

RST / Turbo Studio – FAQ Altitude Training

Will “altitude training” help make me a faster cyclist?

I was asked about this a few times recently, and while it seems a fairly straightforward question, the answer is less so. The short answer is “it depends”. There are several methods of altitude training, and many circumstances under which it may (or may not) be applicable, and the impact on our bodies and endurance cycling performance varies widely.

So anyone who is using or contemplating the use of some form of “altitude training” should do some basic research to firstly define what is meant by it, as well as under what circumstances the application of such training may be beneficial (or indeed detrimental) to endurance cycling performance.

What is Altitude Training?

The basic idea of “altitude training” is to train and/or live in a hypoxic environment (lower than normal/sea-level partial oxygen pressure), either by actually being located at high altitude, or by simulating the hypoxic conditions experienced at altitude.

It can also include the use of methods to raise the partial oxygen pressure (hyperoxic training) either by use of supplemental oxygen in training, or training well below sea level (there are places it’s possible). I won’t expand further on the use of hyperoxic training in this FAQ.

Hypoxic (high/higher altitude) conditions have an acute detrimental impact on cycling power output. So why would we use it?

Well the theory is that exposure to a hypoxic environment stimulates the body’s various systems (pulmonary, cardiovascular, endocrine, skeletal muscles) to respond and adjust in an effort to provide enough oxygen to survive and that these physiological responses may also enhance endurance athletic performance. It is an area of physiological and exercise physiology research that has been widely studied.

How does one do Altitude training?

Exposure to a hypoxic environment is achieved in several ways, commonly (but not exclusively) through:

- **Actually living and/or training at altitude.**
This doesn’t really apply to Australia (or other “low land” countries), since we simply don’t have anywhere high enough for significant enough hypoxic conditions to exist¹. So if one wanted to train in this manner, you would either need to travel to another country, or use other means to simulate a hypoxic environment.
- **Training and/or living in a semi-enclosed atmosphere controlled environment** (e.g. “altitude rooms” or “altitude tents”) with either:
 - o hypobaric hypoxia (where the barometric pressure of the air is reduced, thereby lowering the partial oxygen pressure), or
 - o normobaric hypoxia (where the barometric pressure is normal but the proportion of oxygen in the air breathed is reduced, usually by increasing the proportion of nitrogen).
- **Use of “face-mask” connected to a devices that delivers hypoxic air (Hypoxicator).**

¹ As an example, Jindabyne, a popular Australian location for training camps, is less than 1000 metres above sea level.

Of the above, only being in a location at altitude allows you to train outdoors, the other two require training to be performed within controlled environments on an indoor cycling trainer/ergometer, since the enclosures and equipment are not portable.

What types of altitude training are there?

Altitude training comprises three broad methods, although there are several variations on these basic themes:

- **Live high, train high**
this may be beneficial as a unique early-season overload and also when preparing for competition at altitude.
- **Live high, train low**
can be specifically used to enhance sea-level performance
- **Live low, train high**
may be useful for enhancing sea-level and altitude performance

The above three methods typically require a significant proportion of time spent training and/or living to be done in a hypoxic environment. Even so, not all research supports the use of such training; nevertheless, there is sufficient evidence to support its considered use by well trained athletes in specific circumstances.

The combinations can be achieved by some who live in geography that enable these options, or via the use of simulated environments while living high or low.

Another option becoming available is the use of devices to enable:

- **Intermittent exposure to hypoxia (IHE) / Intermittent hypoxic training (IHT)**

These IHE/IHT devices (typically a face mask connected to a hypoxicator device) are sometimes used on an occasional basis, for relatively short times periods (e.g. once or twice per week for an hour or two while cycling on an ergometer / indoor trainer). However the evidence to support the beneficial performance impacts of such IHE / IHT is equivocal and not supportive of such a method.

To quote Dr David Martin (Senior Sports Physiologist, Australian institute of Sport):

“For those selling devices that allow the athlete to experience IHE, much anecdotal information is cited. It may be tempting to believe that changes in resting hematocrit, haemoglobin and performance after a period of IHE substantiate the effectiveness of this technique. However, rapid changes in plasma volume known to occur after exposure to altitude can explain elevations in hematocrit and haemoglobin without a true increase in red cell mass. Additionally, a placebo effect or a training effect generally can explain improvements in performance. Thus, available evidence does not strongly support the use of IHE”.

Dr Randall Wilber (sports physiologist at US Olympic Training Centre in Colorado Springs and author of the book: *Altitude training and Athletic Performance*) also says the following:

“It is unclear whether IHE or IHT improves red blood cell count and haemoglobin production despite increments in serum EPO. Data are equivocal regarding the claim IHE or IHT enhance VO₂max and endurance performance in well trained athletes”.

