

MODERATE AND EXTREME HYPOXIA AS A POTENTIALLY TRAINING STIMULUS. DIFFERENT APPLICATION WAYS TO INTEGRATE ON A TRAINING PROGRAM.

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ABSTRACT

Since High altitude training has taken part in a big number of middle distance runners and long distance runners. different ways to focus the hypoxia/normoxia workouts have been developed for the physiologists and coaches worldwide. There are no scientific evidence that living high/Training high vs Living High/Training Low can be shown as the best training method and also due to human being diversity the physiological response will be different for each subject. Also according to period of the season and distance event in which the runner is going to take part and coaches should consider what methodology will allow for their runners to achieve higher performances.

Extreme altitude (+3500m/ O_2 conc 13,5%) has been refused by big number of researchers but as we find in the research of (Qadar Pasha et al., 2003) a higher level of SA O_2 , if present in an individual, could be of immense utility to develop a mechanical work like run. With this work we try to show how an expert runner under moderate hypoxia conditions (+2100m/ O_2 conc 16,1%) can achieve a better performance combining normoxia conditions (O_2 conc 20,9%) with artificial normobaric extreme hypoxia conditions, decreasing his SA O_2 under exercise and resting conditions to create a greater potential erythropoietic stimulus.

Dr. Gundersen say's for endurance sports similar levels of oxygen flux required in the competition must be part of the weekly altitude training program to avoid loss of that ability to generate high rates of oxygen flux required for succesful level in international competition but Is the LH/TL the best method for 10000m and marathon runners? Is in middle distance runners the best method in a base period?

Keywords: extreme, moderate, normoxia, hypoxia

Since I began my professional career as a wheelchair athlete in 2003, high altitude training has been integrated as part of my training program by all my coaches since 2003 til 2008 and as trained myself after Beijing Paralympic Games.

My first Hypoxia experience was in October 2003 where I remained in Sierra Nevada High Performance Sports Center at 2320m (O_2 conc 15,7%) for 21 days as as a conclusion of that stage I can say that my red cells didn't increase significantly and in my case what (Friedman B et al., 2005) revealed that 2220m for three weeks elevated Hb_{mass} by 6% it didn't happen to myself, of course, I need to explain how was my training in high altitude in my first three stages that I carried on:

- TH/LH
- Exhausted loads
- Not enough recovery

By the end of my thrid stage in August 2004 I began to have a better response to hypoxia hypobaric conditions and I increased my eritrocites mass in 14%.

In 2006 I repeated two stages of 19 and 20 days respectively in Sierra Nevada and results in red cells and Hb_{mass} didn't change significantly so I spoke with my coach to make some changes for 2007 season.

I began to train for my 2007 season in October and I moved from 1500m to 5000m. We did an hemogram test before going to Sierra Nevada for a three weeks training and we created new training rules for high altitude training camp:

- TH/LH
- Maximun intensity would be delimited by LT
- Bigger recovery between reps
- Recovery between intervals would be as less 96 hours
- In the first 72 hours there would be only aerobic work delimited by AT and alactic loads

After three weeks where I accomplished 180-185-190Km and 13 sessions/week with a bicotidian sistem from Monday til Saturday and a recovery session on Sunday, my red cells were increased in a 9,75% and hemoglobine increased in 11,6%, so we began to think that some changes in my training structure, could make big differences in red cells mass and also LH/TH could be a powerful training system with a potentially erythropoietic effect.

In May 2007 I remained for 10 days in Flagstaff, Arizona (2100, O₂conc 16,0%) and right after come back Spain I did a three weeks stage in Sierra Nevada, where I began to use the LH/TL system and made me increase a little bit more my red cells mass, also I need to detach my world record in 1500m (3'36''04) and 10000m road (23'27'') that I set 19 days and 23 days after finish my high altitude training camp but just detach that twelve days after finish training camp my perfomance in a race celebrated in New York was 39 seconds slower than a year before and just a week before in Toronto I set a new world record in 10000m road (24'03'') in the fourth day after finish my training camp. So as a conclusion we knew that my perfomance was good first four days, then there was a biological crisis between first and second week and my erythropoietic effect was potentially bigger after second week. We decided to make an study of my hematological results for several days after a four weeks stage in winter winter, where I would post my next high altitude camp.

On 4th February 2008 I began my first high altitude stage for Olympic season. It was my first four week stage and I accomplished 65 sessions in 28 days. I did 14-14-19-18 sessions weekly at 2650m (ski cross country) / 2320m endurance workouts and alactic / 690m (Intervals).

