**Beyond glucose: Integrating maternal risk factors, geography, and hospital variation to improve pregnancy outcomes in GDM**

**Background**
Gestational diabetes mellitus (GDM) affects over 53,000 pregnancies annually in Australia yet current glucose-based diagnostic criteria may inadequately predict adverse outcomes. We present findings from three interrelated studies examining how maternal, geographic, and institutional factors influence GDM diagnosis and pregnancy outcomes, with the aim of informing more targeted and equitable care.

**Methods**
(1) Using data from 23,316 participants in the Hyperglycaemia and Adverse Pregnancy Outcome (HAPO) study, we compared logistic regression and Bayesian mixture models combining maternal characteristics with oral glucose tolerance test (OGTT) values to predict perinatal outcomes.
(2) We analysed population-level data from all pregnancies in New South Wales (NSW) between 2016–2020 (n=457,680) to quantify geographic variation in GDM incidence across Statistical Area Level 2 (SA2) regions, assessing the influence of maternal and area-level characteristics.
(3) We examined variation in maternal and neonatal outcomes among 71,200 women with GDM across NSW hospitals using Bayesian multilevel logistic regression, with stepwise covariate adjustment to identify site-specific disparities.

**Results**
Maternal characteristics known early in pregnancy outperformed OGTT glucose values in predicting adverse outcomes in HAPO, including pre-eclampsia, primary caesarean section, and NICU admission. Across NSW, GDM prevalence varied significantly by region, with higher rates in socioeconomically disadvantaged and urban areas ((adjusted median odds ratio1.34). Country of birth and BMI were key drivers of geographic variation. Hospital-level modelling revealed substantial between-hospital variation in the probability of multiple outcomes, including neonatal hypoglycaemia and caesarean section, which persisted even after adjustment for maternal, pregnancy, and hospital-level factors.

**Conclusion**
Our findings support a shift towards broader, contextualised risk stratification in GDM. Maternal and environmental factors provide predictive value beyond glucose thresholds, while geographic and hospital-level disparities underscore the need for tailored regional and institutional strategies. Together, these studies suggest opportunities to refine GDM management, improve equity, and optimise pregnancy outcomes.