

Blunted Autonomic Adaptation in Preeclampsia: A Prospective Digital Biomarker Study

Marie-Louise Meng,^{1,2} Alana Davidson,³ Emma Peek,³ Ashraf Habib,² Jerome Federspiel,⁴ Matthew Fuller,² Andre Diedrich^{5,6}

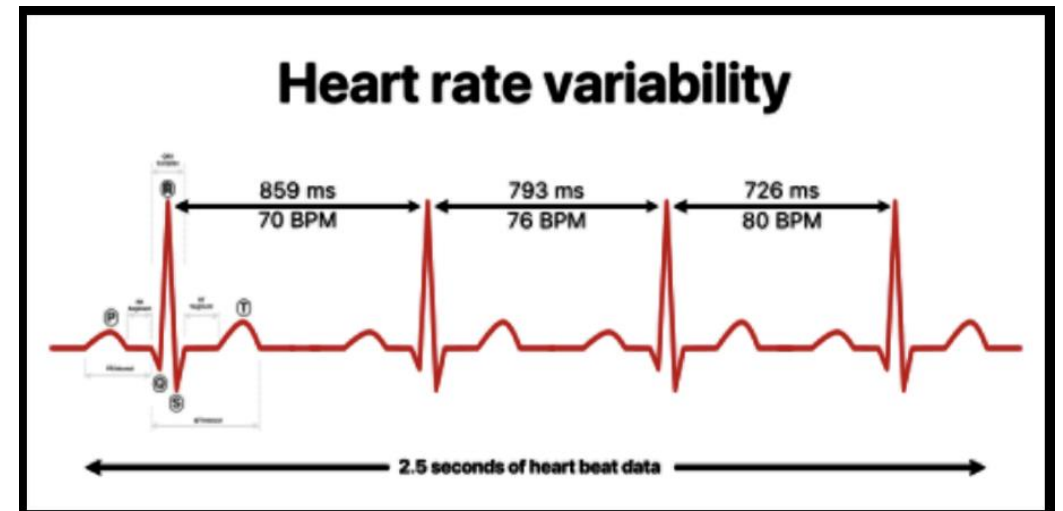
1. Department of Anesthesiology, Vanderbilt University Medical Center, Nashville, Tennessee, 2. Department of Anesthesiology, Duke University Medical Center North Carolina, 3. Duke University School of Medicine, Durham, North Carolina, 4. Department of Obstetrics and Gynecology, Duke University Medical Center North Carolina, 5. Vanderbilt Autonomic Dysfunction Center, Department of Medicine, Division of Genetic Medicine and Clinical Pharmacology, Vanderbilt University Medical Center, Nashville, Tennessee, 6. Department of Biomedical Engineering, Vanderbilt University, Nashville

Background

- Heart rate variability (HRV) is the variation in time between heartbeats
- Higher HRV is associated with autonomic and overall health
- Lower HRV is associated with low vagal activity
- Pregnancy: sympathetic predominance that normalizes postpartum
- HRV patterns in pregnancy are not well defined, and the relationship between sympathetic predominance over cardio-vagal modulation on HRV and preeclampsia (PreE) is unclear

Hypothesis

- Cardio-vagal HRV is lower in pregnant and postpartum patients with cardiovascular disease (CVD) risk factors compared with those without risk factors, and lower in those who develop PreE



Study Design and Methods

Study Design

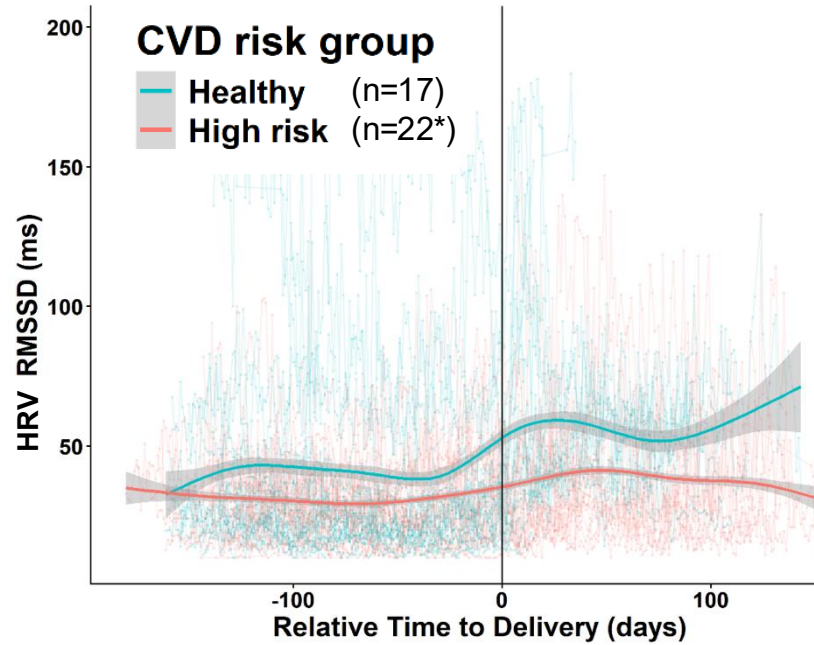
- Prospective, observational study using Oura Ring wearable digital health device
- Enrolled birthing people at 10–16 weeks' gestation until two weeks postpartum
- Two groups:
 - Healthy (n=17)
 - CVD risk factors (n=22)
 - Prior PreE
 - Hypertension
 - Obesity
 - Diabetes
- Stratified by development of PreE per ACOG criteria

