Altitude training for long distance runners.

My first altitude training experience corresponds to a concentration together with a group of companions of the national pre-selection of Venezuela for the Pan-American Games of Caracas in 83, this concentration was held in Mexico City.

Even though I live in Lagunetica, an hour town from Caracas which is located at 5,000 feet high above sea level, the transfer to Mexico City produced on me a series of internal sensations, as well as a mood change that they practically made the nineteen days elapsed there seem like they would never end happen.

To be able to plan permanence in the altitude it is necessary to define the impacts that the different altitudes have on the organism. In that sense, there have been many studies that have been made to decipher those changes, and so far it seems that according to the effect the found there are different responses of the body, so depending on these effects the altitude can be defined in:

High altitude 2,400 to 4,200 meters above sea level.

At this altitude is located the threshold at which the great physiological and metabolic changes in the organism take place and is the most used by most of the runners in the world.

Very high altitude 4,250 to about 5,500 meters above sea level.

Training at those levels is almost impossible since at that altitude the conditions are so severe that they do not bring great benefits to the body and by the contrary, training there represents a risk to the health, however, especially for climbers it is common to make camps adaptation as preparation for more intense promotions.

Extreme Altitude 5,500 to 8,849 meters above the sea.

Undoubtedly, these heights are reached by well-trained mountaineers, from then, the changes that occur there are so severe that they do not allow athletic training, and if so, the intensity of it would be so low that it would not represent profit for the athlete and possibly of deterioration at the metabolic level.

Physiological changes produced by altitude:

Decrease in arterial oxygen saturation. Which is due of deterioration in the diffusion capacity of oxygen in the lungs, as well as to the lowering of partial pressure of oxygen due to altitude. Of course, this parameter will vary from according to the exposure time, the individual characteristics of each athlete and the altitude where stay. Some studies have shown that starting at about 1,500 meters of altitude above sea level, VO2MAX declines approximately 1% per 100 meters that it rise. Hypoxemia compromises the distribution of oxygen to tissues, this due to that the Oxygen Partial Pressure is lower than the alveolar partial pressure even during the maximum hyperventilation. Other studies have shown that the decrease in arterial oxygen saturation is due to two primary

factors: the decrease in oxygen partial pressure and a worsening in the exchange of gases at the pulmonary level.

Increase in pulmonary ventilation.

Those people who have had the opportunity to visit and climb the Cable Car System Mucumbarí of the Bolívar Peak, in Mérida,Venezela, which with its 12.5 km of extension and reaching an altitude of 4,765 m.s.m. one of the highest and longest in the world, can feel that when arriving at its last station their breathing increased very fast, that (hyperventilation) is the first sign of adaptation to altitude, and is due to the decrease in barometric pressure, there is a drop in the partial pressure of oxygen in the air that is breathed, and the pressure gradient between the alveolus and the venous blood of the pulmonary capillaries decrease at altitude causing the oxygen pressure in the arterial blood to reduce, it is due to sensors at the level of the aorta and carotid bodies which are so sensitive to these changes, making the respiratory center to increase pulmonary respiration to compensate those changes.

This is perhaps the first change that occurs from the moment of arrival at altitude. To the first 30 minutes of exposure to hypoxia, the organism through those sensors stimulates breathing, producing hyperventilation in order to compensate for the low atmospheric pressure and the partial pressure of oxygen at arterial level.

Hem concentration.

Once the altitude is reached, the blood plasma decreases by approximately 10 to 15 %. According to some studies, this decrease in blood plasma is due to the loss of fluid in the intracellular spaces, hypoxia and altitude are the possible mechanism for this happens. As the altitude increases, the environment temperature decreases, it produces very important losses of liquid because when inspires cold air, it heats up inside the lungs so it would expel more amount of water vapor from the body, which when exhaled causes to lose water.

Increase in hemoglobin and hematocrit levels.

The main objective of training at altitude is to increase the levels of red blood cells in the blood to theoretically have better results in long distance races. They have not been fully verified the mechanisms by which erythropoiesis is regulated in the organism. Seems to be that it depends of a balance between production and degradation of erythropoietin, as well as a changes at the plasma level. This plasma level is lower in people who live in the altitude than those who live at sea level. As it is known, the amount of oxygen that blood can carry is determined by the hemoglobin concentration in this. This is how the adjustments in the ability to transport oxygen depend of the production of red blood cells and hemoglobin.

There are renal sensors which, when released, regulate the formation of erythropoietin, and the marrow bone stimulates the production of erythrocytes. In hypoxic conditions, these sensors are stimulated so it is presumed that the sensitivity of those oxygen sensors depends of the radius of oxygen supply to the kidney and the consumption of this the erythropoietin production.

Blood PH levels Increases.

As a result of hyperventilation, carbon dioxide decreases and PH increases. When passing the time these levels of PH tend to regularize to values close to the basal level from sea. This increase in PH levels has a blocking effect and prevents the muscle from acidify to an extreme degree.

Metabolic changes produced by altitude:

Decrease in the ability to use lipids.

When reaching the altitude there is an increase in the basal metabolism, an increase that is normalized with longer stays in it. So, as acclimatization is taking place at altitude the fat absorption capacity is increased to meet the demands of the organism, requirements that are greater during exercise. Some scientists maintain that lipolysis is stimulated at the level of the adipose tissues in the human body, releasing acids fatty acids in the blood which contributes significantly to the saving of muscle glycogen.

This is undoubtedly of great importance in long distance running and with intensities of less about 70% of Vo2max.

Decrease in muscle mass.

It seems that chronic hypoxia decreases the percentage of skeletal muscle hypertrophy. This is probably due to certain hormonal variations and a decrease in the values of insulin. Although, it has been shown in some studies that the human growth hormone (HGH) is increased by exposure to altitude, but that stimulus is counteracted by the decrease in insulin levels. However, it seems that this decrease in the size of muscle fibers occurs at extreme altitudes, and at about 2,000 meters above sea the mass muscle does not suffer major decreases. At 4,000 meters altitude, something like altitude of the Collado del Cóndor at the Venezuelan Andes if a biopsy is performed to an inhabitant of that Andean area a reduction in the size of the muscle fibers would be appreciated, mainly due to the loss of myofibrial proteins.

It is not known for sure if this is due to exposure to hypoxia or nutritional factors.

Based on my own experience al altitude, as the achievements obtained by the athletes that I had the fortune to train and for the achievements that have been observed by many runners in the international arena, I concluded that the use of altitude training is of great help to obtain good results in competitions and trainings, even more, if these will be competing at altitude.

In my opinion migration to altitude, especially in the phase of general preparation, and if the training has been dosed in an efficient manner, with the participation of an interdisciplinary team and where factors are taken into account nutritional, hydration, with constant evaluations of biochemical variations and hemoglobin, it will be possible to obtain an improvement in the results in competitions when competes at low levels and even more so when they are in areas with considerable elevation above the sea level.