LIMITING FACTORS OF PHYSICAL EXERCISE AT MODERATE AND HIGH ALTITUDE.
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It is well known that maximal aerobic performance (VO$_2$max) is decreasing with increasing altitude. A significant attenuation of has been recorded at altitudes as low as 800m. Moreover, the decrease in performance seems greater in endurance trained than in sedentary subjects. It has been debated for a long time which step in the transport of oxygen from the ambient air to the muscle mitochondria is the most limiting when exercising at high altitude. To define the limiting step requires to prove that increasing the capacity of O$_2$ transfer in this particular step will increase the overall VO$_2$max. We tried to explore this problem in comparing endurance trained subjects with sedentary ones during maximal exercise performed at various simulated altitudes (normobaric hypoxia): 0m, 1000m, 2500m, 4000m. Main cardio-respiratory variables were measured, including cardiac output by transthoracic impedanceometry. Two main factors contributed to the greater limitation in VO$_2$max in trained than untrained subjects: a greater decrease in maximal heart rate and a lower arterial and mixed venous O$_2$ saturation. In trained subjects, muscle O$_2$ extraction is already almost maximal at sea level so that mixed venous PO$_2$ is very low and cannot contribute to an increase in arterio-venous difference with increasing altitude, as for the untrained subjects. The low venous PO$_2$ is responsible for the low arterial O$_2$ saturation, associated with a blunted hypoxic ventilatory response. In conclusion, peripheral O$_2$ diffusion is mainly responsible for the greater decrease in performance in trained than untrained subjects at moderate and high altitude.