That was a week structure in this training camp:

M: 30min reg / 90min cross country ski + / Gym + Medicine Ball + Technique + 6x60m + 6x50m + 2x100m

T: 30min reg / 75min cross country ski + Electroestimulation / 6Km + 20x400m (690m) (Avg. 64'') Rec:60''

W: 30min reg / 75min cross country ski + Electroestimulation / 16Km (AT) + abdominal proprioception

Th: 30min reg / 75min cross country ski / Gym + Medicinal Ball + Technique + 6x60m + 6x50m + 2x100m

F: 30min reg / 75min cross country ski + Medicine Ball + Electroestimulation / 14Km (AT) + abdominal proprioception

S: 30min reg + Abdominal Proprioception / 6Km + Technique + 4 x3000m (690m) (8'00''/7'57''/7'59''/7'51'') Rec.3'

Su: 60min cross country ski / 8Km Kreg

All sessions were accomplished at 2320m, except intervals which were done at 690m and cross country ski sessions which were at 2650m.

I need to detach that my oxygen arterial desaturation was decreased from 93-94% from last stages to 97% and that make me realize that Sierra Nevada hypoxic environment couldn't be maybe the highest potentially erythropoietic stimulus for my better adapted capacities to moderate hypoxia conditions.

After four weeks Hb_{mass} was increased in 13,7% and eritrocites were increased in 15,35%, also we did hemograms on 2nd, 3rd, 5th, 8th, 9th, 10th, 11th, 12th, 16th, 25th. 33rd after finish training camp and they showed that best results shown in red cells and Hb_{mass} were 3rd and 9th and that there was a biological crisis on 10th and 12th days after coming down to sea level, so we should avoid those days for competition and even for an intensive training.

I did an stage in Flagstaff, Arizona (2100, O_2 conc 16,0%) from 10/05/08 to 25/06/08 and where I focus all my training in my improvement of endurance qualities (Increase AT and LT) and increase my red cells and Hb_{mass} .

Due to we haven't the chance to train at sea level because it would take me a long drive to training facilities, we fixed some training factors for this training camp:

- LH/TH
- High volume of aerobic capacities
- There wouldn't be anaerobic lactic loads

In those 45 days I accomplished 58 sessions and 871Km and right after some competitions in the US where my performance wasn't the best due to I didn't carry on any specific workouts, I comeback home and 28 days after finish this stage in Flagstaff I moved to Sierra Nevada for a five weeks stage.

That was a week structure in Flagstaff:

M: Morning off / 20Km Reg + 5x80m accelerations

T: 20Km Reg + 5x80m accelerations / Evening off

W: 15Km Reg + 5x80m accelerations / 23Km AT + 5x80m accelerations

Th: 15Km marathon pace+ 5x80m accelerations / 4Km + Dynamic stretching + Technique + 5x80m accelerations + 3x(10x80m field) + 3x80m + 2Km + Rec. 30''/3'

F: 18Km Reg + 5x80m accelerations / 2Km + Technique + 5x80m accelerations + 2x(10x150m) + 1Km + Rec. 40''/8'

S: 15Km marathon pace + 5x80m accelerations

Su: 15Km Reg + 5x80m accelerations

For five weeks stage in Sierra Nevada prior to Beijing Olympics and due to in last stage on February we observed a 97% SaO₂, we decided to decrease the Conc O₂ with an hypoxic altitude tent (mask device). Those were the bases for this training camp:

- We would make an introductory period of 72/96 hours with loads below and in the AT, before begin to sleep higher that the center environment (2320) with the tent (2hours nap + 9 hours night)
- We would divided loads at 2320m altitude (Below AT, AT and between AT and LT or marathon pace) and loads at 690m altitude (Above LT). LH/TL
- We would increase altitude levels with tent depending on the SaO₂ observed

daily with a pulxiosimeter. Measurements would be done 15min after begin nap and 15min after after starting to sleep at night.

- Hematological test would be done on 4th, 8th, 15th, 22nd, 25th and 33rd right after regenerative days.
- Altitude increase would follow this structure 2320m (O₂conc 15,7%), 2700m (O₂conc 14,8%), 3050m (O₂conc 14,2%), 3500m (O₂conc 13,5%), 3900m (O₂conc 12,8%), 4300m (O₂conc 12,2%), 4400m (O₂conc 12,0%)
- After finish high altitude camp we would follow sleeping 11 hours at extreme altitude (nights 35 and 36) with a really easy training low.

