KEY FACTORS IN SUCCES OF ALTITUDE TRAINING FOR FOOTBALL PLAYERS

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Abstract

When players are exposed to high altitude over days, weeks and months, their bodies gradually adjust to the lower partial pressure in the air. It takes approximately two weeks to adapt to the changes associated with the hypobaric conditions at 2000m. Every 600m, increase requires an additional week of acclimatization to altitude. But, however no matter how they acclimate to the conditions at high altitudes, they never fully compensate for the hypoxia and no matter how long an individual lives at high altitude, they don't ever make up for the lack of oxygen or regain the level of aerobic power or endurance performance they could achieve at sea level.

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1. Introduction

Several high-profile clubs are forking out big money to send players to altitude training camps in an attempt to gain a competitive edge.

But is it worth the effort? How much of an impact does altitude training have on overall performance?

Acclimatization to altitude

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Content

The major adaptations occur with acclimatization to altitude:

Respiratory System Response to Altitude

- Breathing rate increases at rest and during exercise. A smaller number of oxygen molecules per given amount of air means that increased ventilation is required to consume the same amount of oxygen as at sea level.

- Oxygen diffusion decreases. At sea level oxygen exchange from the lungs to the blood is unhindered and the oxygen-carrying component of blood, hemoglobin, is about 98% saturated with oxygen. As altitude increases and the partial pressure of oxygen in the air drops, so does the pressure gradient between oxygen in the lungs and blood. This decreases the saturation of hemoglobin to about 90-92% at 2439m In effect, less oxygen passes (diffuses) from the lungs to the blood .

- The diffusion gradient at the active tissues decreases**.** As mentioned above, oxygen passes from the lungs to the blood due to a pressure gradient. The same process occurs when oxygen-rich arterial blood reaches the active tissues. The partial pressure of oxygen in arterial blood is about 100mmHg at sea level. In body tissue, it is a steady 40mmHg a difference or pressure gradient of 60mmHg. At an altitude of 2439m arterial oxygen pressure decreases to 60mmHg so the difference or pressure gradient drops to just 20mmHg - a 70% reduction. In effect, less oxygen passes (diffuses) from the blood to the tissues

- VO2 max decreases. Maximal oxygen uptake begins to decrease significantly above an altitude of 1600m .For every 1000m above that VO2 max drops by approximately 8-11%. At the summit of Everest, an average sea level VO2 max of 62ml/kg/min can drop to 15ml/kgmin .For individuals with a sea level VO2 max less than 50 ml/kg/min would be unable to move as their VO2 max would drop to 5 ml/kg/min enough only to support resting oxygen requirements .

Cardiovascular System Response to Altitude

- Blood volume decreases. Plasma volume decreases by up to 25% within the first few hours of exposure to altitude and doesnt plateau until after a few weeks. This is partially a deliberate response by the body as reducing plasma (the watery part of blood) in effect increases the density of red blood cells. While no extra red blood cells have been produced in this acute phase, the amount of hemaglobin per unit of blood (called hematocrit) is now increased resulting in greater oxygen transport for a given cardiac output.

- Red blood cell count increases. Lack of oxygen stimulates the release of erythropoietin**,** the hormone responsible for red blood cell production, within 3 hours and reaches a peak after 24 to 48 hours .The concentration of red blood cells within a given volume of blood is called hematocrit. In sea level residents, hematocrit is about 45-48%. With 6 weeks exposure to an altitude of 4540m these levels can increase to 59% .Initial exposure to altitude decreases plasma volume. However, this begins to increase slightly with long-term acclimatization to altitude.

- Cardiac output increases during rest submaximal exercise. During the first few hours at altitude stoke volume decreases during submaximal exercise, a result of the reduction in plasma volume. Heart rate increases enough to compensate for this and to actually slightly raise cardiac output. After a few days however, oxygen extraction becomes more efficient reducing the need to increase cardiac output. In fact after 10 days acclimatization to altitude results in a lower cardiac output at any given, sub maximal exercise intensity compared to sea level. While sub maximal cardiac output increases in the acute stage, following acclimatization to altitude it decreases to below sea level values. This is primarily due to a further reduction in stroke volume, which presumably occurs as changes in the oxygen-carrying capacity of the blood take the burden off the heart.

- Maximal cardiac output decreases. During exhaustive exercise at maximum levels both maximal stroke volume and maximal heart rate decrease with altitude .This obviously combines to have a significant effect on maximal cardiac output. In conjunction with the reduced diffusion gradient to drive oxygen from the blood to working tissues, it is easy to see why VO2 max.

- Muscle cross sectional area decreases. Muscle biopsy studies following 4 to 6 weeks at altitude show that slow-twitch and fast-twitch fiber area decreases by as much as 20-25%. This decreases muscle area by 11-13% .It may be that muscle wasting of this nature is due to loss of appetite that often accompanies living at altitude.

The different training strategies:

- Live high-train high – Players both live and train at a higher altitude to gain the adaptation benefits. It turns out that while adaptations do occur, the Players can't exercises as much at the higher altitudes, so the effects we're not that impressive. The lack of training intensity potentially cancels out the altitude adaptations!

- Live high-train low – This involves living at a higher altitude, but then returning to a lower altitude to train more intensely. The research is mixed, however, and most studies didn't control for the placebo effect. Furthermore, it seems elite Players don't gain much, because they already have strong adaptations, such as high red blood cell volume (RCV) – especially for elite endurance players.

- Live low-train high – This involves living at a normal elevation, and then training at higher elevations or in special facilities. It's the easiest method to sell, but there is no good evidence to suggest it works. Think about it: the typical amount of time spent at a training facility is not long enough to induce adaptations, and Players can't train as hard either!

- Intermittent hypoxia at rest – This involves repeated exposure to hypoxic air for relatively short durations throughout the day, or while sleeping. Another easy method to sell ***(masks, tents, etc.)*** but once again – no good evidence that it works. It seems these methods are missing the drop in air pressure that seems vital to making significant adaptations Acclimatization to altitude has become an important part of the preparation process for Players competing above 1500m

Health risks of acute exposure to altitude

Apart from the cold, wind and solar radiation, the players are confronted with symptoms of acute altitude sickness. This disorder is characterized by symptoms such as headache, vomiting, difficulty breathing and insomnia. These symptoms can occur anywhere from 6 to 48 h after arrival at high altitude and are most severe on days 2 and 3.

Conclusions

The players who must perform at altitude should do so within 24 h of arrival, before the detrimental side effects that occur at altitude become too great.

Alternatively, the players who must perform at altitude could train at an altitude between 2000 m and 3000 m for a minim 2 weeks prior to performing.

Altitude training relies on forcing the blood’s oxygen-carrying capacity to respond to reduced partial pressure of oxygen: the “thinner air” at altitude. To do this, the red blood cells’ hemoglobin mass increases, allowing blood to carry more oxygen to the muscles and resist fatigue.

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