Altitude Training for Sea Level Performance: Best Practices and Timing for Championships

2011 IAAF Athletics Championships Daegu, South Korea

Introduction

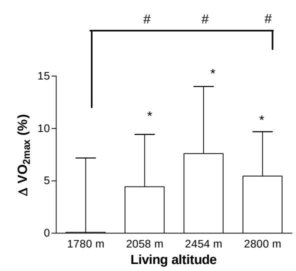
The 2011 IAAF Outdoor Track & Field Championships will be held in Daegu, South Korea from <u>August 26 to September 4</u>. Between the end of the USA Championships and the start of the World Championships there are 62 days, allowing distance athletes (who so desire) adequate time to complete an altitude training camp. Below is information regarding potential impact, the latest scientific information on best practices for executing an altitude training camp, and current knowledge on appropriate timing of the camp relative to the date of championship competition.

Altitude Training for Performance Enhancement in Distance Events in Daegu: How much can it help?

USOC and USATF sponsored research studies utilizing a 28 day "live high – train low" approach to altitude training in elite distance runners have shown an average improvement in 3000m or 5000m time trial performance at sea level of between 1.1% and 1.5%. For our athletes at the World Championships, this amount of improvement can have a significant effect on race outcomes. In the research studies, some athletes who were strong "responders" to altitude training showed improvements of up to 5% in race performance after 28 days of "high-low."

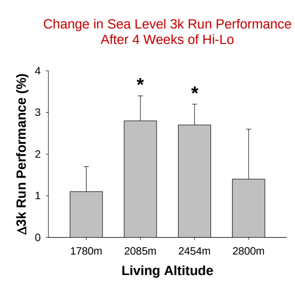
Best Practices for Executing an Altitude Training Camp for Sea Level Performance

In recent years, there has been a great wealth of applied sports science research conducted on the best and most effective way to execute an altitude training camp for the purposes of enhancing performance in sea level competitions. Below is a list that summarizes the data and currently accepted "best practices" from the scientific and coaching communities. NOTE: these recommendations are specific for altitude training for <u>competitions at or near sea level</u>. The recommendations for altitude training for <u>competitions at altitude</u> are different, and are described on another handout specific for the 2011 Pan American Games in Guadalajara, Mexico.



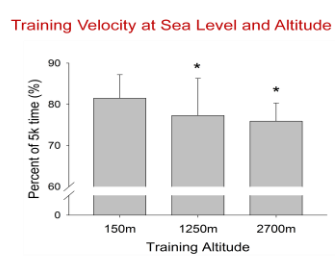
A. <u>How high to live</u>. One of the primary purposes for a distance athlete to live at altitude is to increase the number of red blood cells in the body, and thus increase the amount of oxygen delivered to muscles during exercise. In general, the higher an athlete lives, the greater the production of erythropoietin (EPO), the hormone that controls red blood cell production. However, there appears to be both a minimum threshold altitude for red cell production, as well as a ceiling, above which adaptation and performance may ultimately be impaired.

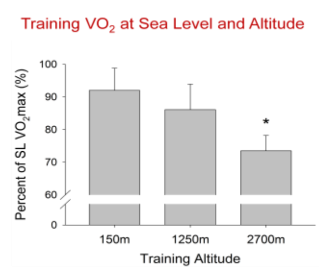
In a well controlled research study, a group of athletes completed 28 days of "high-low" altitude training, with the group divided into four different living altitudes: one group each living at 6000ft, 7000ft, 8000ft, and 9000ft (on the graphs below 1780m, 2085m, 2545m, and 2800m). The study showed that as altitude increased, the athletes generally made more EPO. However, only the groups that lived at 7000ft and above showed an increase in maximal oxygen consumption (VO_2max), and only the athletes who lived at 7000ft and 8000ft showed an improvement in 3000m race performance after the altitude training camp. The groups who lived at 6000ft and 9000ft showed no change in race performance after altitude training.



