



The interactive effects of maternal stress and diet in pregnancy on markers of inflammation

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Introduction:

- Excess inflammation during pregnancy may exert adverse effects on fetal development and birth outcomes, including prematurity, intrauterine growth restriction, and preeclampsia.
- Maternal nutrition and stress are two of the most frequently but independently studied factors for their influence on prenatal inflammatory status, but their interaction in the context of pregnancy has been significantly understudied.
- The Dietary Inflammatory Index (DII) is a validated method to characterize and quantify the cumulative inflammatory potential of an individual diet,¹ and has been previously used in prenatal populations.^{2,3}
- Ecological Momentary Assessment (EMA) methods are an effective way to assess psychosocial states in real-time, ambulatory, naturalistic settings, reducing the potential for recall and saliency bias associated with traditional retrospective questionnaires.⁴

Results: Demographics, Perceived Stress and Dietary inflammatory Index

- Mean pre-pregnancy BMI = 26kg/m²; mean age = 27 years; Hispanic ethnicity = 46%.
- DII scores range: -4.14 (anti-inflammatory) to +3.66 (pro-inflammatory); median = -.045
- PSS scores range: .01 (least stressed) to 2.46 (most stressed); median = 0.98

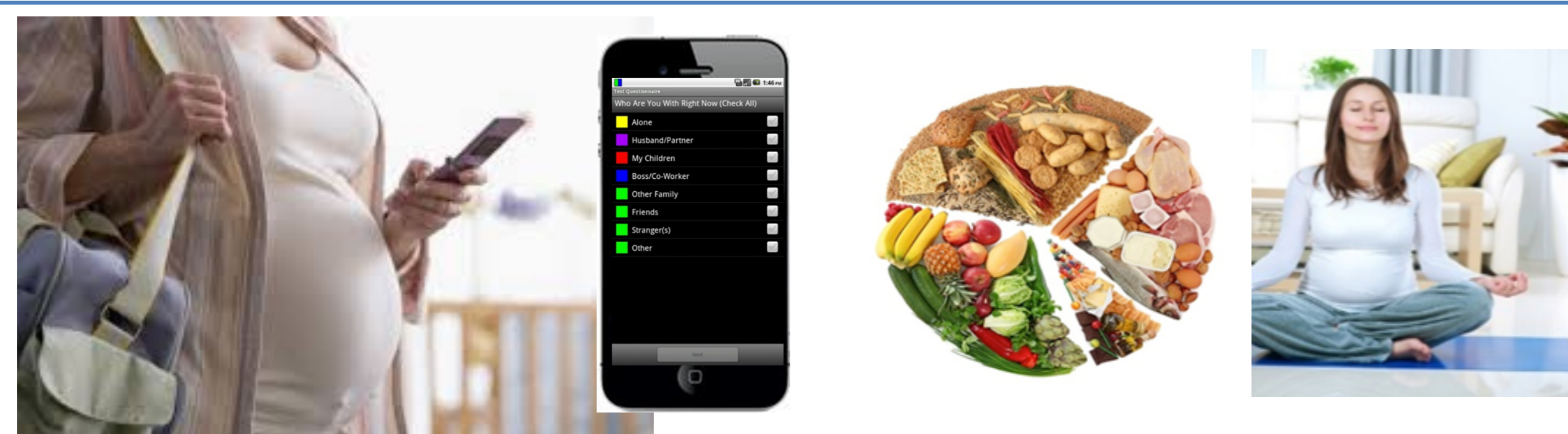
Table 1: Pearson correlations between mean pregnancy PSS, DII, TNF-α and IL-6

	PSS	DII	TNF-α	IL-6
PSS	-	0.137*	-0.042	-0.021
DII	0.137*	-	0.195**	0.187**
TNF-α	-0.042	0.195**	-	0.298**
IL-6	-0.021	0.187**	0.298**	-

* Significant at the 0.05 level (2-tailed). ** Significant at the 0.01 level (2-tailed).

Objective:

The aim of this study is to investigate the combined effects of perceived stress (PSS) and dietary inflammatory index (DII) across pregnancy on markers of maternal inflammation.