Should I consider using altitude training?

When deciding whether and what type of altitude training to use one also needs to consider for each individual, the:

- Current state of fitness and/or whether they are rehabilitating from injury
- Time of season
- Type of events being targeted and when
- Altitude of events / competition being prepared for
- Duration of hypoxic exposure
- Unique response to hypoxia (everyone is affected differently and strategies need to account for that)

As with all things fitness related, if you haven't already sorted the basic fundamentals of improving athletic performance, then you should not view altitude training as a "magic bullet". The best way to improve performance is through good training, good diet and ensuring sufficient recovery.

Even when training at altitude, these fundamental principles still apply, indeed much more care needs to be taken as there are many additional impacts that altitude training may create that need to be managed (e.g. heart rate responses; hydration levels; carbohydrate metabolism /glycogen depletion; iron levels; immune system; oxidative stress; exposure to UV light; sleep recovery disturbance; and altitude sickness). Power (or HR) training levels will need adjustment and everyone's responses are different.

Some scenarios for which one might consider the use of altitude training include:

- Athletes preparing for events/competition at altitudes significantly above where they typically live and train
- A cyclist who is already very fit and requires a novel overload
- An athlete seeking to enhance sea-level or moderate altitude level performance and has several weeks available for altitude exposure

In essence, the best use of altitude training is for athletes that are preparing for competition or riding at altitude.

How long does it take to attain an improvement and how long do performance benefits last?

Athletes will need to consider exposure to hypoxic conditions for several weeks. Studies have shown at least four weeks exposure to altitude is required if one is expected to derive associated haematological and muscle buffering benefits.

And this exposure needs to be a minimum of 8 to 10 hours per day.

As to how long beneficial effects last, well if one remains at altitude then they will of course maintain their adaptations accordingly, provided basic training fundamentals are followed. As for returning to sea-level, then this is highly individual and varies widely but studies have shown the beneficial effects may last for up to three weeks post-altitude.

How does altitude affect power output?

From the Wattage FAQ:

"The effects of altitude on the volume of oxygen uptake (VO_{2max}) and hence aerobic power are highly individual, so it is difficult to predict to what extent any one person will be affected, although as a general rule it has been shown that elite athletes, as compared to normal

individuals, have a greater decline in $VO_2\max$ under conditions of reduced ambient pO_2 (partial oxygen pressure). This is caused by their higher cardiac output, which results in a decreased mean transit time for the erythrocytes (red blood cells) within the pulmonary capillary, and thus less time for equilibration between alveolar air and blood in the pulmonary capillary”.

The range of impact to aerobic power varies upon altitude, individual fitness levels, whether one has acclimatised and other factors. Different research studies have found performance is impacted as follows (but individual response varies):

Elevation above sea-level (metres)	Available Aerobic Power compared to sea-level performance
1000	95 – 97 %
2000	89 – 93%
3000	82 – 89%
4000	75 – 81%

Sources: via Wattage FAQ site: <http://www.midweekclub.ca/powerFAQ.htm#Q17>

Bassett, D.R. Jr., C.R. Kyle, L. Passfield, J.P. Broker, and E.R. Burke. Comparing cycling world hour records, 1967-1996: modeling with empirical data. *Medicine and Science in Sports and Exercise* 31:1665-76, 1999.

Peronnet, F., P. Bouissou, H. Perrault, and J Ricci. A comparison of cyclists' time records according to altitude and materials used. *Canadian Journal of Sport Science* 14(2):93-8, June 1989.

More information?

The details of how and when one should consider the use of these training techniques and all of the specific issues to consider is far beyond the scope of this FAQ.

For those interested in reading further about the topic, there are a couple of very good chapters on the topic from two excellent references which cover the science and research specifically applicable to cycling:

- Professor Asker Jeukendrup's book, *High Performance Cycling*, includes a very helpful chapter by Dr David Martin on the subject.
- Dr Edmund Burke's book, *High Tech Cycling, the Science of Riding Faster*, has a detailed chapter by Dr Randall Wilbur, specifically investigating the use of altitude training in preparation for competition at sea level.

As well as an entire book on the subject by Dr Randall Wilbur: *Altitude Training and Athletic Performance*.

These are by no means the only available summaries or information on the research and scientific literature. However the above references should provide more than enough information for anyone to make sound decisions about how and when they should consider altitude training, and in what form.

Alex Simmons
Performance Director, RST Professional Training Systems
Hooper Lane Turbo Studio

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