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Maternal age, Immune system activation, & Nutrition and their effect on fetal Development.

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Terms of Reference:
This report is directed to the staff of the BMS faculty & was written for the purpose of fulfilling the request made by our faculty to write a scientific report regarding a related topic to our current learning objectives in the reproductive system block, the report is a summary of a compilation of various research.

Abstract:
The fetal brain is highly plastic and is not only receptive to but requires cues from its intra-uterine environment to develop properly which is affected significantly by the nutritional status of the mother which causes changes in that environment. Furthermore, mothers who smoke or are exposed to tobacco smoke passively gave birth to underweight babies and also increased the risk of them developing mental retardation. The available empirical evidence appears to support the notion that exposure to excess stress in intrauterine life has the potential to adversely affect short- and long-term neurodevelopmental outcomes due the activation of the mother immune system and the effect of the released immune mediators on the fetus.

Introduction:

Fetal growth is exponential and during the last 20 weeks of gestation the fetus gains 95% of its weight. Genetic, nutritional, environmental, and fetal factors have been suggested to influence fetal growth. Those factors can be affected due to smoking, maternal age and nutritional status of the mother. The foundation of the baby's intelligence is being built during the intrauterine life. This stage is very critical because this is where the raw materials of their intelligence and personality are being formed. Fetal brain development has long lasting effect on the baby's personality, future and quality of life.

Objective of the Report:

The main purpose of this report is to review some of the factors the influence fetal brain development particularly smoking, maternal age, immunity & nutritional state.

1. Smoking, maternal age, fetal growth, and gestational age at delivery

Exposure to tobacco smoke, through both active and passive measures, has a significant impact on women's health, including effects on the cardiovascular, pulmonary and reproductive systems. Of particular interest is the effect of smoking on pregnancy outcomes. One crucial outcome that has been linked to the subsequent development of both neonatal and adult disease is intrauterine or fetal growth restriction. The relationship between smoking and maternal age and their combined effects on birth weight, intrauterine growth retardation, and preterm delivery were studied. Smoking lowers birth weight both by decreasing fetal growth and by lowering gestational age at delivery. However, the effect of smoking on both fetal growth and gestational age is significantly greater as maternal age advances. In a multiple logistic regression model adjusting for race, parity, marital status, maternal weight, weight gain, and alcohol use, smoking was associated with a fivefold increased risk of growth retardation in women older than 35 but less than a twofold increased risk in women younger than 17. Smoking reduced birth weight by 134 gm in young women but 301 gm in women older than 35. Smoking in older women also was associated with more instances of preterm delivery and a lower mean gestational age when compared to women 25 or younger.[1]

2. Maternal Nutrition and Fetal Development

Nutrition is the major intrauterine environmental factor that alters expression of the fetal genome and may have lifelong consequences. This phenomenon, termed "fetal programming," has led to the recent theory of "fetal origins of adult disease." Namely, alterations in fetal nutrition and endocrine status may result in developmental adaptations that permanently change the structure, physiology, and metabolism of the offspring, thereby predisposing individuals to metabolic, endocrine, and cardiovascular diseases in adult life. Animal studies show that both maternal undernutrition and overnutrition reduce placental-fetal blood flows and stunt fetal growth. Impaired placental syntheses of nitric oxide (a major vasodilator and angiogenesis factor) and polyamines (key regulators of DNA and protein synthesis) may provide a unified explanation for intrauterine growth retardation in response to the two extremes of nutritional problems with the same pregnancy outcome. There is growing evidence that maternal nutritional status can alter the epigenetic state (stable alterations of gene expression through DNA methylation and histone modifications) of the fetal genome. This may provide a molecular mechanism for the impact of maternal nutrition on both fetal programming and genomic imprinting. Promoting optimal nutrition will not only ensure optimal fetal development but will also reduce the risk of chronic diseases in adults.[2]

3- Activation of maternal immune system.

Many triggers can generate immune responses, such as infections, stress, illness, or allergies. When the body's immune system detects one of these triggers, proteins are released as part of an inflammatory response. Animal studies have shown that some of the proteins released during this response can impact offspring, but little is known about the effect on humans. The current study was designed to determine whether this immune response can impact the developing nervous system of infants. The study recruited young women in their second trimester and involved a blood draw and fetal heart monitoring during the third trimester, anatomical brain scans of the newborns, and cognitive behavioral assessment of the babies at 14 months of age. The ages of the pregnant young women (14 to 19 years) put them at high risk for psychosocial stress and resulting inflammation. This unique, prospective study design allowed to follow babies from a critical point in fetal brain development in utero, through birth, and all the way into toddlerhood. The goal was to examine the possible link between markers of inflammation in the mother's blood with changes in the nervous system of their babies. Blood drawn from mothers during their third trimester was tested for levels of IL-6 and CRP – two proteins that are found at higher levels when the immune system is activated. Fetal heart rate was monitored as an indicator for nervous system development. The team found that CRP did correlate with variability of the fetal heart rate, which is influenced heavily by the nervous system, indicating that maternal inflammation was already beginning to shape brain development. When the babies were born, they were given MRI scans in their first few weeks of life, providing researchers a unique view of early neural development and the influence of prenatal factors. Brain imaging revealed a striking finding – significant changes in the communication between specific brain regions correlated with elevated maternal IL-6 and CRP levels. These brain regions are known collectively as the *salience network,* whose job is to filter stimuli coming into the brain and determine which deserve attention. The correlations of elevated maternal inflammatory markers were not limited to the newborn period but continued to persist into toddlerhood. When the babies turned 14 months of age, researchers assessed them for motor skills, language development, and behavior. Following the established Bayley Scales of Infant and Toddler Development-Third Edition, Peterson found significant changes in the scores of toddlers born to mothers with elevated levels of both IL-6 and CRP.[3]

Conclusion:

In conclusion, while researchers still have much work to do in order to completely understand just how these factors contribute to altered fetal development, these studies represent an important step forward in filling in a missing piece of our understanding. Those studies indicate some of the factors that can be associated with short- and long-term changes in child's development, which will now allow us to identify ways to prevent those effects and ensure children develop in the healthiest possible way beginning in the womb and continuing through later childhood and beyond.

References:

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