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FROM THE AMA NATIONAL CONFERENCE HIGH ALTITUDE PERFORMANCE AND NOTES ON WATER SPORTS.

Contestants in the 1968 Olympic games will find that the México City location presents problems. The 2240 meter altitude can cause a fall-off in performance. However, studies recently conducted in the mountains of New Mexico indicate that the athlete can acclimatize himself to conditions of lowered barometric pressure, with little or no loss in performance capability.

Bruno Balke, M.D., of the University of Wisconsin, former head of the biodynamics section of the Civil Aeromedical Research Institute, Oklahoma City, reported the studies at the Sixth National Conference on the Medical Aspects of Sports.

Athletes in the endurance events, such as distance runners, will be most affected by high Mexican altitudes, Dr. Balke said. Sprinters on the other hand will experience almost no impairment of normal performance, even without acclimatization. Sprint-type efforts depend upon so-called "anaerobic work capacity", unaffected by immediate environment, whereas strenuous effort lasting beyond forty to sixty seconds is a function of "aerobic work capacity". This is directly affected by reduced concentration of oxygen at high altitude.

Dr. Balke explained that cardio-respiratory adjustment to sudden increase in energy expenditure is relatively slow. Violent efforts of less than one minute's duration cannot be covered by the external oxygen supply. Instead the body performs while incurring an "oxygen debt" which is later restored. The oxygen debt capacity, or anaerobic work capacity, is determined by factors of age, muscle mass, myoglobin content, buffering capacity of blood and tolerance of pain. Lower atmospheric oxygen will not lessen the duration of the athlete's initial burst of work. It will, however, make restoration of the oxygen debt a longer and more painful process.

Oxygen debt capacity loses significance in strenuous activity of greater duration. After the first minute or so, aerobic work capacity controls the athlete's performance. This represents his cardiovascular capacity to utilize oxygen from the atmosphere. It depends on the volume of blood in circulation, the amount of his blood actually reaching the working tissues, and the concentration of oxygen available for gas exchange in the arterial blood. The last factor is the one affected by high altitude: slightly lower oxygen saturation of arterial blood can cause cardiac limitations in strenuous efforts sooner than expected.
During the summer of 1964, field studies of the altitude factor were conducted at Red Rock, New Mexico, whose 2300 meter altitude is similar to that of Mexico City. An Olympic pentathlon contestant, a middle distance college runner, a medical student excelling in cross country events, and laboratory personnel, were the test subjects. Time trials and laboratory tests of work capacity were conducted at a control location (Oklahoma City) and at the New Mexico site, where the athletes underwent a 10-day period of training and hiking into even higher mountain country.

Aerobic work capacity was determined by heart rate, pulmonary and blood pressure studies, first at Oklahoma City, then after two or three days at Red River, and after the 10-day training period there. All subjects showed the same sign of lessened work capacity in the first test at altitude: about a 6% loss in oxygen intake capacity. The other measures of cardiac performance were unchanged. On retesting after 10-days of acclimatization and training, maximum oxygen intake capacities were back to normal in the test subjects. A slight increase in maximum breathing capacity was the only evident cardiovascular adjustment.

Dr. Balke said, further, that on return to Oklahoma City, aerobic work capacity had reached a new peak in 4 of 5 subjects, with higher maximal heart frequency and continued high pulmonary ventilation, but no change in blood pressure.

Anaerobic work capacities were rated by comparing duration of an athlete's all-out performance under a controlled work load at Oklahoma City with an identical effort at Red River. Individual results showed little variation, regardless of location of the test. Oxygen debt capacity was not affected by mild hypoxia at high altitude. On return to normal barometric pressure, anaerobic work capacity tended to be slightly higher, probably due to acclimatization.

Field tests confirmed these observations. Times for the 400 meter run, a test of anaerobic work capability, were unaffected even temporarily by change to a high altitude. The mile run, on the other hand, is a test of aerobic work capacity. The early trials at Red River's 2300 meter altitude were "considerably slower" than at Oklahoma City. After 10 days, performances were heading back toward "normal", and after returning home previously attained marks were surpassed.

Dr. Balke said laboratory tests revealed some of the reasons for the improved performance capacity. In all subjects, blood volume, hematocrit and hemoglobin were increased after 10days at altitude. This implies an increase both in maximum cardiac output and concentration of available oxygen in arterial blood. Most subjects also showed a reduction of serum cholesterol, although no special diet had been used.
Dr. Balke said this information may have some bearing on study of coronary heart disease as well as on training for sports competition. He emphasised that further extensive experimentation is required.