

Athletic performance and altitude response in horses exposed to simulated high altitude (3658 m)

Howe D, & GD Swanson.. Presented at 13th Annual International Hypoxia Symposium. Banff, Alberta, Canada. February 19th - 22nd, 2003.

The effect of altitude training on sea level performance in sport horses has received substantial attention in response to the demonstrated benefits of altitude training in elite athletes. Through the use of the latest altitude simulation technology as a training aid, trainers are realizing **increases in aerobic power** and endurance that reflect the horse's true genetic potential. This increased stamina and performance translates into:

- more efficient training
- faster and more complete recovery from high intensity workouts
- lower incidence of training induced stress/fatigue injuries
- reduced incidence of exertional rhabdomyolysis (tying up)

In an effort to improve athletic performance in sport horses the use of banned substances has surged. Beyond the fact that the use of these substances is illegal, many of these substances are potentially harmful to the horses that receive them. In stark contrast to illegal drug use, the use of altitude simulation as a training aid relies on nothing more than the horse's adaptive physiological mechanisms, so there are no harmful side effects or concerns about illegal drug use.

Following high altitude acclimatization horses experience enhanced oxygen delivering capacity during training and racing. There are two approaches to altitude training: you can train at altitude or you can reside at altitude and train at sea level. Beyond the practical limitations, one of the fundamental drawbacks to training at altitude (versus living at altitude) is that V_{O2max} (a measure of aerobic power output) decreases with increasing altitude, so horses that are trained at altitude cannot train as hard as they can at sea level. The result is that there is actually a "detraining" effect on sea level performance after training at altitude. In order to circumvent the detraining effects of high intensity altitude training - reductions in muscle mass, oxygen uptake, training intensity, and cardiac output - trainers have adopted the "live high, train low" approach to altitude training whereby the horses train in oxygen rich sea level elevations but sleep at higher altitudes.

The proven advantages of the "live high, train low" approach to altitude training are that horses can benefit from the physiological effects of altitude acclimatization without suffering the untoward effects of chronic altitude exposure. High-low training allows for the beneficial physiological adaptations from exposure to hypoxia with concurrent maintenance of high intensity exercise because of maximal oxygen flux during low altitude training.

Research has shown that in order to achieve the physiological benefits of altitude training sufficient exposure time is needed to allow the natural physiological

adaptations of altitude simulation to occur. Whereas **Intermittent Hypoxic Training** purports to mimic the effects of altitude acclimatization by providing short bursts of severely hypoxic air, research has conclusively demonstrated that the length of exposure with IHT systems is too short to elicit the appropriate physiological adaptive responses. In clinical research trials which studied the length of hypoxic exposure necessary for physiological adaptation, a minimum of 8-10 hours of hypoxia per day, delivered consecutively for 25 days was needed before the beneficial effects of altitude acclimatization were demonstrated on athletic performance.

Research was conducted to quantify and validate the effects of High-low training in horses. In the cross over research design, horses spent 30 days at sea level and 30 days at a simulated altitude of 3658 meters (12,000 feet) for a duration of 8 hours per day. Hematological and endurance performance measures were obtained before and after the 30 day simulated altitude exposure. Following 30 days exposure to 3658 meters the horses demonstrated the following significant alterations:

- 11% improvement in V_{O2}max and aerobic power output (as measured by time to V₂₀₀ on a stationary treadmill) – see Graph 1
- 60 second increase in total endurance time (the total amount of time that the horses could sustain maximal speed during a standardized protocol on a high speed treadmill – see Graph 2
- 19% improvement in post exercise heart rate recovery – see Graph 3

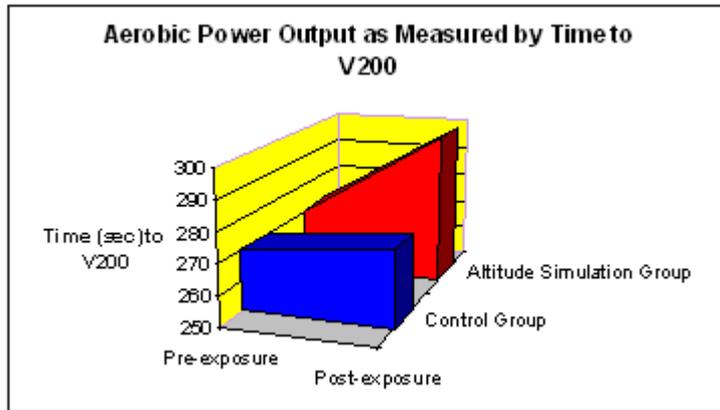
The results of this study demonstrate that 8 hours of simulated altitude exposure per day for 30 days can significantly improve the aerobic performance and stamina of horses.

The following benefits of altitude training in horses have been demonstrated in other controlled research studies:

- Increased 2,3-DPG concentration in red blood cells - resulting in improved oxygen delivery to tissues during exercise
- Significant increase in total blood volume due to increased red cell volume - resulting in increased oxygen delivery to the tissues
- Increased skeletal muscle capillarity -resulting in decreased oxygen diffusion distances in skeletal muscle and increased removal of lactic acid
- Increased mitochondrial concentration in skeletal muscle - resulting in increased metabolic capacity of skeletal muscle
- Lowered skeletal muscle lactate production - resulting in decreased reliance on anaerobic metabolism and improved aerobic capacity

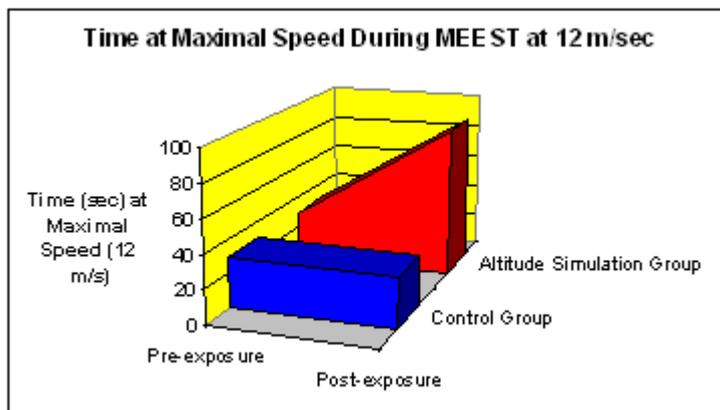
Graph 1

11% improvement in V02max and aerobic power output (as measured by time to V200 on a stationary treadmill)



Graph 2

60 second increase in total endurance time



Endurance time is the total amount of time that the horses could sustain maximal speed during a standardized protocol on a high speed treadmill.

Graph 3

19% improvement in post exercise heart rate recovery

