Percentage of sleep time with increase in respiratory effort is a strong predictor of prevalent hypertension in OSA patients

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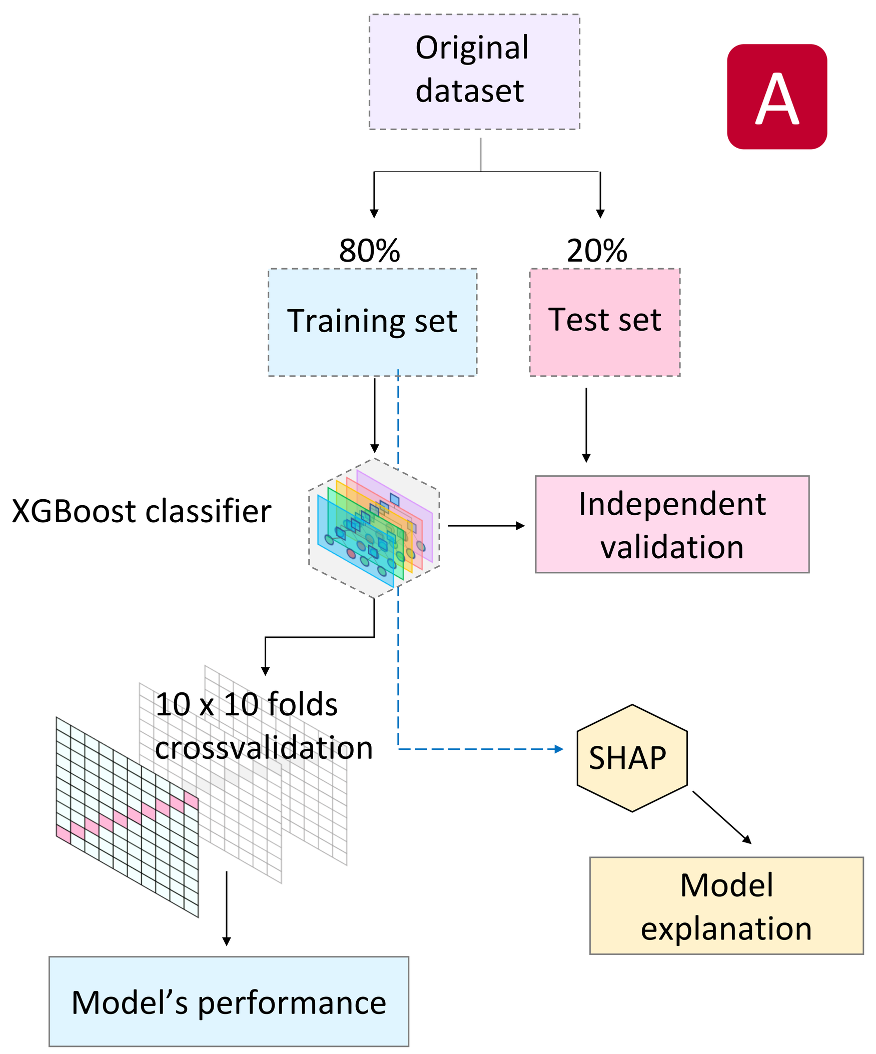
1 Introduction

Increased respiratory effort (RE) is one of the main features of OSA and is associated with sympathetic overactivity, leading to increased vascular wall stiffness and remodelling. In this study, we investigated the relationship between a new measure of RE burden (percentage of sleep time spent with increased RE based on measurement of mandibular jaw movements [MJM]; RE_MJM-dt, %TST) and prevalent hypertension in adults referred for evaluation of suspected OSA.

2 Methods

A machine learning model (XGBoost classification algorithm) was built for detecting patients with hypertension from the input data of 18 features, including anthropometric, sleep studies indices: male sex (binary value), age, body mass index (BMI), neck circumference, Epworth Sleepiness Scale (ESS) score, nine PSG-derived indices (TST, respiratory disturbance index [RDI], obstructive RDI [ORDI], AHI, obstructive AHI [OAHI], oxygen desaturation index [ODI], arousal index [ArI], proportion of TST spent with SpO2 <90% or <95%), and four indices provided by Sunrise automated MJM signal analysis (Sr_TST, Sr_ArI, Sr_ORDI and RE_MJM-dt).

A



The data analytics plan is summarised in Figure A. The model's performance was evaluated using the 10-fold cross-validation procedure, which implied multiple data splitting and random resampling, thus allowing unbiased evaluation of model performance on 10% of unseen data.

Lundberg Shapley additive explanation (SHAP) method was applied to evaluate the contribution of each feature to the model final prediction.

