

Comparative Analysis of PPG-Derived Physiological Characteristics Across Sleep Apnea Events

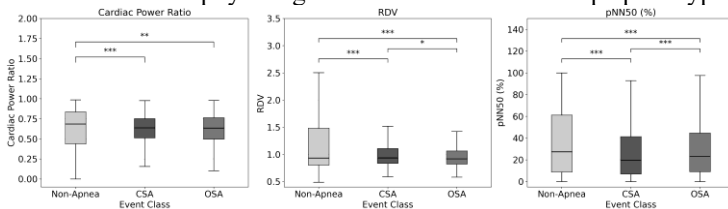
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Aims: This study aimed to quantify physiological differences among normal, obstructive sleep apnea (OSA), and central sleep apnea (CSA) events using PPG. We hypothesized that PPG-derived indices reflecting autonomic, cardiovascular, and respiratory components would exhibit distinct patterns across apnea event types.

Methods: We utilized PPG signals from the Multi-Ethnic Study of Atherosclerosis (MESA) database and segmented PPG signals with 50% overlap to preserve temporal continuity. Bandpass filters were applied to extract cardiac (0.5–5 Hz) and respiratory (0.1–0.5 Hz) components. Pulse rate variability (PRV) features were derived, including pNN50 as an index of parasympathetic activity. Respiratory-related features, including respiratory power ratio and respiratory disturbance variable (RDV), were computed for each segment. Group differences among normal, OSA, and CSA segments were evaluated using one-way analysis of variance (ANOVA) with Tukey's HSD post-hoc test ($\alpha = 0.05$).

Results: In the results, cardiac power ratio was lower in apnea events than in normal segments, which may reflect a relative reduction in the cardiac component due to increased respiratory variability. RDV values in both OSA and CSA events were closer to 1, indicating unstable respiratory dynamics. This suggests that RDV effectively captures the physiological characteristics of sleep-disordered breathing events, including OSA and CSA. Additionally, pNN50 was higher in normal segments and reduced in CSA, indicating diminished parasympathetic activity. These results suggest that PPG-derived indices can characterize physiological differences across sleep apnea types.



Conclusions: PPG-derived indices, including cardiac, respiratory, and autonomic indices, can effectively characterize physiological differences among normal, OSA, and CSA events. These findings suggest the potential of PPG as a non-invasive tool for understanding and differentiation sleep apnea mechanisms.