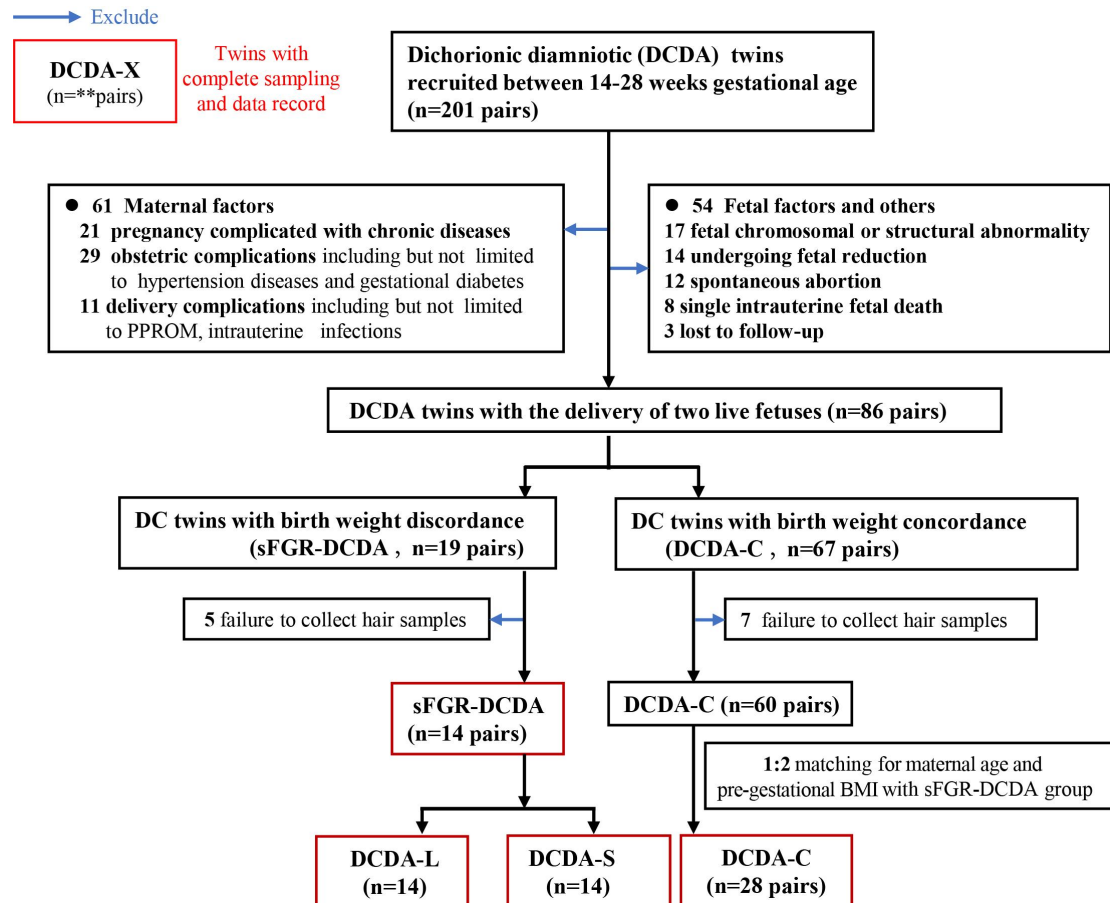
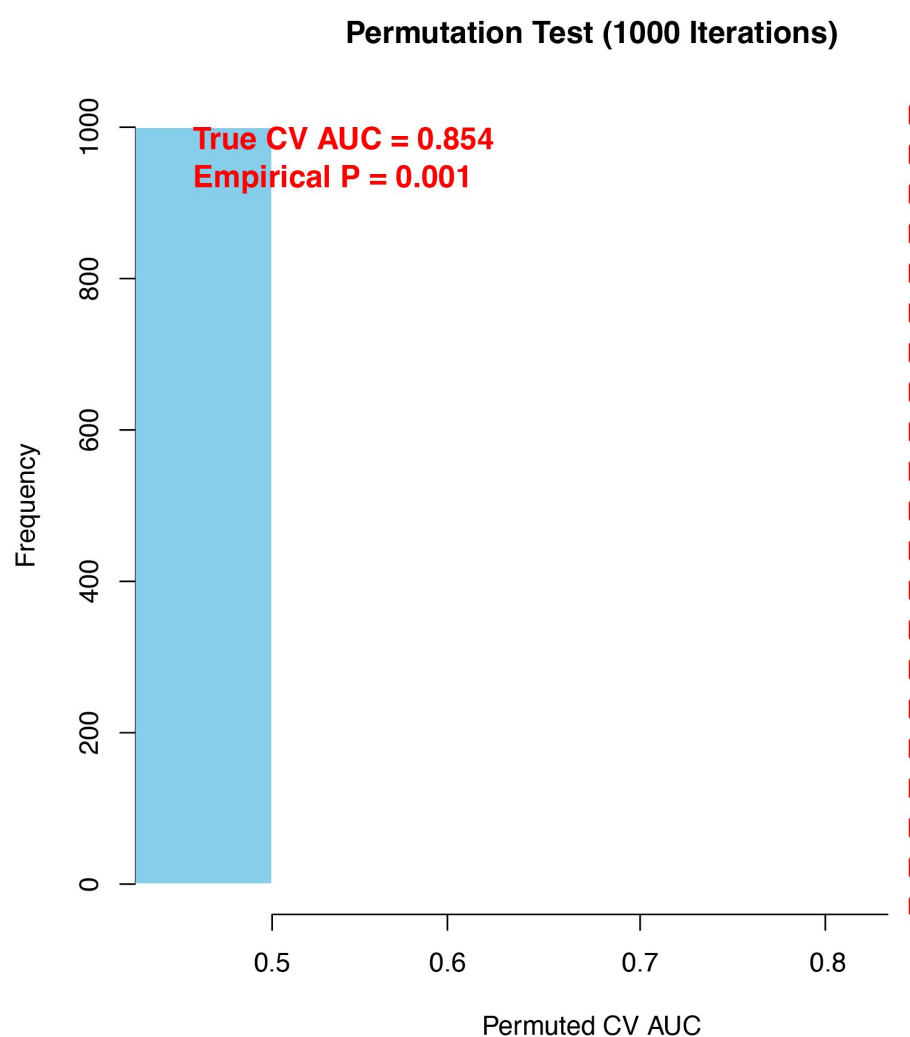




