

Correlation Analysis between Physical Fitness Norm and Cardio-Pulmonary Signals under Graded Exercise and Recovery

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Abstract : Physical fitness is the adaptability of the body to physical work and the environment, and is generally known to include cardiopulmonary-fitness, muscular-fitness, body flexibility, and body composition. This paper is aimed to study the ventilatory and cardiovascular activity under various exercise intensities for subjects at distinct ends of cardiopulmonary fitness norm. Three graded upright biking exercises, light, moderate, and vigorous exercise, were designed for subjects at distinct ends of cardiopulmonary fitness norm from their physical education classes. The participants in the experiments were 9, 9, and 11 subjects in the top 20%, middle 20%, and bottom 20%, respectively, among all freshmen of the Feng Chia University in the academic year of 2015. All participants were requested to perform 5 minutes of upright biking exercise to attain 50%, 65%, and 85% of their maximum heart rate (HR_{max}) during the light, moderate, and vigorous exercise experiment, respectively, and 5 minutes of recovery following each graded exercise. The cardiovascular and ventilatory signals, including breathing frequency (f), tidal volume (VT), heart rate (HR), mean arterial pressure (MAP), and ECG signals were recorded during rest, exercise, and recovery periods. The physiological signals of three groups were analyzed based on their recovery, recovery rate, and percentage variation from rest. Selected time domain parameters, SDNN and RMSSD, were computed and spectral analysis was performed to study the heart rate variability from collected ECG signals. The comparison studies were performed to examine the correlations between physical fitness norm and cardio-pulmonary signals during graded exercises and exercise recovery. No significant difference was found among three groups with VT during all levels of exercise intensity and recovery. The top 20% group was found to have better performance in heart recovery (HRR), frequency recovery rate (fRR) and percentage variation from rest (Δf) during the recovery period of vigorous exercise. The top 20% group was also found to achieve lower mean arterial pressure MAP only at rest but showed no significant difference during graded exercises and recovery periods. In time-domain analysis of HRV, the top 20% group again seemed to have better recovery rate and less variation in terms of SDNN during recovery period of light and vigorous exercises. Most assessed frequency domain parameters changed significantly during the experiment ($p < 0.05$, ANOVA). The analysis showed that the top 20% group, in comparison with middle and bottom 20% groups, appeared to have significantly higher TP, LF, HF, and nHF index, while the bottom 20% group showed higher nLF and LF/HF index during rest, three graded levels of exercises, and their recovery periods.

Keywords : physical fitness, cardio-pulmonary signals, graded exercise, exercise recovery

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