ENCYCLOPEDIA
on Early Childhood
Development



# The Effects of Prenatal Stress on Child Behavioural and Cognitive Outcomes Start at the Beginning

**Vivette Glover, MA, PhD, DSc**

Institute of Reproductive and Developmental Biology, Imperial College London, United Kingdom

April 2019, Éd. rév.

## Introduction

The importance of development during the fetal period is well established with regards to the association between the baby's growth in the womb, and later vulnerability to physical disorders such as cardiovascular disease and other aspects of *metabolic syndrome*.[1] It is now clear that environmental effects on fetal development are important with respect to emotional, behavioural and cognitive outcomes too. Animal studies have shown that stress during pregnancy can have long lasting effects on the neurodevelopment of the offspring.[2]

## Subject and Research Context

Many groups around the world are studying how the emotional state of the mother during pregnancy can have long-lasting effects on the psychological development of her child.[3-4] Some are using large population cohorts, which have the advantage of being able to statistically allow

for many confounding factors including postnatal maternal mood.[5] Others are smaller observational studies which can examine the child in more detail.[6] Stress is a generic term which includes anxiety and depression, but also includes distress due to poor relationships or the response to an acute disaster. All these have been shown to be associated with altered outcome for the child.

**Key Research Questions**

What type and degree of prenatal stress have an effect on the fetus and the child? What are the gestational ages of vulnerability for different outcomes? What are the range of effects on the child and how long do they last? How does prenatal stress interact with genetic vulnerabilities? How are the effects of prenatal stress moderated by the nature of the postnatal care. How do outcomes vary with different ethnic groups and in different parts of the world?[7]

**Recent Research Results**

Many independent prospective studies have now shown that if a mother is stressed, anxious or depressed while pregnant, her child is at increased risk for having a range of problems, including emotional problems, ADHD, conduct disorder and impaired cognitive development. Both altered brain structure[8] and function[9] have been shown to be associated with prenatal stress, and also the mother's experience of early childhood trauma.[10] While genetic transmission and the quality of postnatal care are likely to contribute to some of these findings of association, there is good evidence that there is a causal influence of the mother's emotional state while pregnant also. Some studies have found stronger associations with prenatal maternal mood than paternal.[11] Several large cohort studies have found associations independent of possible confounding factors, such as birthweight, gestational age, maternal education, smoking, alcohol consumption, and most importantly, postnatal anxiety and depression.[5] Thus, although the mother's postnatal emotional state and the quality of early postnatal care are clearly important for many of these outcomes, the evidence suggests that there are substantial prenatal effects also.

We have shown that, within a normal population, the children of the most anxious mothers during pregnancy (top 15%), had double the risk of emotional or behavioural problems, compared with the children of the less anxious mothers.[5] Most children were not affected, and those that were, were affected in different ways. However a doubling of risk is of considerable clinical significance. Several studies are finding that boys and girls can be affected in different ways.3 There are gene

environment interactions too, in that a child with a specific genetic vulnerability is more likely to be affected in a particular way.[12]

It is clear that it is not just toxic or extreme prenatal stress that are important, as several studies have shown that problems such as daily hassles, pregnancy specific anxiety or relationship strain[6] can have an adverse effect on the developing fetus. Effects of acute disasters such as 9/11[13] have also been demonstrated. Different studies have shown different gestational ages of vulnerability. This may vary for different outcomes. Increased vulnerability to schizophrenia has been found to be associated with extreme stress in the first trimester.[14] The risk for other outcomes, such as ADHD, has been found to be associated with stress later in pregnancy.[5]

The mechanisms underlying all this are just starting to be understood; altered function of the placenta, allowing more of the stress hormone cortisol to pass through to the fetus, may well be important,[15] as may the function of the maternal immune system.[16]

**Research Gaps**

It has been suggested that a small degree of stress is actually beneficial for child outcome, as DiPietro has shown for motor and cognitive development.[17] It may be that different outcomes are affected in different ways; for example prenatal stress may cause both a more rapid physical development and more anxiety in the child.[4] Much remains to be understood about what types of stress, and at what level, stress has effects on the developing fetus. We know little about the effects of different types of work stress during pregnancy. We need to know more about gestational ages of vulnerability for different outcomes. There are research gaps in our understanding of the contribution and interactions between prenatal stress and the genetic vulnerabilities of both mother and child. We also need to know more about to what extent, and at what times, it is possible for sensitive postnatal care to counteract the effects of prenatal stress.

**Conclusions**

Maternal stress during pregnancy increases the risk of the child having a range of altered neurodevelopmental outcomes. The stress can be of different types, and at least for some outcomes, there seems to be a linear dose response effect. Not all children are affected, and those that are, are affected in different ways. The gestational age of vulnerability probably differs for different outcomes. It is of interest to view all this in terms of our evolutionary history. In a stressful environment it may have been adaptive for our ancestors to have children who were

more vigilant (anxious) or with readily distracted attention (ADHD), and possibly with more rapid motor development. But in our modern world several of these changes can be maladaptive,  and cause problems for the child and their family.

