How to Cite:
Kumar, T. R., Pallavi, A., & Kumar, C. S. (2022). A case study on altitude training and its effects of volly ball players. *International Journal of Health Sciences*, *6*(S3), 747–753. https://doi.org/10.53730/ijhs.v6nS3.5433

A Case Study on Altitude Training and Its Effects of Volly Ball Players

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***Abstract*---**Altitude training is to enhance training performance. The fundamental theory behind altitude training in that, by exposing an athlete to an environmental that is low in oxygen, (Hypoxic), the body will eventually adapt and improve its efficiency (acclimatized). In volley ball it is necessary to clarify the effect of altitude training on hematological variables, increased oxygen intake, fitness factor, molecular adaptations, and genetic adaptations acclimatization. The main objective of altitude training and team sport is to present cutting –edge research on the basic & applied aspects of altitude training to enhance match related performance in team sport. Exercise and training in hypoxic environment includes neuromuscular metabolic and cardiac vascular adaption. Despite the limited research on the effects of altitude (or hypoxic) training interventions on team-sport performance, players from all around the world engaged in these sports are now using altitude training more than ever before. In March 2013, an Altitude Training and Team Sports conference was held in Doha, Qatar, to establish a forum of research and practical insights into this rapidly growing field.

***Keywords*---**altitude, training, volleyball, assessing physical, training modalities, enhancing sports performance, elite performance.

International Journal of Health Sciences ISSN 2550-6978 E-ISSN 2550-696X © 2022.
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Manuscript submitted: 18 Nov 2021, Manuscript revised: 09 Feb 2022, Accepted for publication: 27 March 2022

Introduction

Exercise at altitude has been gaining popularity in recent decades. High altitude exercise ranges from casual hiking to highly competitive ultra-endurance races (e.g., foot race, mountain biking, cross-country skiing) and even includes team sports. Travel to high altitude has potential significant health consequences. Not only are altitude and environmental factors a concern for the athletes' safety, but access is often a barrier to appropriate medical care. For safety reasons, proper acclimatization is important for those traveling to high altitudes. Altitude training is also thought to be beneficial for athletic performance, though the evidence for this is not clear. The purpose of this article is to review physiologic changes at high altitude, altitude illness, and medical considerations for both recreational and competitive athletes. As skill proficiency increases, it is clear that overall technical and tactical effectiveness—rather than (competitive) physical performance per se—have a greater impact on winning. Over the last two decades, however, it is indisputable that team sports have experienced a tremendous increase in the tempo of play and energy demands imposed on players during matches. In this context, coaches and their staff are continuously looking for innovative ways to improve match outcomes, and moderate altitude training (~ 2000–3000m) too has emerged as a popular ergogenic aid. Precompetition acclimatization while residing at altitude (e.g., training for 1–2 weeks at the competition venue elevation) versus using altitude training to improve players' 'trainability' and competition performance in the days and weeks following return to sea level (e.g., 2–3 weeks of living high and training low during the preseason) are two distinct forms of altitude interventions that were debated by the expert panel. Despite altitude training being an area of interest for many sporting organizations—for example, *Federation International de Football Association* (FIFA), symposium on playing Volleyball at altitude and the *International Olympic Committee* (IOC), consensus statement on thermoregulatory and altitude challenges for all high-level athletes —research on the impact of altitude training for team sports is still in its infancy.

