

# Pulse Photoplethysmography Markers for Cardiovascular Risk Factors in Sleep Apnea Patients

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**Aim:** Sleep apnea is often associated with different cardiovascular diseases (CVD). The aim of this study is to find markers of CVD risk factors in the pulse photoplethysmography (PPG) signal as this enables wearable assessment. To avoid the influence of apneic events on the PPG signal and the requirement to retain the correct sensor positioning for a full night, a method based on wakefulness was investigated.

**Methods:** The dataset comprised finger PPG recordings from polysomnography and information on hypertension, hyperlipidemia and diabetes of 78 patients with suspected sleep apnea. Patients with absence of risk factors for CVD were grouped as Class 1, with one as Class 2 and Class 3 otherwise. From the PPG, the wake period in the evening before falling asleep and the wake period after waking up in the morning were extracted. A set of 148 features derived time and frequency information and characterized the PPG waveform. Feature extraction was performed in non-overlapping windows of 5s. Features with a low correlation to age and BMI were ranked by the ‘Minimum Redundancy Maximum Relevance’ algorithm. The top three features were applied in a 5-fold cross validation using Naïve Bayes classification. Feature extraction and classification was done separately for the evening and morning wake period.

**Results and Conclusions:** The selected features for the evening wake period were the mean diastolic width at 10% of the pulse amplitude, the standard deviation (SD) of pulse slope transit time and SD of the pulse slope. The classification reached a Kappa score ( $\kappa$ ) of 0.47 (Figure 1). The classification with morning period features resulted in a lower  $\kappa$  of 0.32. The evening-based CVD risk prediction could aid to prioritize patients for sleep apnea diagnosis and treatment, in order to avert development of aggravating CVD. Investigation of longer feature windows and improved feature selection could boost CVD risk classification.

Evening, Cohen's Kappa = 0.47

	1	2	3
1	26	6	3
2	7	19	1
3	3	6	7
	1	2	3

True Class

Predicted Class

Figure 1. Classification result with features of evening wake period.