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23a Changes in pulmonary diffusing capacity at simulated high altitudes under different ambient temperatures

A. Yasukouchi, K. Inoue[1] and *M. Sato*[2], Department of Industrial Physiology, National Institute of Industrial Haalth, Nagao, Tama-ku, Kawasaki, Japan,
[1]Department of Anatomy, School of Medicine, Hokkaido University, Kita-ku, Sapporo, Japan, [2]Department of Ergonomics, Kyushu University of Design Sciences, Shiobaru, Minami-ku, Fukuoka, Japan

There has been no study on the effect of cooling on pulmonary diffusing capacity for CO (D_L) at high altitude where it is naturally cool or cold. The purpose of this study is to examine the effects of ambient temperature and hypobaric hypoxia on D_L at rest and during exercise.

Climatic conditions in a biotron were kept constant at temperatures of 16, 20, 24 and 28°C (RH 50%, respectively) combined with barometric pressures corresponding to sea level and high altitudes of 2,000 and 4,000m. Each subject (five young male adults), wearing a thin running shirt and shorts, was exposed to each condition for about 150 minutes. D_L was measured by a breath-holding method at almost the same partial O_2 pressure as that of room air under each condition. D_L, oxygen intake and heart rate were measured at the 5th, 60th and 120th minute of exposure at rest in a sitting position and also measured during exercise after a rest period. Exercise was performed successively at workrates of 50 and 100 watts with a bicy cle ergometer for about 7 minutes each.

D_L increased significantly with increased altitude at rest and during exercise. In addition, D_L in a cool environment, 16°C at 2,000m and below 20°C at 4,000m, was further increased significantly compared with that in 28°C at rest and during mild exercise (50 watts), although any thermal effect was not observed at sea level. This means that the difference in D_L between altitudes was dependent on ambient temperature.

However, the regression coefficient of D_L on oxygen intake was statistically constant under every combined condition between temperature and altitude. The y-intercept of this regression line was affected significantly by the change in ambient temperature at 4,000m, while there was no thermal effect at sea level and at 2,000m.

D_L at high altitude was predicted, presuming that pulmonary capillary blood volume and reaction rate between CO and hemoglobin (0co) were the same as those at sea level. As a result of comparison between measured and predicted value, there was no difference on every occasion at 2,000m, while significant increase in measured D_L was observed at rest and during mild exercise at 4,000m in a cool environment. It was implied that gas exchange surface area increased under hypobaric condition in a cool environment caused by increase in capillary blood volume in itself and/or change in distribution of capillary blood flow in the lungs. However, these effects were relatively reduced at ambient temperature above 24°C. It was presumed that the degree of increase in D_L was more pronounced at higher altitude in a cooler environment, especially at rest.

Judging from predicted D_L at high altitude, it was suggested that the increase in D_L from sea level to 2,000m was caused mainly by increase in Oco due to fewer O_2 molecules to compete with CO for binding sites on the hemoglobin. On the other hand, further increase in D_L from 2,000m to 4,000m was caused mainly by increase in gas exchange surface area due to hypoxic effect in alveoli in addition to further increase in Oco.