## Implications for Parents, Services and Policy

The implications of this research are that if we want the best outcomes for our children we need to provide the best possible emotional care for pregnant women. There needs to be more public health education about this issue, and pregnant women encouraged both to look after themselves emotionally, and to seek help if needed. At present most anxiety and depression in pregnant women is undetected and untreated. We need to make sure that pregnant women are sensitively questioned when they first come into contact with health professionals about their emotional history and current state. It is important to note that it is not just diagnosable disorders that can affect fetal development, but a range of symptoms of stress, anxiety and depression, including a poor relationship with the partner. Appropriate personalized help should be instituted for each woman. This has the potential to prevent a range of neurodevelopmental problems arising in a clinically-significant proportion of children.

**References**


1. Barker DJ. The developmental origins of adult disease. *European Journal of Epidemiology* 2003;18(8):733-6.
2. Weinstock M. The potential influence of maternal stress hormones on development and mental health of the offspring. *Brain, Behavior, and Immunity* 2005;19(4):296-308.
3. Van den Bergh BRH, van den Heuvel MI, Lahti M, Braeken M, de Rooij SR, Entringer S, Hoyer D, Roseboom T, Räikkönen K, King S, Schwab M. Prenatal developmental origins of behavior and mental health: the influence of maternal stress in pregnancy. *Neuroscience and biobehavioral reviews*. 2017. doi: 10.1016/j.neubiorev.2017.07.003. [Epub ahead of print]
4. Monk C, Lugo-Candelas C, Trumpff C. Prenatal developmental origins of future psychopathology: mechanisms and pathways. *Annual Review of Clinical Psychology*. 2019. doi:10.1146/annurev-clinpsy-050718-095539. [Epub ahead of print]
5. O'Donnell KJ, Glover V, Barker ED, O'Connor TG.The persisting effect of maternal mood in pregnancy on childhood psychopathology. *Developmental Psychopathology*. 2014;26(2):393-403.
6. Bergman K, Sarkar P, Glover V, O'Connor TG Maternal stress during pregnancy predicts cognitive ability and fearfulness in infancy. *Journal of the American Academy of Child and Adolescent Psychiatry.* 2007;46(11):1454-1463.
7. Glover V, O'Donnell KJ, O'Connor TG, Fisher J. Prenatal maternal stress, fetal programming, and mechanisms underlying later psychopathology-A global perspective. Dev Psychopathol, 2018. 30(3): p. 843-854.
8. Buss C, Davis EP, Muftuler LT, Head K, Sandman CA. High pregnancy anxiety during mid-gestation is associated with decreased gray matter density in 6-9-year-old children. *Psychoneuroendocrinology.* 2010;35(1):141-53.
9. Mennes M, Van den Bergh B, Lagae L, Stiers P. Developmental brain alterations in 17 year old boys are related to antenatal maternal anxiety. *Clinical Neurophysiology.* 2009;120(6):1116-1122.

10. Moog NK, Entringer S, Rasmussen JM, Styner M, Gilmore JH, Kathmann N, Heim CM, Wadhwa PD, Buss C. Intergenerational effect of maternal exposure to childhood maltreatment on newborn brain anatomy. *Biological Psychiatry.* 2018;83(2):120-127.

11. Capron LE, Glover V, Pearson RM, Evans J, O'Connor TG, Stein A, Murphy SE, Ramchandani PG. Associations of maternal and paternal antenatal mood with offspring anxiety disorder at age 18 years. *Journal of Affective Disorders.* 2015;187:20-26.

12. O'Donnell KJ, Glover V, Lahti J, Lahti M, Edgar RD, Räikkönen K, O'Connor TG. Maternal prenatal anxiety and child COMT genotype predict working memory and symptoms of ADHD. *PLoS One.* 2017;12(6):e0177506.

13. Yehuda R, Engel SM, Brand SR, Seckl J, Marcus SM, Berkowitz GS. Transgenerational effects of posttraumatic stress disorder in babies of mothers exposed to the World Trade Center attacks during pregnancy. *Journal of Clinical Endocrinology and Metabolism.* 2005;90(7):4115-4118.

14. Khashan AS, Abel KM, McNamee R, Pedersen MG, Webb RT, Baker PN, Kenny LC, Mortensen PB Higher risk of offspring schizophrenia following antenatal maternal exposure to severe adverse life events. *Archives of General Psychiatry*. 2008;65(2):146-152.

15. O'Donnell KJ, Bugge Jensen A, Freeman L, Khalife N, O'Connor TG, Glover V. Maternal prenatal anxiety and downregulation of placental 11beta-HSD2. *Psychoneuroendocrinology*, 2012;37(6):818-826.

16. Rasmussen JM, Graham AM, Entringer S, Gilmore JH, Styner M, Fair DA, Wadhwa PD, Buss C. Maternal Interleukin-6 concentration during pregnancy is associated with variation in frontolimbic white matter and cognitive development in early life. *Neuroimage*, 2019;185:825-835.

17. DiPietro JA, Novak MF, Costigan KA, Atella LD, Reusing SP., Maternal psychological distress during pregnancy in relation to child development at age two. *Child Development*. 2006;77(3):573-587.