Supplementary Figure S1. Flowchart of volunteer recruitment and grouping. sFGR, selective fetal growth restriction; DCDA, dichorionic-diamniotic; C, control; L, larger twin; S, smaller twin.



Supplementary Figure S2. Permutation test of machine learning models. Permutation testing (1,000 iterations) yielded an empirical P -value of 0.001 of SVM, confirming that the high predictive accuracy was not attributable to overfitting.

Supplementary Table S1. Machine learning configuration and reproducibility details

Model	R Package	Hyperparameter Tuning Strategy	Class Balancing Method	Validation Strategy	Random Seed
ANN	nnet (via caret)	Grid search (tuneLength = 3)	ROSE (via caret)	Repeated 3-fold CV (10 repeats)	123
Random Forest	randomForest (via caret)	Grid search (mtry)	ROSE (via caret)	Repeated 3-fold CV (10 repeats)	123
SVM	kernlab (via caret)	Grid search (Radial basis function)	ROSE (via caret)	Repeated 3-fold CV (10 repeats)	123
Logistic Regression	stats (via caret)	N/A (Standard binomial)	ROSE (via caret)	Repeated 3-fold CV (10 repeats)	123
Naive Bayes	naivebayes (via caret)	Grid search	ROSE (via caret)	Repeated 3-fold CV (10 repeats)	123
KNN	kknn (via caret)	Grid search	ROSE (via caret)	Repeated 3-fold CV (10 repeats)	123
Decision Tree	C50 (via caret)	Grid search	ROSE (via caret)	Repeated 3-fold CV (10 repeats)	123

Note. Machine learning configuration and reproducibility details for seven supervised classification models used to discriminate DCDA-S infants with low (< 30) versus adequate (≥ 30) ASQ-3 scores in the personal-social domain at 2–3 years of age. All models were trained using a repeated 3-fold cross-validation strategy (10 repeats) with ROSE to address class imbalance. A fixed random seed of 123 was used for reproducibility. AUC, area under the curve; ANN, artificial neural network; SVM, support vector machine; KNN, *k*-nearest neighbors; ROSE, random oversampling examples; CV, cross-validation.