development are not known.

Conclusion-

Trace elements play a crucial role for healthy foetus development and positive outcome of pregnancy. Trace elements viz. zinc, selenium, choline and DHA are especially important during pregnancy. Deficiency of these particular elements in the body during pregnancy has been associated with risk of premature birth, still birth and a very low birth weight baby. Sufficient amount of dietary intake of these essential trace elements can be ensured by taking balanced diet during pregnancy.

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