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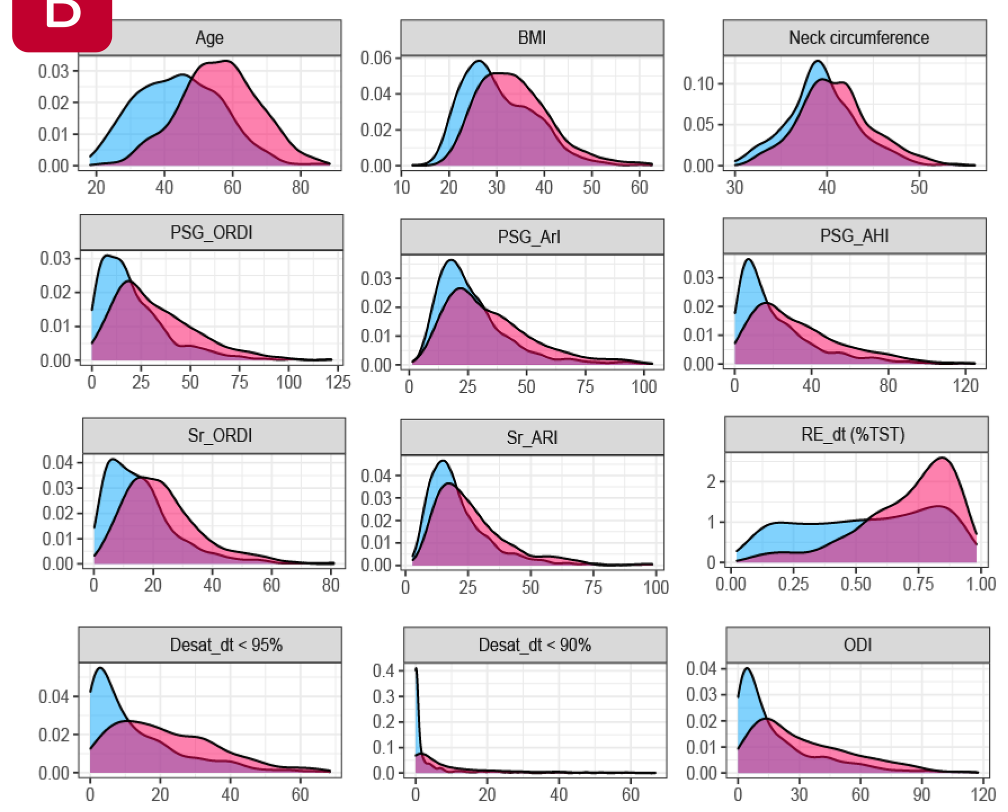
3 Results

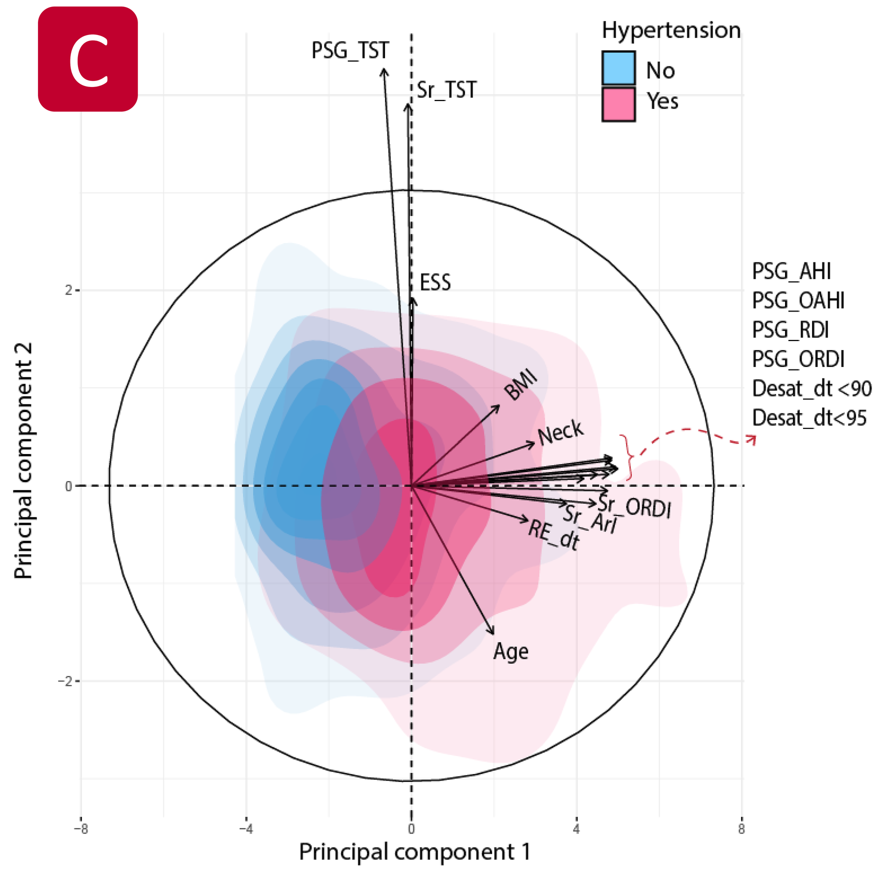
A total of 1127 subjects were included in the study, 901 (80%) in the training subset and 226 (20%) in the validation subset. The prevalence of hypertension was about 31%.

