

Machine-Learning Prediction of Gestational Hypertension and Preeclampsia in Twin Pregnancies: Population-Based Study

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Objective

To assess prevalence and risk factors for gestational hypertension (GH) and preeclampsia (PE) in twin compared with singleton pregnancies, and to develop a prediction model to quantify the risk of developing GH/PE in twin pregnancies at prenatal care entry.

Methods: Population-based study using CDC birth data from 2016-2021. Higher-order pregnancies were excluded. A Chi-square test was performed to identify significant factors associated with GH/PE in twin versus singletons and within each group independently. Multivariable regression analyses were performed first to assess the association between GH/PE and candidate predictors, and second to assess the risk of GH/PE in twin compared with singletons, adjusted for the significant risk factors. All potential predictors were evaluated in two prediction models: logistic regression and machine learning (ML). The predictive accuracy was assessed by AUROC. Non-parametric test was used to compare AUROC of both models and, given the large sample size, P value <0.001 was considered statistically significant.

Results

A total of 17,972,300 singleton and 597,651 twin pregnancies were included. Following multivariable regression, maternal age <20 years and ≥35 years, gestational and pre-pregnancy diabetes, non-Hispanic Black, overweight and class I/II/III obesity, excessive gestational weight gain (GWG), IVF, and periconception cigarette smoking, remained significantly associated with GH/PE in twins. Factors that doubled the risk in twins were pre-gestational diabetes mellitus (DM) (OR 2.07 (1.95 – 2.21), P<0.001), class III obesity (OR 2.59 (2.52 – 2.67), P<0.001), and excessive GWG in the normal BMI group (OR 2.09 (2.02 – 2.16), P<0.001). The prevalence of GH/PE in twins was double that in singletons (OR: 14.18 (14.10-14.26) in twins vs 7.39 (7.37-7.40) in singletons (p<0.001). Following adjustment for significant factors, twins remained significantly associated with double the risk of GH/PE compared to singletons (OR 2.08 (2.06 – 2.09), P<0.001). The candidate predictors incorporated in the two prediction models were age, parity, race-ethnicity, nativity, education, BMI, insurance, Women Infant Children program, periconception cigarette use, pregestational DM, and IVF pregnancy. The prediction performance of the ML model was similar to that of the logistic regression, with AUROC of 0.630 (0.628 to 0.633) vs. 0.625 (0.622 to 0.628) (P=0.008). Both models were well-calibrated and neither had poor fit. An online calculator was developed for risk estimation.

Conclusions

Pre-pregnancy diabetes, class III obesity, and excessive GWG doubled the risk of GH/PE in twins. This prediction model is a useful tool for counselling women regarding their risk of GH/PE, over and above that in the general twin population.