Therefore, it appears that there is likely a narrow window of an "optimal" altitude where elite distance athletes should live to get maximum performance benefit. Living at lower altitudes below this window does not provide enough stimulus to increase EPO and number of red blood cells. Living at higher altitudes above the window does not increase the volume of red cells appreciably, while adding negative components of altitude acclimatization and adaptation which ultimately impairs potential performance enhancement.

Best Practice Recommendations: For <u>optimal</u> hematological (blood) and performance response, athletes completing an altitude training camp should live at altitudes nearer to 7000 – 8000ft. Some athletes can live outside of this window and receive a performance benefit; however, most will respond best by living within this window.

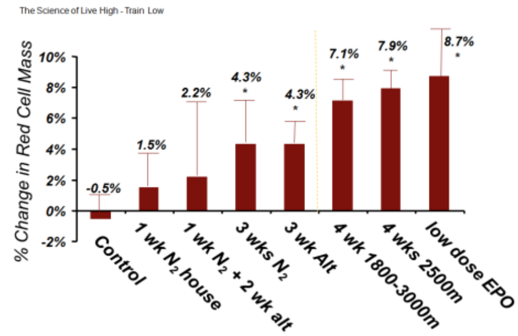




B. <u>How low to train</u>. Historically, altitude training research studies where athletes completed "classical" altitude training – where the athlete lives and trains at altitude – has produced mixed results. One potential factor is that when athletes train at altitude, they run at a slower velocity and with a lower oxygen uptake. Both training velocity and oxygen uptake (VO_2) are important stimuli to cause training adaptations and fitness improvements. To address this training limitation at high altitude, researchers devised the "live high – train low" altitude training model. With "High-Low" the athlete lives at altitude, but completes all high intensity training (typically 2-3 days per week) at a lower altitude. In the graphs on the right, athletes completed their training at 2700m (8900ft) slower and at a lower VO_2 than at both 1250m (4000ft) and at sea level, but this reduction was mitigated by training at a lower altitude of 1250m (4000ft). However, it is important to note that for some athletes, while training at the "lower" altitude of 4000ft can help, it will still be too high for some athletes. Additionally, multiple research studies show that for effective execution of the "high-low" model, only high intensity workouts need to be completed at low altitude. Gentle runs (at a pace slower than the lactate threshold pace) can be completed at high altitude, making a high-low camp logistically easier to complete.

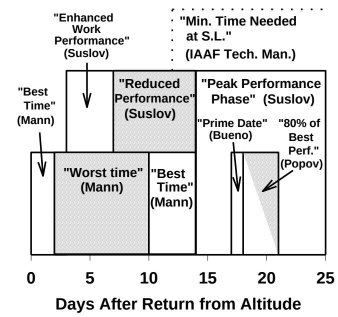
Best Practice Recommendations: Athletes should complete all high intensity workouts (i.e. repetitions longer than 90s in duration and faster than lactate threshold pace) at a low altitude. An altitude of 4000ft appears to be low enough for the majority of athletes to gain a positive training effect. However, some athletes may need to go lower than 4000ft to gain the most benefit from high intensity workouts. As a general rule, "as low as possible" is the best altitude choice for high intensity workouts.

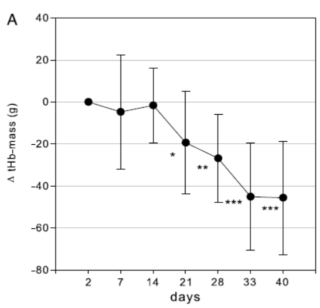
C. <u>How long to stay at altitude</u>. From the graph at the right showing the increase in red cell mass with varying lengths and types of altitude or hypoxic exposure, there is a clear and significant increase in red cell mass of about 4% after 3 weeks at altitude. However, it is important to note that the difference between 3 weeks and 4 weeks is quite large. By staying one extra week, the increase in red cell mass almost doubles to nearly an 8% increase.



Best Practice Recommendations: Living at altitude for 2 weeks or less is largely ineffective in increasing red cell mass. Living at altitude for 3 weeks produces, on average, a 4% increase in red cell mass, which is large enough to produce an improvement in sea level performance. However, staying at altitude for an additional week, out to 4 weeks, nearly doubles the increase in red cell mass to 8%. Therefore, we strongly recommend planning altitude camps to be a minimum of 4 weeks in duration.

