

Altitude Training and Athletic Performance

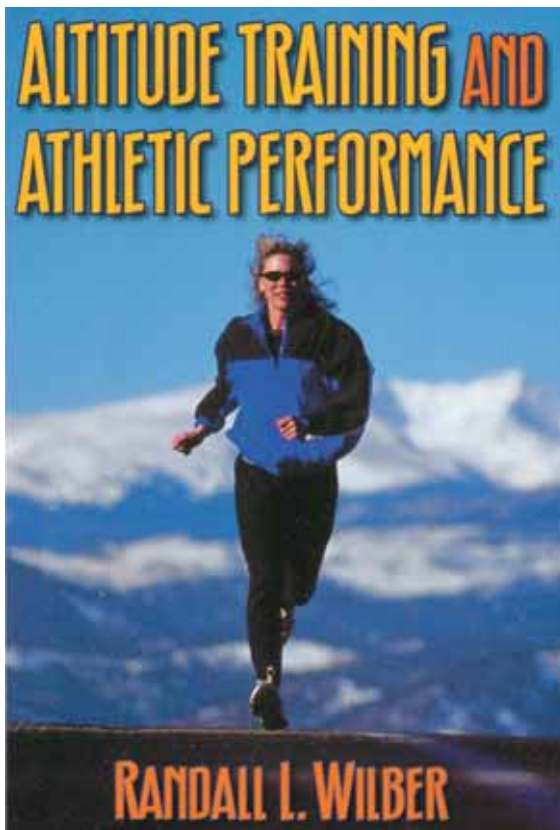
by Randall L. Wilber

The effect of altitude training on athletic performance has interested coaches, athletes, and sport scientists for many years. The key question has always been and still is: "Does altitude training lead to improvements in athletic performance?" Data from several scientific studies have failed to conclusively answer this question. Anecdotal evidence, however, suggests that altitude training can enhance athletic performance under certain circumstances.

Those athletes include Lance Armstrong (five-time winner of the Tour de France, two-time Olympian), Michael Phelps (five-time World Champion and five-time world-record holder at the 2003 Swimming World Championships), Apolo Ohno (2002 Olympic gold medallist in short track speedskating), Derek Parra (2002 Olympic gold medallist and world-record holder in long track speedskating), and Johnny Spillane (2003 World Champion in Nordic combined skiing, 2002 Olympian).

Given the not yet abated controversy on the topic of altitude training, the purpose of this book is to examine both the scientific and anecdotal evidence pertinent to altitude training and its effect on athletic performance. Without claiming to provide the definitive answer regarding the efficacy of altitude training, *Altitude Training and Athletic Performance* is designed to evaluate the efficacy of altitude training from the perspective of both scientific evidence and "real-life" practice by coaches and athletes.

The author of the book, Randall L. Wilber, is perfectly qualified to cover both the theoretical and practical side of altitude training because he is not only a researching sport physiologist at the U.S. Olympic Training Center in Colorado Springs, Colorado, but he has also worked with U.S. Olympic team athletes from a variety of sports and advised them on the scientific and practical aspects of



The introduction to Altitude Training and Athletic Performance provides a historical overview of the development of altitude training from the successes and problems that athletes encountered at the 1968 Olympics, which were held in Mexico City at an elevation of 2,300 m and triggered interest in altitude training – right up to recent scientific research, as well as today's most effective and innovative training techniques (e. g. the “live high – train low” strategy and the “nitrogen house”). The question of why athletes from altitude-based countries like Kenya and Ethiopia tend to dominate endurance events in athletics is also introduced.

Part I, “The Science of Altitude Training”, includes two chapters dealing with the physiological aspects of altitude training. The purpose is to provide the reader with an understanding of the physiological responses and adaptations of humans at altitude, as well as the ways in which some of these physiological adaptations may enhance athletic performance.

Chapter 1 describes the scientific theory and rationale for using altitude training as a means of improving athletic performance in endurance-based sports such as distance running, triathlon, road cycling, and cross-country skiing. It is believed that altitude training stimulates the release of erythropoietin (EPO), which subsequently leads to improvements in red blood cell mass and hemoglobin concentration and thus enhances the blood's capacity to deliver oxygen to the exercising muscles. Although the improvement of aerobic performance seems to be a proven effect of training at altitude, there is inadequate scientific rationale at present to support the use of altitude training for the enhancement of most anaerobic events.

