There is convincing evidence that maternal stress, depression and anxiety have negative programming effects on fetal neurodevelopment and birth outcomes but the mechanisms are not well defined. The autonomic nervous system (ANS) regulates maternal physiologic reactions to unpleasant conditions or perceived threat or by altering sympathetic and parasympathetic input but there is limited evidence that the fetus responds to maternal emotional or autonomic state in real-time.

Specific Aim: To determine if maternal autonomic reactivity induces a similar response in the fetus. If confirmed, the results would support a model of in utero programming, suggest underlying mechanisms by which maternal stress affects child outcomes, and support early assessment and interventions for maternal mental health.

Methodology

Simultaneous maternal-fetal biomagnetometry was recorded and subjected to independent component analysis (ICA) to extract and separate maternal and fetal MCGs and other fetal signals, e.g., breathing movements, Figure 1, right. The MCGs were processed in Kubios software to calculate metrics of heart rate (HR) and variability (HRV) in time, frequency, and nonlinear domains. Time-frequency plots were used to assess maternal and fetal autonomic reactivity.

Results

Examples of Maternal-Fetal HR Change from Baseline While Viewing

To calculate the change induced by viewing the stimuli, the mean maternal and fetal HR of each picture category was subtracted from mean baseline HR. (Fig. 4) If the fetus reacts to maternal ANS response, we expect to see similar patterns in HR and HRV at the gestational age tested (30-32 weeks). We do not expect to see the type of parasympathetic-sympathetic interaction in the fetus as we see in the mother. The parasympathetic system begins to exert influence on fetal HR and HRV at the gestational age tested (30-32 weeks). However, the ANS in the fetus, infant and child is dominated by the sympathetic system.

Conclusion

These data establish a link between maternal and fetal ANS reactivity that occurs while women view pictures designed to evoke emotional responses. These data support our hypothesis and suggest that maternal emotion and physiologic reactions related to stress, depression, anxiety and threat may have a direct effect on the autonomic reactivity and neurodevelopment of the fetus.

Simultaneous maternal-fetal biomagnetometry and use of metrics to characterize autonomic reactivity and fetal neurobehaviors may identify at-risk patients and could lead to a better understanding of underlying physiologic mechanisms that lead to poor fetal and infant outcomes. Multidisciplinary research is needed to understand biological, psychological and social risk factors. Interventions should begin early in gestation and include long-term follow up in order to benefit women and the next generation.

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