

# Heart Rate Variability Analysis of Pilot In-Flight Workload

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**Purpose:** The purpose of this study was to investigate the impact of pilot stress on workload during in-flight tasks using heart rate variability (HRV).

**Method:** Three-lead electrocardiogram (ECG), photoplethysmography (PPG) behind the ear, and electroencephalogram (EEG) recordings were collected simultaneously from ten collegiate aviation student subjects during uniform flight scenarios. Participants had Federal Aviation Administration (FAA) commercial pilot certificates and FAA Class I or II medical certificates. Flight scenarios consisted of tasks such as climbs, descents, climbing or descending turns, heading altitude holds, steep turns, course intercepts, and instrument approaches. These procedures varied in workload designated as low, medium and high workloads. In this analysis ECG was analyzed and HRV metrics of standard deviation of normal-to-normal RR (SDNN), root mean square of successive RR (RMSSD), low frequency over high frequency (LF/HF) were calculated for each participant over five-minute intervals for each task load. Mean, Min and Max heart rate (HR) values were also calculated. One-way ANOVA was used to compare task loads. A probability of  $p < 0.05$  was considered significant.

**Results:** LF/HF showed significant change in comparing low to high and medium to high task loads. LF/HF values were lower at low task workloads and progressed higher to high task workloads. Values of SDNN and Min HR had significant change of medium to high and low to medium task loads but not of low to high task loads. RMSSD, Mean HR, Min HR and Max HR had significant change of low to medium and low to high task loads but not in comparing medium to high task loads.

**Conclusion:** LF/HF was higher at high task loads suggesting higher sympathetic dominance where as LF/HF values were lower during low task loads from parasympathetic responses. The HRV analysis suggests that pilots have higher cardiovascular sympathetic stress responses during high task workloads.

	Low Task Load	Medium Task Load	High Task Load
Mean HR (bpm)	82 ± 11	86 ± 12 *	85 ± 11 *
Min HR (bpm)	70 ± 10	74 ± 10 *	69 ± 10 **
Max HR (bpm)	96 ± 14	103 ± 13*	105 ± 9 *
SDNN (ms)	34 ± 11	32 ± 9	36 ± 10 **
RMSSD (ms)	29 ± 12	24 ± 9 *	26 ± 12 *
LF/HF	3.0 ± 1.81	3.3 ± 1.64	5.5 ± 2.63 ***

\* Low  $p < 0.05$ , \*\* Med  $p < 0.05$ , \*\*\* Low and Med  $p < 0.05$