Impact of partial pressure

The human body is a highly aerobic organism, in which it is necessary to match oxygen supply at tissue levels to the metabolic demands. Along metazoan evolution, an exquisite control developed because although oxygen is required as the final acceptor of electron respiratory chain, an excessive level could be potentially harmful. Understanding the role of the main factors affecting oxygen availability, such as the gradient of pressure of oxygen during normal conditions, and during hypoxia is an important point. Several factors such as anesthesia, hypoxia, and stress affect the regulation of the atmospheric, alveolar, arterial, capillary and tissue partial pressure of oxygen (PO_2). Our objective is to offer to the reader a summarized and practical appraisal of the mechanisms related to the oxygen's supply within the human body, including a facilitated description of the gradient of pressure from the atmosphere to the cells. In high-altitude environments, you draw in less oxygen per breath than you would at lower altitudes. When they compete at lower altitudes, they get a natural boost to the muscles when additional oxygen is available. This blood expanding effect can enhance performance in elite athletes by 1 to 2 percent. In Hemoglobin concentration (Hb) 50% saturation is at 26.80mm of Hg while 50% saturation of has a higher affinity for oxygen than does myoglobin (Mb) occurs at 1mm of Hg. Therefore co-operative binding much more efficient in Hb than Mb. Mb doesn't show co-operative binding of O_2.

O_2 + Hb ------ Oxy Hemoglobin
O_2 + Mb ----- Oxy Myoglobin

Mb has higher affinity for O_2 than Hb. Although the percentage of **oxygen** in inspired air is constant at different **altitudes**, the fall in atmospheric **pressure** at higher **altitude** decreases the **partial pressure** of inspired **oxygen** and hence the driving **pressure** for gas exchange in the lungs. The role of Mb is to take up O_2 from the blood & function as a reservoir of O_2. Instead of binding of the O_2 by Mb is unaffected by the O_2 pressure in the surrounding tissue. The Figure 1 shown below is Oxygen Binding Curve:

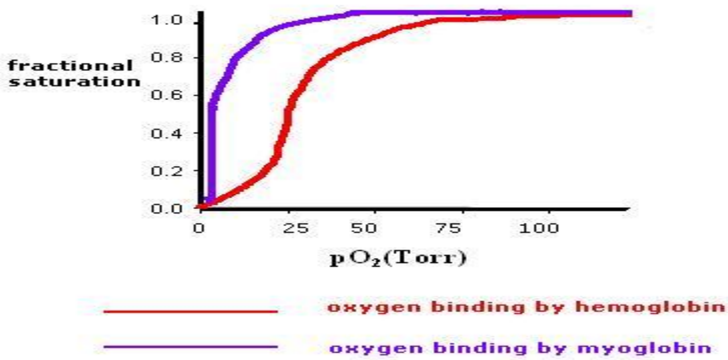

Figure 1. Oxygen Binding Curve

Purpose of study

While elite team-sport players do not exhibit the specific physical/physiological capacities of elite endurance and sprint athletes, they generally possess an efficient combination of 'aerobic' and 'anaerobic' potential, though the relative contribution of oxidative versus glycoltic component varies widely across players and sports. Although aerobic metabolism dominates the energy delivery during most team sports, decisive actions (e.g., sprints, jumps and tackles) are covered by means of anaerobic metabolism. As a result, the demands of team sports lend themselves towards a potential gain from adaptations to hypoxia from aerobically (maximal oxygen uptake (VO_2 max), economy and PCr resynthesis) and anaerobically (muscle buffer capacity) derived mechanisms. However, because the extent to which a player may benefit from different altitude-training methods may differ according to both their general and specific training focus (more aerobic vs. anaerobic type of adaptations), no uniform recommendations can be made across all team sports. Nonetheless, it is anticipated that those activities displaying shorter exercise-to-rest ratios and/or requiring prolonged time spent at high relative exercise intensity are more likely to benefit from altitude training.

It has been acknowledged that in elite endurance as well as team-sport athletes the effect of altitude training on red cell mass may depend on the initial hemoglobin mass. Noteworthy, however, is the observation that meaningful increases in Hb mass also occur in highly trained endurance athletes—that is, with some of the highest reported pre intervention Hb mass values—from different sports and after various forms of altitude training. In team sports, where a high Hb mass is not necessarily a pre-requisite in all positions, players are generally characterized by a low to moderate Hb mass (or VO_2max values usually ranging from 55 to 65?mL/min/kg) in comparison with endurance athletes, The rationale for attempting to increase Hb mass in team-sport players would be to increase their VO_2max and enhance blood buffer capacity, and thereby decrease relative exercise intensity during games and increase tolerance for repeated-sprint exercises, respectively.