First week training structure in Sierra Nevada stage before increasing altitude:

Su: Travel to Sierra Nevada

M: 10Km reg + 5x80m accelerations + Medicine Ball + Electroestimulation / 15Km reg + 5x80m accelerations + abdominal propioception

T: 10Km reg + 5x80m accelerations + Medicine Ball + Electroestimulation / 15Km reg + abdominal propioception

W: 12Km reg + 5x80m accelerations / 20Km AT + 5x80m accelerations + abdominal propioception (**Begin to sleep at 2700m**)

Th: 12Km reg + 5x80m accelerations + Medicine Ball + Electroestimulation / 20Km reg + 5x80m accelerations + abdominal propioception

F: 14Km reg + 5x80m accelerations + Medicine Ball / 23Km AT + 5x80m accelerations + abdominal propioception

S: 14Km reg + 5x80m accelerations + 28Km AT + 5x80m accelerations + abdominal propioception

Su: 10Km reg + 5x80m accelerations + 10Km reg + 5x80m accelerations + abdominal propioception

Third Training week structure in Sierra Nevada:

M: 18Km reg + 5x80m accelerations + Medicine Ball + Electroestimulation / 2Km + Technique + Dynamic stretching + 5x80m accelerations + 2x(10x150m) +2Km + abdominal proprioception Rec. 40''/8'

T: Abdominal proprioception / 8Km + Dynamic stretching + 5x80m accelerations + 3x(3x500m) + Specific technique + 2Km Rec. 90''/8'

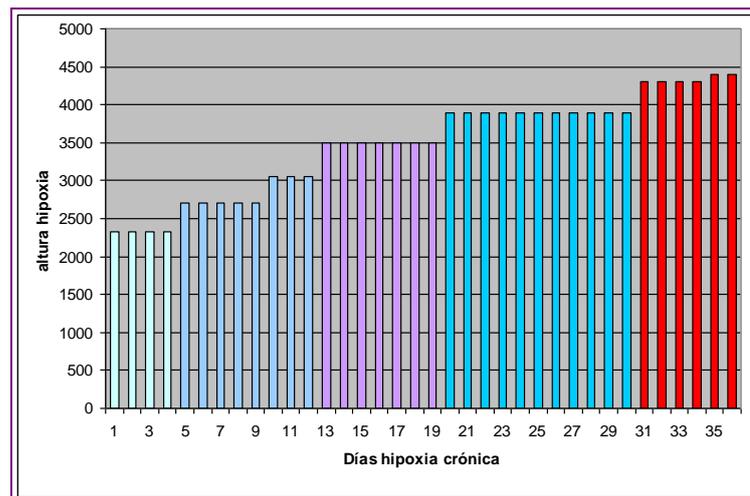
W: 18Km reg + 5x80m accelerations + Medicine Ball + Electroestimulation / 14Km Marathon pace finishing faster last 400m + abdominal proprioception

Th: 20Km reg + 5x80m accelerations + Electroestimulation / 4Km + Technique + 5x80m accelerations + 3x(10x80m field) + 3x80m curve + 4Km + abdominal proprioception Rec. 30''/8'

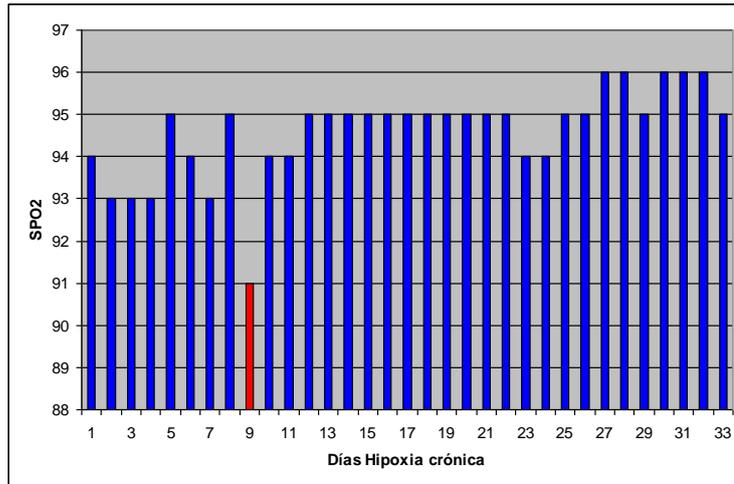
F: Rest / 14Km Marathon pace finishing faster last 400m + Medicine Ball + abdominal proprioception