Clear differences in the distribution of a variety of features based on the presence or absence of hypertension (Figure B. RE burden (RE_MJM-dt , %TST) was significantly higher in patients with versus without hypertension, suggesting a high capability of RE_MJM-dt to differentiate between patients with and without hypertension. Result of principal component analysis (Figure C),RE burden was identified among the most relevant features that efficiently contributed to the classification presence of hypertension.

B



C



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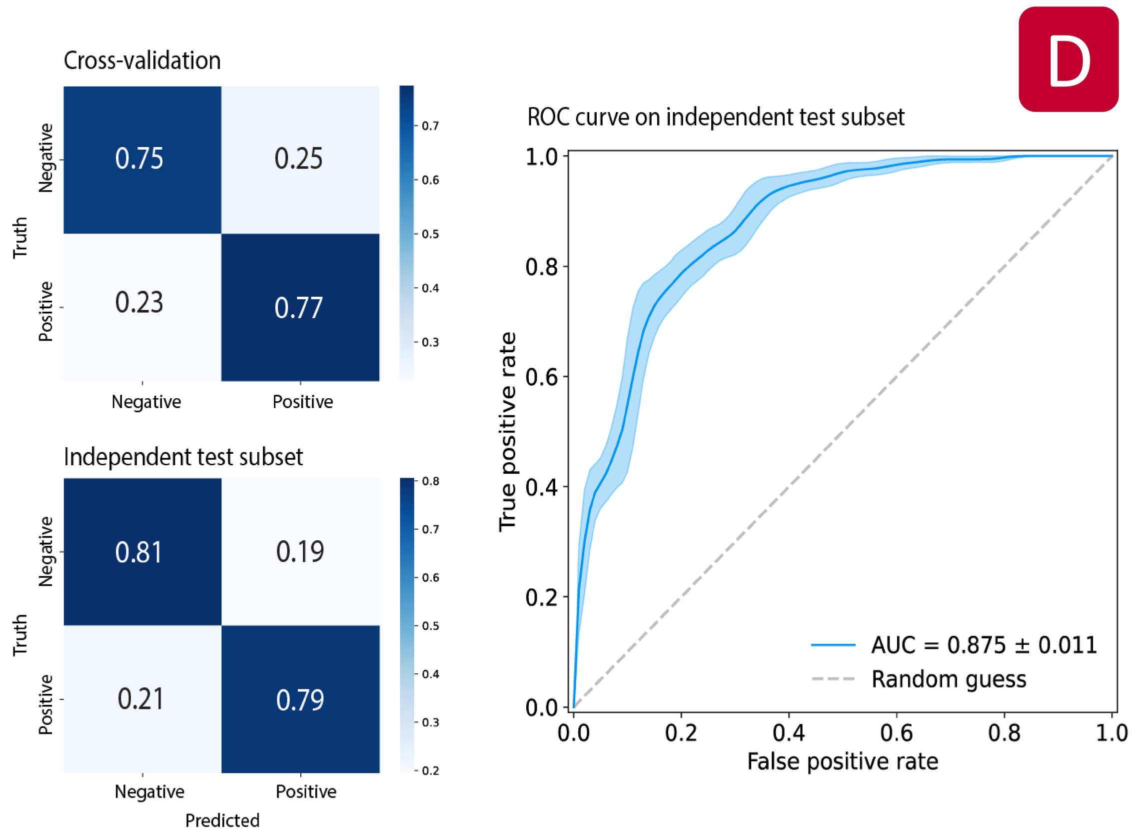
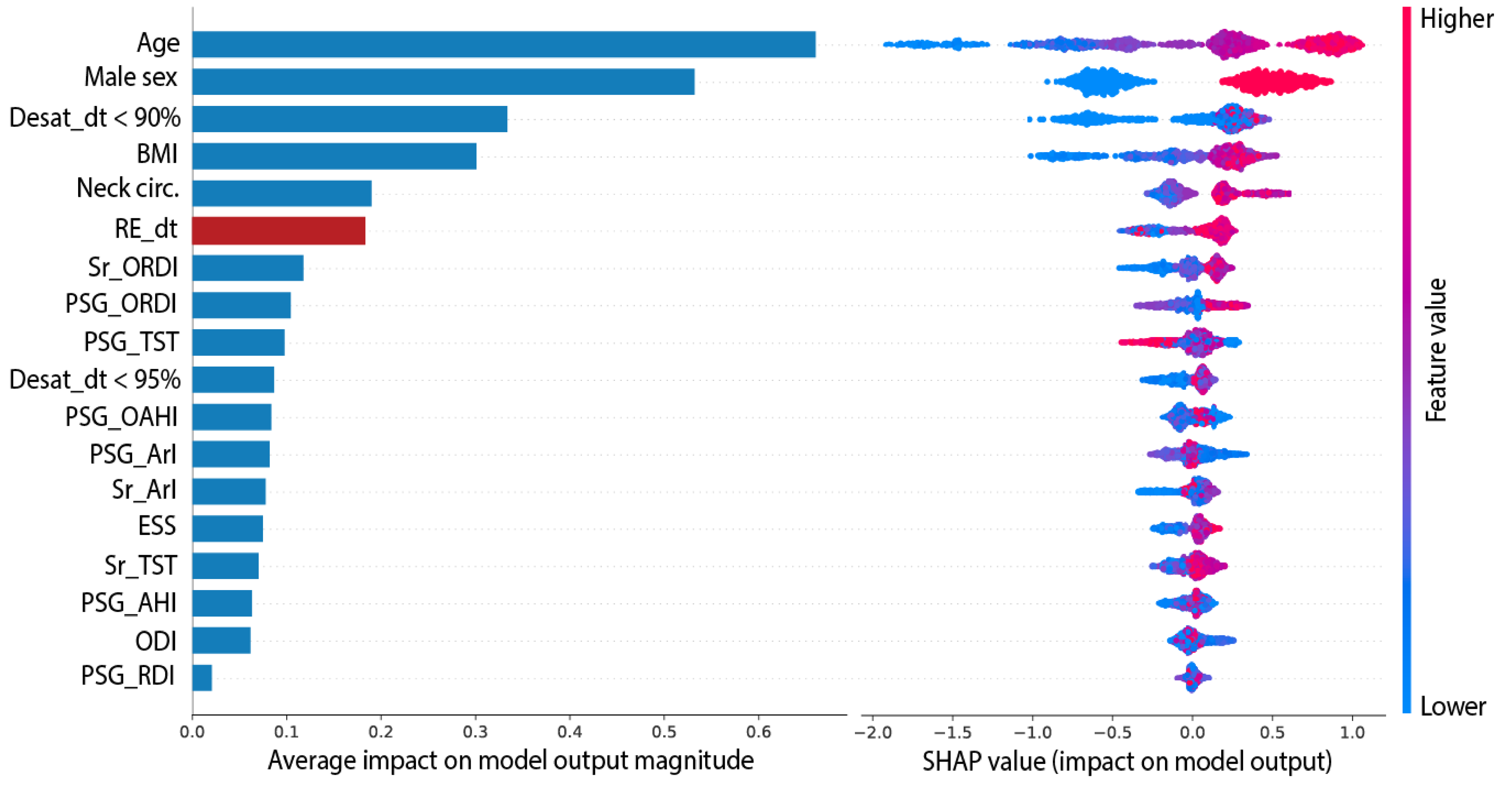