Methodology

Contemporary altitude-training practices among athletes include: living high and training high (LHTH), living high and training low (LHTL) as well as living low and training high (LLTH). These paradigms can be achieved with natural altitude, simulated altitude or a combination. In a 2009 meta-analysis of sea-level performance after hypoxic exposure, it was found that in elite endurance athletes, an enhancement of maximal aerobic power output was only possible with natural LHTL (4.0%; 90% confidence limits±3.7%), and unclear with LHTH (1.6%;±2.7%) and LLTH (0.6%;±2.0%). While it is arguably easier to accumulate hours of hypoxia with LHTH, a recent meta-analysis concluded that Hb mass increases at approximately 1.1% per 100 of altitude exposure regardless of the type of exposure (i.e., LHTH (>2100? m) or LHTL (? 3000? m)). Alternatively, work? Rest ratios could be altered during sessions also taking into account the altitude of the training venue and players' background. Exercise capacity during high-intensity intermittent exercise not only depends on the blood oxygen-carrying capacity, but also on molecular adaptations in the skeletal muscle and the efficiency of the neuromuscular system. Training at sea level in enhancing peripheral adaptations (i.e., oxidative capacity, capillary density and muscle glycol tic potential as well as increased expression of hypoxia inducible factor 1? (HIF-1?) and downstream genes to oxygen and transport) and, thereby, high-intensity intermittent performance [3]. Likewise, resistance training combined with systemic hypoxia has been reported to further increase muscle strength.

Current trends in altitude training

In individual athletes, the success of altitude training requires living high enough (>2000? m), for enough hours/day (>14–16? h/day), for a sufficient period of time (>19–20? days) in order to sustain an erythropoietin effect of hypoxia; that is, the so-called altitude dose (? 300–400? h). There is a widespread belief that elevation higher than 3000? m should be used with caution because of the excessive loss of training intensity and the characteristics of ball flight will change substantially due to the thinness of the air. On the one hand, the degree of hypoxia determines the magnitude of the induced physiological changes in a 'dose–response' relationship, with higher altitudes triggering larger/faster increases in red cell mass. The field of altitude training represents a good example of how a better understanding of the acute/chronic effects of hypoxia, as well as the best practices to acclimatize, can help teams to better prepare their players.

The scientific approach of altitude training

Hb binds O_2 molecules to its iron atoms & transports them form lungs to muscles where they are delivered to Mb molecules. These (Mb) store the O_2 until it is required for metabolic action. Hb then uses certain amino groups to bind CO_2 carry it back to the lungs. The Skeletal muscle of driving mammal is particularly rich in Mb which serves as a store of O_2 during drive. Although Hb is about as good as O_2 binder as Mb at high O_2 pressure, it is much poorer at the lower pressures prevailing in muscles, hence passes on its O_2 to the Mb as required. The need for O_2 will be greatest in tissues that have already consumed O_2 & simultaneously have produced CO_2. The CO_2 lower the PH, thus causing the Hb to release even more O_2 to the Mb (Bohr effect). The O_2 binding curves for Mb & Hb. The graph showing the PH dependence for the latter (Hb) thus at low partial pressure Hb releases significant amount of O_2. In other words at the low partial pressure the Mb is totally saturated(bound with O_2) and binding of O_2 (sigmoidal curve) indicates that, partial pressure PH dependence (Bhor effect) both of are essential to the role played by Hb (i.e. O_2 transport). However atmosphere pressure at about 13Km (8 miles) above the sea level there is $1/5^{th}$ of the O_2 present to that of sea level. With every 10m increase in altitude there is 1mm of Hg (pressure) decrease in O_2 pressure.