S: Abdominal proprioception / 8Km + Dynamic stretching + 5x80m accelerations + 2000m (5'07'')+1500m (3'44'')+800m (1'59'')+500m (1'12'')+200m (29''3) + specific technique + 2Km Rec. 10'-10'-8'-3'

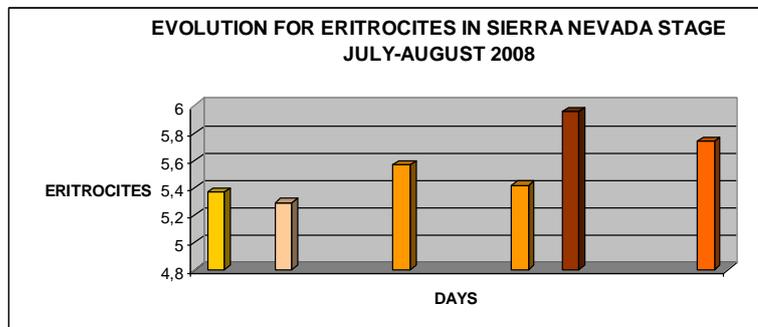
Su: 18Km reg + 5x80m accelerations + abdominal proprioception



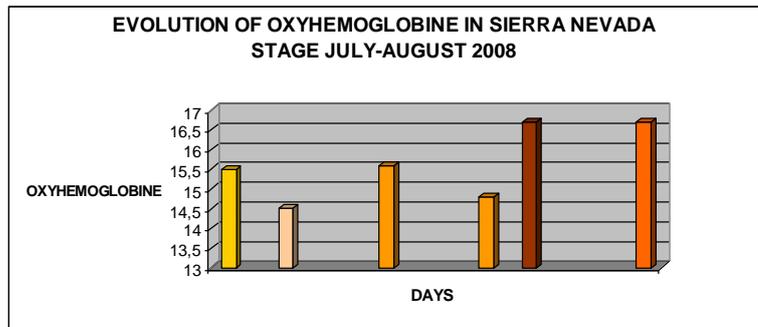
“Altitude progresión from moderete to extreme hypoxia”



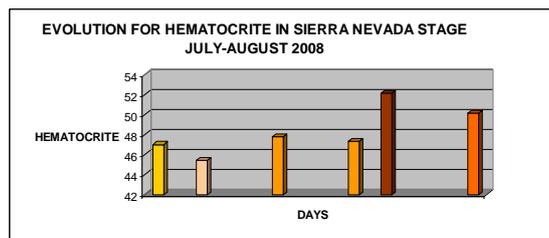
“SaO₂ at 2320m during July-August stage 2008”



“Evolution for eritrocites during July-August stage 2008”



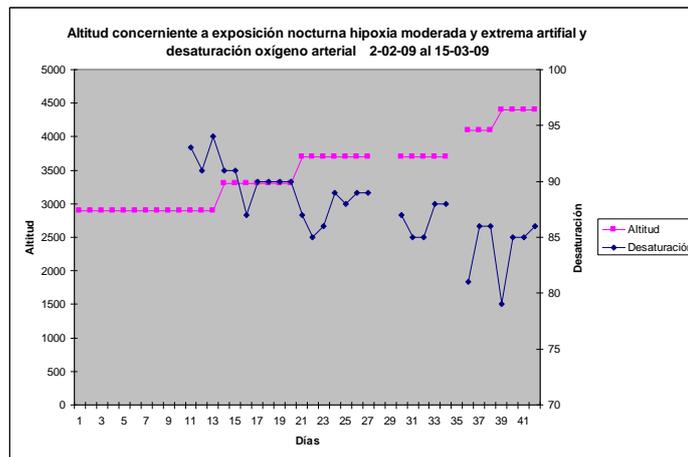
“Evolution for oxyhemoglobine during July-August stage 2008”