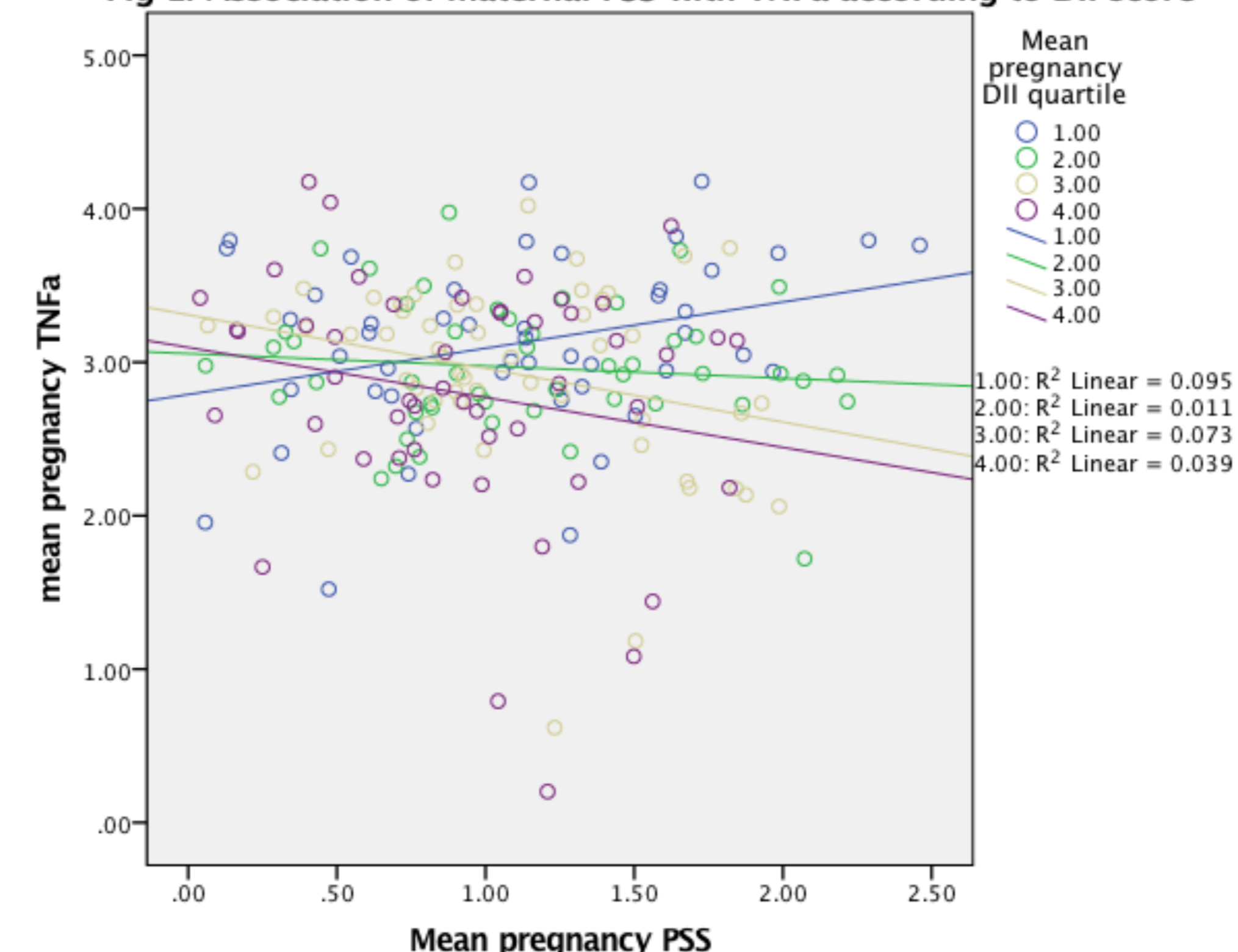
Results: Interactive effect of PSS*DII on TNF-α and IL-6

- Neither the interaction term nor the main effects of PSS and DII in the model were significantly associated with mean pregnancy IL-6.
- The PSS*DII interaction term was significantly associated with mean pregnancy TNF-α (p=0.02), which persisted after adjusting for maternal covariates (p=0.015).
- However, there was no main effect of PSS or DII on TNF-α in the model.
- As depicted in Figure 1 below, among women with the highest inflammatory diet (DII in top quartile), TNF-α values increase as PSS increases.

Methods:

- Non-diabetic pregnant women (N=250) were recruited in early pregnancy and followed prospectively with study assessments at three time points across gestation.
- Each assessment included a blood draw at the lab visit followed by a 4-day ambulatory EMA period during which participants completed an electronic diary multiple times per day on a dedicated study smartphone.
- The EMA diaries evaluated moment-level perception of stress, from which the PSS was computed.
- Dietary intake was assessed by 24-hr diet recalls on 3 non-consecutive days, including one weekend day. From these, average daily energy, nutrient and food group intakes were generated and the DII was computed.
- Blood samples were assayed for Interleukin (IL)-6 and Tumor Necrosis Factor (TNF)-α.
- As PSS, DII, IL-6 and TNF-α were each highly correlated across time points, mean pregnancy values were used.
- Linear regression tested the association of the prenatal stress-diet interaction (PSS*DII) with IL-6 and TNF-α, including the main effects of PSS and DII in the model and adjusting for the following covariates: maternal age, pre-pregnancy body mass index (BMI), socioeconomic status, race/ethnicity.

Fig 1: Association of maternal PSS with TNFα according to DII score



Conclusions:

- The inflammatory potential of a prenatal diet (DII) is positively associated with levels of inflammatory cytokines.
- Elevated levels of maternal perceived stress potentiates the effects of a pro-inflammatory diet on TNF-α levels across pregnancy
- Further research is required to determine whether the combined effects of maternal stress and poor diet exert adverse pregnancy and infant outcomes.

References:

- Shivappa et al., Designing and developing a literature-derived, population based dietary inflammatory index. *Public Health Nutr* 2014;17:1689–96.
- Moore et al., Proinflammatory Diets during Pregnancy and Neonatal Adiposity in the Healthy Start Study. *J Pediatr* 2018;195:121-7.
- Shin et al., Pre-Pregnancy Body Mass Index Is Associated with Dietary Inflammatory Index and C-Reactive Protein Concentrations during Pregnancy. *Nutrients* 2017;9:351-365.
- Csikszentmihalyi M, Larson R. Validity and reliability of the Experience-Sampling Method. *J Nerv Ment Dis* 1987;175:526-36.

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