Biological advantages

People living in higher altitudes (low O_2 pressure) are genetically adapted to have more RBC`s (with Pink/Red checks). To carry sufficient O_2 to the tissue. There is an aadvantage of Sports Person living in higher altitude, we can say they are genetically adapted (evolved) to be supplied with more Hb thus more storage reserves of Mb. This can release more O_2 during vigorous physical activity. Ex: Athlete gets extra energy when the rest of his competitors get exhausted. It`s an example of biological evolution or genetic modification. Biological Advantages: Hb carries $4O_2$ molecules at a time. Whereas Mb carries $2O_2$ molecules (biological Dioxygen carrier) Hb shows co-operative binding i.e. binding of $2O_2$ molecules. The binding of O_2 to Hb is Co-operative as Hb binds successive O_2. The practice of training at an altitude is well-known among coaches and athletes, particularly elite athletes. The enhancement of performance, often at sea level, is the main goal for athletes training at an altitude. This is also called "hypoxic" training. Altitude training is differentiated into "live high-train high" (LHTH), "live high-train low" (LHTL), "live moderate-train moderate" (LMTM) and "live low-train high" (LLTH). Cardiovascular Progress is high-altitude training improves your body's oxygen-carrying capacity.

Results

Cardiovascular advantages

High-altitude training improves our body's oxygen- carrying capacity. Under normal conditions, kidneys release a hormone called erythropoietin, which stimulates bone marrow of athlete's to produce and release adequate amount red blood cells to transport oxygen to tissues and organs. At high altitudes, the reduced oxygen levels cause kidneys to increase erythropoietin release, resulting in more number of corpuscles, which transport more oxygen throughout the body.

Respiratory improvements

High-altitude training exerts beneficial effects on respiratory system of an athlete. VO_2 is a measure of how much oxygen body can use and convert to energy from food. This is done by converting nutrients from diet to a high-energy molecule called adenosine triphosphate. High-altitude training increases VO_2 max, which in turn improves endurance and athletic performance.

Improves cortisol

High-altitude training is effects on cortisol levels. Cortisol is a stress hormone, and it increases when athletes body is placed under stress. The low-oxygen conditions at high altitude triggers adrenal glands to increase cortisol production. Cortisol is a catabolic hormone, its break down muscle for energy in a process called catabolism. High cortisol levels causes body to go from a muscle building state to a state of muscle breakdown.

Discussions

Some individual possesses inherited beneficial enzymes, as well as specially equipped cells, that enable them to withstand the physical demands of high-altitude living. As per Hoppeler led, a joint Swiss/Italian team that took muscle tissue samples from nine Tibetans who live approximately two to three miles above sea level and six of their parents who had emigrated to the lowlands of Tibet. Late Peter Hochachka indicated that the Quechas people of the Andes also possess genetic adaptations for improved high-altitude living American Association for the advancement of Science appears to support Hoppeler's claim that high-altitude dwellers have evolved unique physical abilities.

Conclusions

The field of altitude training represents a good example of how a better understanding of the acute/chronic effects of hypoxia, as well as the best practices to acclimatize, can help teams to better prepare their players. At present, most of our understanding, and information on altitude-training methods, have been focusing on endurance (individual) athletes. Based on this literature, there is little question as to the benefits of training at altitude for the purpose of improving performance at altitude (acclimatization). However, the benefits of using a LHTH, LHTL and LLTH altitude-training intervention or a combination of those methods to improve team-sport-related physical performance upon return to sea level are not as definitive. The approach that consists of extrapolating existing data obtained with individual athletes to understand the effects of altitude training on complex team-sport performance is limited. The question of whether altitude/hypoxic training are it natural or artificial is relevant to improve team-sport performance (and its putative underlying mechanisms) has not yet been convincingly proven. Nevertheless, it is undeniable that no single recommendation is likely suitable for all players in a team, or across all team sports, requiring the development of optimized interventions at the individual player level.

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