Our classification model showed good performance for the prediction of hypertension in both cross-validation and independent validation (Figure D), with a ROC AUC of 0.88 (95% CI 0.85–0.9), sensitivity of 0.75 (0.66–0.83) and specificity of 0.83 (0.78–0.88)

E Contribution of the eighteen input features to the classification output, evaluated by the Shapley Additive Explanation (SHAP) method



The model explanation analysis by SHAP method is presented in Figure E. The five strongest predictors of prevalent hypertension in patients with OSA were age, male sex, time with SpO2 <90%, BMI and neck circumference. The three next most important contributors were RE_MJM-dt, Sr_ORDI and PSG_ORDI. These were followed by other PSG indices (in descending order of importance): PSG_TST, time with SpO2 <95%, PSG_OAHI and PSG_ArI. Of these metrics, only RE_MJM-dt and Sr_ORDI showed a clear asymmetric pattern in SHAP values distribution, where the highest values of RE_MJM-dt and Sr_ORDI would drive positive prediction of hypertension.

4 Conclusion

In conclusion, our study highlights the role of RE burden as a relevant risk factor for prevalent hypertension in OSA, beyond classical anthropometric cardiovascular risk factors and usual PSG metrics. Risk stratification using new metrics beyond AHI is a new paradigm in OSA. RE based on measurement of MJM allows objective measurement of sleep time spent with RE and should be included in the clinical data for OSA management.