THE ADAPTATION OF ATHLETES TO ALTITUDE

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Experiments have confirmed the accepted view that races of half a mile up to three miles will be run at a slower speed at an altitude of 3,500 metres than they will at sea level, but it is the Marathon and other very long duration events may be carried out at a speed similar to that at sea level.

Certain physiological factors will influence performance, at altitude. Oxygen take-up drops in rarefied air. For example, the $\dot{V}_{O_2}$ in litres/minute during the last 2 minutes of 5 minutes work on the bicycle ergometer falls from the sea level value of 3.78 litres/min. to 3.41 at altitude, at work rates of (sea level) 1620 kgm/min and (Altitude) 1720 Kgm/min., the higher later figure being probably a training effect. Less oxygen is taken in to the body, but it is used more efficiently. There is virtually no difference in the oxygen debt acquired at altitude compared with the sea level value.

During exercise, there is a large fall in blood pH, the increased acidity being due to accumulation of carbon dioxide. There is also an increase in blood temperature, energy expenditure leading to heat production in the muscle, and this heat being dissipated by the circulation in the muscle. Both these factors alter oxygen dissociation of blood, leading to a fall in oxygen saturation at high rates of work. This in turn leads to the lowered oxygen carrying capacity of the blood, more significant at altitude than at sea level. This will prevent rapid bursts of speed in long duration games and races, because of lowered recovery rates.

On first reaching a high altitude, everyone experiences a drop in maximum oxygen intake, but after about a week there is some improvement, lower than the sea level value, although the performance on the bicycle ergometer shows a much greater improvement.

Heat production at altitude.

Even on a cool summer's day in England, a marathon runner has achieved a rectal temperature of 41.1°C (106°F) at the end of a race, and lost 7% of his body weight. It is usually accepted that a rectal temperature of 39°C with a 5% weight loss would cause collapse. The trained athlete has the ability to dissipate heat efficiently, and therefore has a lower rectal temperature after exercise than does an untrained man performing a task equally stressing. He may sweat at a rate of 2 litres an hour (compared with 1.2 litres an hour observed by Wyndham in South African gold miners).

At Mexico City, even if the temperature is 21°C (70°F), with low humidity, runners might collapse if races are run at mid day because of solar radiation. An early evening or late afternoon start is strongly indicated. There are several procedures that can be taken by competing teams to offset the heat hazards; some concern administration, and others the athletes' individual schedules.

Warm up. As speed falls at a rectal temperature of 40°C , the longer it takes to reach this level, the better the chances of a fast early part of the event. A long and vigorous warm up may cause this temperature to be reached before the event even starts, so warm up should not be too vigorous, and of only a few minutes duration.

Clothing. To assist with heat dissipation, there should be the legally permissible minimum clothing worn. (From a physiological viewpoint the classical Greek "dress" was ideal). Where permissible, no vest should be worn, or if regulations insist, it should be of light weight, preferable cotton, and should fit loosely to permit maximum ventilation. Nylon does not get wet, so sweat cannot evaporate easily, it is contraindicated for use in heat combined with exercise. White materials, or very pale colours, reflect heat, and are most suitable. If possible, the clothing should not be in close contact with the skin; this is worth 5°C .

Training at altitude. Repeated exercise at altitude might have great psychological benefits, so that the competitor can gain personal experience of his own performance under these conditions.

Pre altitude training. Training runs of an hour's duration whilst dressed in track suits can be beneficial, if the work is hard enough to get a high temperature, and lead to a 5% fall in body weight.

Heat stroke. This may be a serious medical hazard, which doctors and officials must keep in mind. The skin will display "gooseflesh", not sweating. Those showing signs must stop hard exercise immediately, walk quietly if possible, and be given tepid (NOT COLD) sponges. There may be changes in cardiac conduction, perhaps brought about by temperature changes in the myocardium. Standing blood pressure will fall, although it may appear normal if taken with the patient lying down.

HEAT REGULATION IS AS MUCH OF A PROBLEM FOR MEXICO AS OXYGEN INTAKE.