EXPERT OPINION

Impact of Protein Deficiency on Reproductive Health

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Reproductive health is vital for the survival of any sexually reproducing organism[1]. The human reproductive system is a complex network of physiological processes that requires a balanced diet to function correctly. In particular, an unbalanced diet deficient in protein can harm the safety and efficiency of gametes and their implantation[1]. Nutrition is, therefore, a crucial factor affecting reproductive health in both men and women[1].

Moreover, nutritional factors influence not only oocyte maturation but also the quality of embryos and the efficiency of implantation[1].

EFFECTS OF PROTEIN DEFICIENCY IN VARIOUS STAGES OF LIFE

Effect of Protein Deficiency in Adolescent Girls

Protein undernutrition can cause stunted growth, anemia, physical weakness, and edema in adolescents[2]. The primordial follicle pool is built up at the early stage of development and is, therefore, vulnerable to any nutritional deficiency[2]. Therefore, reproductive maturation and capabilities depend on early-life events. Previous reports from clinical and experimental studies have indicated that early-life problem is associated with a decline in ovarian follicular reserve, changes in ovulation rates and altered age at the onset of puberty. Delayed puberty again can have long-lasting effects on fertility and pregnancy outcomes[2].

Effects of Protein Deficiency in Perinatal Period

The nourishment of a pregnant mother, specifically her dietary protein consumption, is a crucial element that determines the embryo's survival, growth and development[3]. Inadequate dietary protein intake may lead to embryo loss, intrauterine growth restriction (IUGR), birth defects, preterm birth, pre-eclampsia and eclampsia due to the absence of specific amino acids essential for cellular metabolism and function[3].

Perinatal exposure to a protein-deficient diet and mother/child malnutrition during the critical developmental period can lead to certain life-long psychopathological changes and increased susceptibility to dysfunction that underlies most origins of health defects and disease[2]. Protein malnutrition during the perinatal period can program the offspring's sexual maturity through epigenetic factors[2].

Effects of Protein Deficiency in the Postnatal Period

Maternal deficiency of proteins has negative effects both on mother and child, like- reduced postnatal growth and feed efficiency, impaired offspring growth and development, maternal insulin resistance, cretinism, cognitive and behavioral defects, postpartum complications, anemia, maternal hemorrhaging, etc[3].

Furthermore, low maternal dietary protein intake causes the greatest abdominal adiposity in fetuses[3]. IUGR increases neonatal mortality, and surviving IUGR infants experience an increased risk of developing metabolic disorders, hormonal imbalances, abnormal development and cardiovascular disorders into adulthood[3].

ROLE OF PROTEIN IN VARIOUS REPRODUCTIVE FUNCTIONS

Role of Proteins in PCOS

The amount of protein consumption may affect the ovulatory function or women's fertility[1]. Protein intake is known to deregulate steroidogenesis in women affected by polycystic ovary syndrome (PCOS), likely by reducing hyperinsulinemia[1].

A study conducted by Mumford et al found that a protein-rich diet was significantly associated with lower testosterone levels in healthy women[1]. In another study by Chavarro et al, the consumption of vegetable proteins was associated with a lower risk of ovulatory infertility in healthy women[1].

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Role of Proteins in Pubertal Hormone Profile

Puberty and ovulation depend on the hypothalamic-pituitary-gonadal axis, and any interference with luteinizing hormone (LH) and follicle-stimulating hormone (FSH) can delay ovulation and puberty[2]. Protein deficiency can disrupt LH and FSH periodic surges, resulting in increased cystic and antral follicles and decreased corpora lutea. These hormonal modulation disruptions may also contribute to reproductive failures and ovarian dysfunctions[2].

Role of Proteins in Ovarian Morphology and Function

Proper ovarian functioning is critical to maintaining reproductive status and overall health[2]. The development of follicles at different stages, particularly the transition of primordial follicles into primary follicles, is critical to normal ovulation physiology. Protein deficiency leads to abnormalities in primordial transition, causing pathological conditions such as ovarian failure[2]. Ovarian morphometric analysis has shown decreased primary follicles, increased primordial follicles, decreased corpora lutea and increased cystic follicles in protein-deficient groups (which all can cause problems getting pregnant or staying pregnant)[2].

Role of Proteins in Intrauterine Growth and Survival of the Fetus

Protein deficiency during gestation leads to slow growth in fetuses, caused by competition for available nutrients between the mother and fetus, resulting in suboptimal conditions for the fetus. Maternal protein restriction affects fetal development and can lead to IUGR, which impacts the offspring's survival, growth and development[2].

Role of Proteins in the Fetal Genome

Maternal protein nutrition is significant in fetal programming and can alter gene expression in the fetal genome[3]. L-arginine (Arg), an amino acid necessary for synthesizing molecules with metabolic and cell signaling functions, is critical for fetal growth and development during pregnancy. Adding Arg to the diet during pregnancy can improve embryonic survival and conceptus development[3].

Animal studies have shown that maternal undernutrition, particularly deficiencies in protein and amino acids, during early gestation are more harmful than during late gestation. Because the demands of the fetus and mother for nutrients change rapidly, dietary protein and amino acid requirements vary at different stages of gestation[3].

BENEFICIAL INTERVENTIONS

Numerous animal studies regard Arg supplementation to be safe for humans. Studies have shown that dietary Arg supplementation during pregnancy can improve embryonic survival and growth by increasing placental angiogenesis and blood flow and promoting embryonic protein synthesis. A deficiency in Arg can cause preterm labor by stimulating the uterine myometrium due to the reduced bioavailability of nitric oxide (NO). NO deficiency is also linked to pre-eclampsia, which causes proteinuria and high blood pressure in pregnant women[3].

- Adding 3 g of Arg to the diet daily for 4 weeks in women with pre-eclampsia reduces blood pressure, improves fetal health and growth, and also beneficially prolongs pregnancy[3].
- Daily intravenous infusion of 20 g Arg for 7 days during late gestation (Week 33) increases birth weight by 6.4% in IUGR babies[3].
- Furthermore, Arg supplementation decreases placental apoptosis and improves the development of IUGR fetuses[3].

In conclusion, regulating maternal dietary protein intake during pregnancy is crucial to ensure proper embryonic survival, growth and development. The deficiency of specific amino acids due to low maternal dietary protein intake can lead to embryonic loss and impaired growth and development of the conceptus. The resulting IUGR can have long-term adverse effects on the surviving neonate. However, dietary supplementation with amino acids such as Arg and L-glutamine during specific stages of gestation can help overcome the harmful consequences of maternal protein malnutrition.[3] Adequate maternal dietary protein intake can also result in healthier mothers and infants, improving reproductive success. Thus, regulating maternal protein nutrition during pregnancy is vital for the health and well-being of both the mother and offspring[3].

REFERENCES

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