D. <u>When to come down from altitude prior to a major competition</u>. Among scientists and coaches, there is no universal recommendation as to when to return to sea level prior to a major competition. The graph at the right shows the wide-ranging beliefs on the topic, with most of the evidence as being anecdotal. There are normally three major physiological considerations for timing an altitude camp prior to a major competition: a) the rate at which the additional red blood cells are naturally removed from the body, b) time needed to regain a feeling of neuromuscular and biomechanical "turnover," and c) the influence of added ventilation upon return for altitude.





Red blood cell decay rate. Although red blood cells typically live for 120 days, most evidence shows that upon return to sea level from altitude, the decay in red blood cell mass is quicker. In the graph on the left, Kenyans who travelled from Nairobi to near sea level in Germany showed a significant decline in total hemoglobin mass at 21 days, and a return to pre-altitude (normal) levels after 30-40 days. This data would suggest that it is better, from the perspective of added red blood cells enhancing performance, to compete sooner rather than later after return from altitude training. However, keep in mind that most athletes will have the ability to train harder and faster at sea level, returning from altitude in a natural "blood doped" state. This increase in training induced fitness appears to have the ability offset the slow decline in red cell mass over the 30-40 days at sea level after the altitude camp, extending the performance gains to 30 days or longer after return in some instances.

Biomechanical / Neuromuscular factors. Many athletes note a sensation of feeling uncoordinated or lacking turnover at fast speeds upon return to sea level after an altitude training camp. It is theorized that because the athlete will do most runs at altitude at a slower pace, over the course of 3-4 weeks at altitude, there may be a subtle change in either running mechanics or in neuromuscular recruitment. To test this, researchers measured stride length, stride frequency, time on the ground and time in the air at speeds from 800m pace to the marathon in a group of elite distance runners before and after 28 days of High-Low altitude training. In the end, there were no differences from pre-altitude to post-altitude in any of these variables related to running mechanics or neuromuscular recruitment. However, these athletes did complete the High-Low model, where they went to a lower altitude 2-3 times per week for all high intensity workouts.

Added cost of breathing with altitude acclimatization. After 4 weeks of altitude training, breathing at any given pace and during maximal exercise at sea level is typically elevated, compared to pre-altitude camp levels. This is due to a process called ventilatory acclimatization. The "cost" of work of the added ventilation has been estimated to be as much as 20% of the increase in VO_2max after altitude training. The added ventilation will slowly go away with time at sea level, but how quickly this occurs is not known. Athletes should note their sensation of breathing effort upon return from altitude, note when the added breathing seems to go away, and consider scheduling competition accordingly.

Best Practice Recommendations: The data on when to return to sea level prior to a major competition is currently unclear. Specifically for competing in Daegu, where the conditions will be hot and humid and time zone adjustment will be needed, most athletes would likely benefit from 2-3 wks of warm weather sea level training. This will allow for both heat acclimatization and time zone adjustment. The individual nature of this response may require athletes and coaches to do individual trials to determine the best time for each athlete.

F. Iron Supplementation. A key factor in producing extra red blood cells while at altitude is the athlete's iron status. Athletes should have serum ferritin measured at least two weeks prior to departure for altitude, and for optimal red blood cell production, should aggressively supplement before and during the altitude camp to keep ferrtin levels above 30 mg/dl (men) or 20 ng/dl (women).

Recommended Locations for Altitude Training

Flagstaff, AZ (low altitude sites in Sedona, Camp Verde, Phoenix)
Park City / Deer Valley, UT (low altitude sites in Salt Lake City)
Mammoth, CA (low altitude sites in Bishop)
US Olympic Training Center, Colorado Springs

Contacts for more information or questions:

Robert Chapman, PhD – USATF
317-713-4669 robert.chapman@usatf.org
Randy Wilber, Ph.D. – USOC
719-866-4528 randy.wilber@usoc.org