Comparison of Machine Learning and Deep Learning Methods based on Recurrence Analysis for Obstructive Sleep Apnea Detection

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Background and Aim. Obstructive sleep apnea (OSA) is linked to severe cardiovascular diseases, but it remains undiagnosed in general population. To facilitate OSA detection in clinical practice, a variety of algorithms based on combining features from heart rate variability (HRV) with machine learning techniques have been proposed in the last years. Features derived from recurrence quantification analysis (RQA) have reported promising results in previous works, however there is still limited research on the use of that approach for detecting OSA episodes using deep learning methods. Hence, this study aims to compare the performance of traditional machine learning methods and a modern deep learning approach based on RQA for OSA detection.

Methods. The study enrolled three publicly available databases from Physionet. ECG recordings were segmented into one-minute intervals, and the general recurrence plot (GRP) and common RQA features were extracted from the HRV. Support vectors machine (SVM), k-nearest neighbors (KNN), and tree-decision classifier (TREE) were trained on common RQA features, while a pre-trained version of AlexNet was inputted with GRPs. The performance of the methods was determined following the TRIPOD guidelines, i.e., using a database for training and the remaining for testing.

Results. As the table below shows, the performance in terms of accuracy (Ac), sensitivity (Se), and specificity (Sp) was better using the deep learning scheme than traditional machine learning models. The AlexNet-based model also reported more balanced values of Se and Sp than common classifiers.

Conclusions. The deep learning model presented a higher generalization ability than machine learning algorithms to detect OSA from the HRV analysis using RQA. Although the values of Ac obtained by AlexNet were still moderate, they were also greater than those reported by previous machine learning models based on HRV features different from RQA and under the TRIPOD guidelines, thus drawing an interesting line research for OSA detection.

Model	Ac (%)	Se (%)	Sp (%)
SVM	67,13	22,95	86,66
KNN	62,29	37,21	73,37
TREE	59,20	43,23	66,27
ALEXNET	71,30	58,95	76,76