Methods

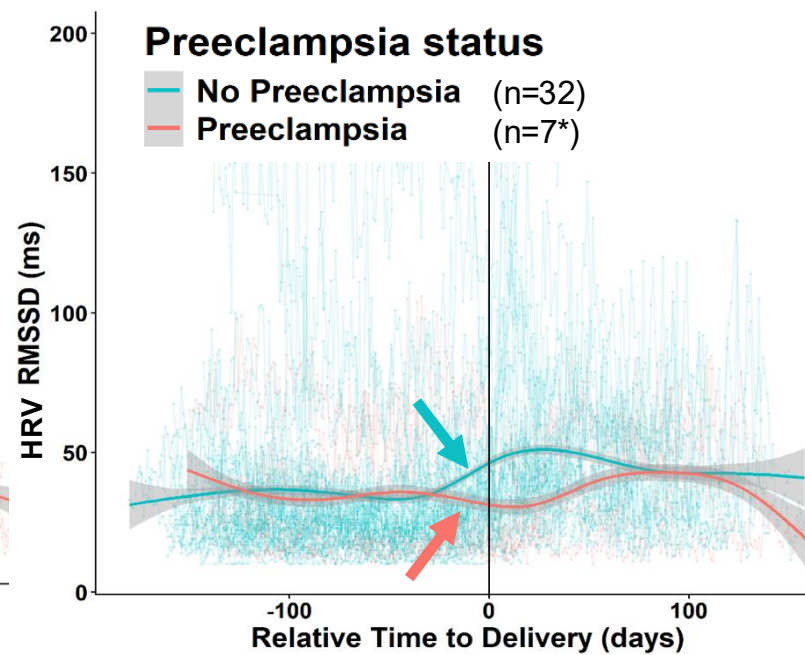
- HRV by Root Mean Square of Successive Differences (RMSSD), calculated from sleep using continuous recordings from the Oura Ring
- HRV trajectories of weekly averaged RMSSD (values ≥ 10 ms) in pregnancy and postpartum were examined by CVD risk status and PreE development

Results: HRV trajectories through pregnancy and postpartum

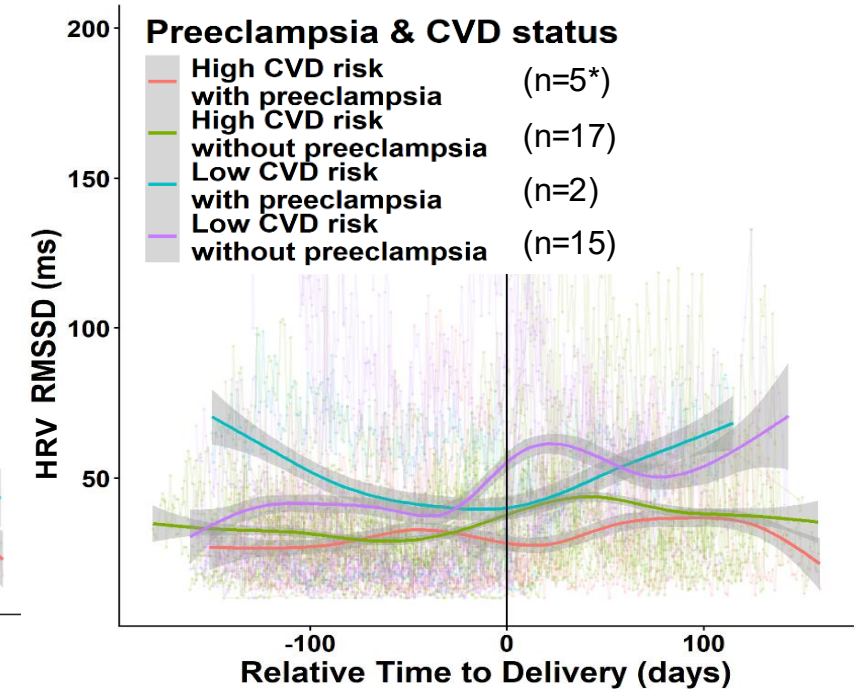
*one outlier removed



Panel A



Panel B



Panel C

- Healthy participants without CVD risk factors had higher HRV across pregnancy than those with CVD risk factors
- Among those who did not develop PreE, HRV trajectory shows a U-shaped pattern
- Those with PreE have monotonically declining HRV trajectory
- Postpartum HRV was lower after pregnancies complicated by PreE
- HRV recovered postpartum in healthy participants regardless of PreE status
- Those with CVD risk factors maintained low postpartum HRV
- Lowest values in those with both CVD risk factors and PreE

Conclusion and Discussion

- Distinct HRV trajectory patterns of cardio-vagal modulation were observed before and after delivery
- PreE was characterized by failure of HRV to rise predelivery and reduced HRV postpartum
- Persistent postpartum low HRV among participants with CVD risk factors—especially those with both CVD risk and PreE—suggests impaired vagal tone
- These findings support further investigation into mechanisms underlying failure of normalization of sympathetic and vagal activity after pregnancy and whether altered HRV trajectories signal increased long term CVD risk
- Continuous HRV monitoring may help identify PreE before delivery, detect incomplete postpartum recovery, and reveal subclinical autonomic dysfunction