Chapter 2 describes the physiological responses and potential limitations that athletes experience when living and training at altitude. For example, athletes typically have

to reduce their normal sea-level training volume or training intensity, or both, upon ascent to higher elevations. The reason is that athletes experience a number of physiological changes upon exposure to altitude that may limit their ability to compete or train. Two of the most important physiological changes that occur are altitude-induced decrements in arterial oxyhemoglobin saturation and maximal oxygen consumption. In addition, exposure to altitude may bring about changes in heart rate, hydration status, acid-base balance, carbohydrate utilization, iron metabolism, and immune function. Chapter 2 addresses each of these altitude-induced physiological changes in the context of athletic performance.

Part II, “Altitude Training and Athletic Performance,” includes two chapters that address the question “Does altitude training lead to improvements in athletic performance?”

Chapter 3 is a summary of the relevant findings of several altitude training studies within the context of athletic performance at sea level. This chapter is organised to two forms of altitude training: (a) traditional “live high – train high” (LHTH) and (b) contemporary “live high – train low” (LHTL) altitude training. The effects of these altitude training forms on sea-level endurance performance, as well as their effect on hematological variables and skeletal muscle factors are examined. The essential result of this comprehensive and detailed review of the scientific literature pertinent to altitude training is that incredibly, when all the objective evidence is weighed, one still cannot say unequivocally whether altitude training leads to improvements in sea-level performance.

Chapter 4 tries to give an answer to the following question: Do athletes adapt after living or training for several days at altitude? After a brief review of the scientific literature dealing with performance at altitude after acclimatisation, this chapter describes the altitude acclimatisation programme used

by the U.S. Olympic Team in preparation for the 2002 Salt Lake City Games.

Part III, "Practical Application of Altitude Training," includes three chapters devoted to practical and applied methods of altitude training.

Chapter 5 is based on the anecdotal evidence in support of the use of altitude training for the enhancement of sea-level performance. It describes the altitude training programs of several coaches and athletes who have attained success in World Championship or Olympic competitions. The altitude training programmes described in this chapter are organised into three groups: (1) "Traditional" altitude training camps, (2) training programs used by permanent altitude residents, and (3) contemporary altitude training programmes that utilise "live high – train low" (LHTL) techniques. Chapter 5 summarises what successful coaches and athletes consider the optimal altitude at which to train, the optimal duration of an altitude training camp, the optimal training regimen at altitude, the time to return to sea level, and so on. Although some of the altitude training programmes described in this chapter have utilised LHTL principles, LHTL altitude training may not be a viable option for many athletes because they may not have the financial means to access the geographic locales, laboratory facilities, or equipment necessary to conduct effective LHTL training. In addition, it appears that some coaches and athletes are not convinced that LHTL training is more effective than traditional altitude training in enhancing sea-level performance.

Chapter 6 describes several unique, state-of-the-art altitude training strategies and devices currently being used by elite athletes to improve performance. These include:

- normobaric hypoxia via nitrogen dilution (nitrogen apartments),
- supplemental oxygen training,
- hypoxic sleeping units, and
- intermittent hypoxic training.

This chapter provides an overview of these novel approaches to altitude training and reviews the scientific literature pertinent to each. A final section of the chapter briefly addresses the issue of ethical integrity of using these devices.

Lastly, chapter 7 provides a summary of recommendations and guidelines for effective altitude training based on the scientific and anecdotal evidence presented in this book. It also includes supplemental information such as a list of major altitude training locations throughout the world. It is once again emphasised that each athlete responds differently to living and training at altitude. Therefore, the general recommendations and guidelines presented in this chapter should be regarded as a starting point for effectively designing an individualised altitude training programme for each athlete

In summary, the book by Wilber shows that altitude training and its effect on human athletic performance is still a controversial topic among athletes, coaches, and sport scientists. The purpose of this book is to consolidate the current body of knowledge, both scientific and anecdotal, relevant to the topic of altitude training and athletic performance. For writing this book hundreds of altitude-training studies have been evaluated. It is therefore a great resource for those seeking coverage of state-of-the-art training strategies. It is unique in that it is written from both a scholarly and applied perspective and thus should be of interest to sport scientists, students, athletes, and coaches alike.

Reviewed by Jürgen Schiffer

Randall L. Wilber

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