The purpose of this study was to determine the effects of hypercapnia on cardiorespiratory responses during exercise. Six healthy males (23.8 ± 2.0 yr, 172.0 ± 6.0 cm, 66.9 ± 4.7 kg) volunteered to participate in the present study. Each subject performed incremental exercise until exhaustion on two occasions: 1) breathing ambient air (Air), 2) breathing hypercapnic (21% O2, 3% CO2, N2=balance) gas (3%CO2). Subjects breathed ambient air or hypercapnic gas from 10 min before the start of exercise until the end of exercise. Exercise tests were conducted using an electrically-braked cycle ergometer. The initial workload was 30 Watt (W), and thereafter the workload was increased by 30 W every 2 min until exhaustion. Oxygen uptake (VO2), carbon dioxide production (VCO2), respiratory exchange ratio (RER), expired minute ventilation (VE), breathing frequency (f), and end tidal CO2 fraction (ETCO2) were measured by automatic expired gas analyzer. Heart rate (HR), stroke volume (SV), and cardiac output (CO) values were continuously measured by thoracic impedance method. Maximal workload differed between the subjects. Therefore we unified the data as a relative intensity and evaluated at pre-exercise, 30%, 60%, 75%, 90%, and 100%VO2max. Exercise performance time was not different between 3%CO2 and Air. VO2 max was significantly lower in 3%CO2 than that in Air (P < 0.05). During exercise, VE and ETCO2 were significantly higher in 3%CO2 than those in Air (P < 0.05). But, f and RER were not different between 3%CO2 and Air. VO2 and VCO2 were significantly lower in 3%CO2 than those in Air (P < 0.05) more than 75%VO2max. HR and SV were not different between 3%CO2 and Air. But, SV tended to be lower in 3%CO2 than in Air (P=0.073). CO was significantly lower in 3%CO2 than that in Air more than 75%VO2max (P < 0.05). From respiratory responses, it is considered that hypercapnic gas (3%CO2) inhalation provokes an accumulation of CO2 in pulmonary alveolus, which promotes VE and decreases VO2/VE. But f and RER during exercise are not affected by hypercapnic gas inhalation. On cardiocirculatory responses, it can be considered that hypercapnic gas inhalation leads to reduction of SV, which decreases CO during exercise. Hypercapnic gas (3%CO2) inhalation: 1) promotes VE and decreases VO2/VE during exercise, 2) decreases CO during exercise.

This research was supported in part by a Grant-in-Aid for Young Scientists (B) from the Japanese Ministry of Education, Culture, Sports, Science and Technology (Grant No. 18700519).

Keywords: Exercise Physiology, Respiratory, Cardiac