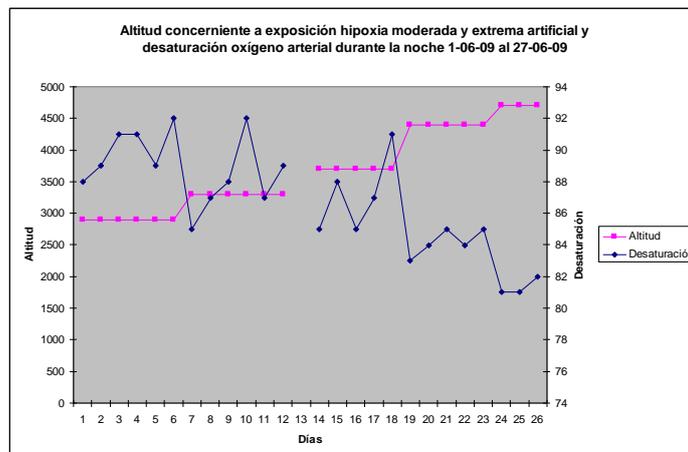
“Evolution for Ht during July-August stage 2008”

Due to an IPC (International Paralympic Committee) decision the 5000m in Beijing was scratched so I race and the marathon (there's no 10000m in wheelchair events in Paralympic schedule) and my performance was great. I led the race til last turn in the 41,4Km where I crashed with a conce and flip over. Finally I finished fourth two minutes ahead of winner who set a new world record (1h40'07''). I finished in 1h42'05''.

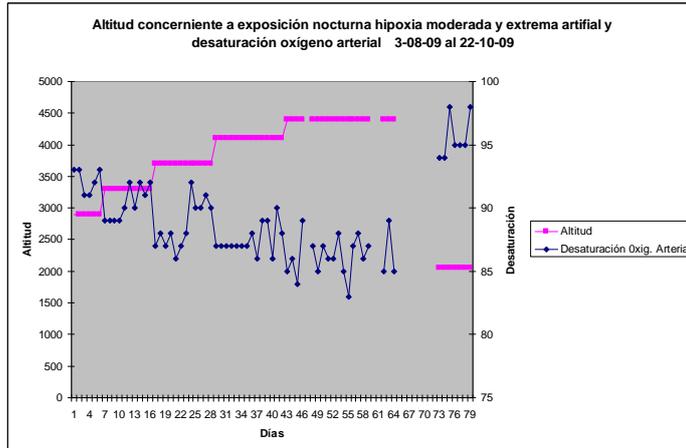
In 2008/09 season I moved to 10000m training, just before last long distance runner step (marathon training) and I decided stay home with a new system (TL/Living extreme high), using a tent for sleep (2 hours nap + 9 hours night).



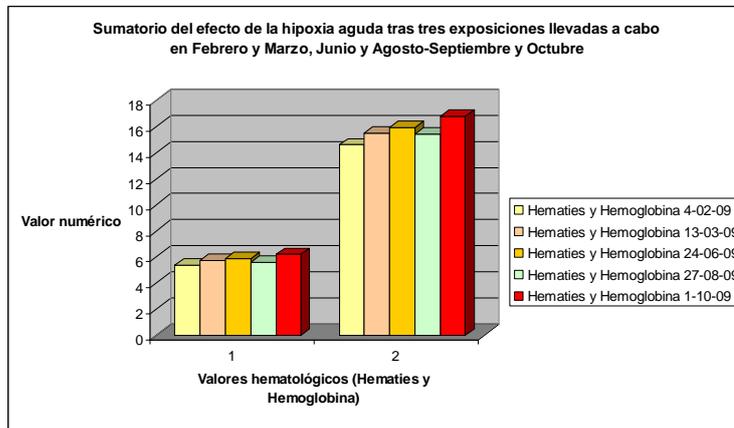
“Altitud exposure and SaO₂ February/March 2009”



“Altitud exposure and SaO₂ May 2009”



“Altitud exposure and SaO₂ August-October 2009”



“Summation effect after extreme hypoxia intermitent exposure over eritrocites and oxyhemoglobine”

As a physiological results we found the biggest increase in eritrocites mass and oxyhemoglobine if we compare with the other training methods explained before, also I set the faster ever marathon time under wet conditions in Japan (1h47'46'') and won to Athens champion and bronze medal in Beijing.

This year we have added the extreme normobaric hypoxia as a dynamic training load, using an arm ergometer and combined with normoxia loads and normobaric hypoxia resting and with moderate hypobaric hypoxia in Breckenridge, Colorado (2920m O₂conc 14,6%) but results haven't been analyzed yet.

I'll attend to extreme hypoxia normobaric conditions in Peru (3820m O₂conc 13,0%) because it seems to be a powerful erythropoietic stimulus and great conditions to create aerobic bases for long distance runners.

Biography

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