OPEN ACCESS

Journal of Advances in Sports and Physical Education
Abbreviated Key Title: J Adv Sport Phys Edu
ISSN 2616-8642 (Print) | ISSN 2617-3905 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Influence of Different Altitude Training on Vo2max and Stress

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DOI: https://doi.org/10.36348/jaspe.2024.v07i11.001 | **Received:** 26.09.2024 | **Accepted:** 01.11.2024 | **Published:** 07.11.2024

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Abstract

The purpose of the study was to find out the influence of different altitude training on VO2max and stress. Forty-five male middle distance runners studying in various colleges around Kodaikanal Town, Dindigul District, were selected and divided into three equal groups (n = 15), in which group - I underwent low altitude (sea level) training, five days per week for twelve weeks and group II underwent moderate level altitude training and group – III acted as control which did not participate any special training apart from their regular activities. The subjects were tested on selected criterion variables such as VO2max and stress at prior to and immediately after the training. For testing the VO2max, Cooper's 12 minutes run/walk test result was taken and a formula recommended by Cooper was applied, and for stress, Girdano and Everly Stress Scale was used. The Analysis of Covariance (ANCOVA) was used as statistical tool to find the training effect difference between three groups. Since there were three groups involved in this study the ScheffèS test was used as pos-hoc test. The result of the study shows that the VO2max was improved and stress level was decreased significantly for the training groups when compared with the control group. The result of the study also shown that there was no significant difference occurred between the experimental groups, such as, low altitude and moderate altitude training groups.

Keywords: Different Altitude Training, VO2max, and Stress.

INTRODUCTION

More than ever, people are aware of how altitude affects the human body, especially in relation to exercise. More studies than ever before are being conducted on the many physiological effects of altitude on the body, particularly as it relates to athletes who train and compete at altitude [2-9].

A series of metabolic and musculocardio-respiratory adjustments that impact oxygen transport and consumption are triggered by acclimatisation to ambient hypoxia. Even better, achieving peak levels of physical performance at altitude requires having been born and reared at an altitude; yet, there is now conflicting scientific data to support these effects after returning to sea level [1].

To reap the benefits of explosive movements and both aerobic and anaerobic metabolism, elite athletes often undertake altitude training, which lasts for two to four weeks [10]. The most well-liked training method used by elite athletes is the tried-and-true continuous exposure to natural or artificial altitude, sometimes referred to as "live high-train high," in which athletes live and train at a terrestrial altitude (i.e., 1800-3300 m.a.s.l.) [11]. The enhancement of anaerobic capacities, such maximum or explosive strength, remains a contentious issue. Although the effects of hypoxic erythropoietin on aerobic capabilities are widely recognised [12], there is still significant debate over the most efficient ways to optimise anaerobic attributes such as maximum or explosive strength. Altitude training is a common strategy used by competitive endurance athletes to improve their performance at sea level [13].

Despite several controlled studies that indicate no group gain in sea-level performance after living and exercising at altitude, there are numerous anecdotal anecdotes that suggest a broad variation in performance following a traditional altitude training camp [14, 15]. We have previously demonstrated that part of the variability in performance at sea level following altitude training can be explained by a high incidence of iron insufficiency among experienced athletes [16].

Athletes, military personnel, climbers, and others who partake in high-intensity physical training report improved muscle function following two to three weeks of continuous elevation [17]. While remaining at an altitude may result in negative outcomes such as isolation due to a lack of accommodations and safety support [18], a rise in stress or oxidative stress [19], disturbed sleep [20], and general discomfort or boredom. On the other hand, IAE (Intermittent Altitude Exposure) eliminates or minimises these losses every day, suggesting that a different exposure to altitude or hypoxic conditions would be more bearable [21].

In order to perform better when they return to lower altitudes, elite athletes from a variety of sports frequently train at high elevations. An increase in circulating erythropoietin concentration brought on by hypoxia-inducible factors increases the quantity of red blood cells and their capacity to deliver oxygen at high elevations with low atmospheric pressure and low oxygen concentrations [22, 23].

One research found that after seven days of basic training and five days of intermittent training at 2315 m, athletes' exercise capacity and VO2max considerably increased. Furthermore, the improvement was larger than that of participants who trained at low altitude [24]. In a different research, elite mid- and long-distance runners who used a "Hi-Lo" training regimen trained in hypoxia for 14 hours per day (6 nights at 2500 m, 12 nights at 3000 m) [36].

The critical function of stress and clarifies how it affects oxygen supply, energy use, and the delay of exhaustion during exercise. Furthermore, how the cardiovascular system can adapt to training stimuli, demonstrating the possibility of significant gains in endurance capacity through focused training interventions. [30, 31].

MATERIAL AND METHODS

In this study it was aimed to find out the impact of different altitude training on VO2maxand stress. To achieve the purpose thirty male middle distance runners studying in various colleges Kodaikanal around Dindigul District, Tamilnadu were selected as subjects. They were divided into three equal groups of fifteen each and such as one experimental group and one control group, in which the group I (n=15) underwent low altitude (sea level) training and group II underwent moderate level altitude training and group – III acted as control which did not participate any special training apart from their regular activities.

For every training programme there would be a change in various structure and systems in human body. So, the researchers consulted with the experts and then selected the following variables as criterion variables: 1.VO2max and 2 Stress. For testing the VO2max, Cooper's 12 minutes run/walk test was administrated, and for stress, Girdano and Everly Stress Scale was used.

Analysis of the Data

Analysis of Covariance was used to determine the differences, if any, among the adjusted post-test means on selected criterion variables separately. The level of significance was fixed at .05 level of confidence to test the 'F' ratio obtained by analysis of covariance.

Table 1: Analysis of Covariance and 'F' ratio for VO2max and Stress of Different altitude training Group and Control Group

Variable Name	Group Name Test ± S.D	Exp. Group – I	Exp. Group - II	Control Group	'F' Ratio
VO2 Max	**Pre-test Mean ± S.D**	43.56 ± 2.07	43.40 ± 0.73	43.37 ± 0.76	0.092
	Post-test Mean ± S.D.	44.56 ± 2.03	45.38 ± 1.79	42.98 ± 1.14	7.73*
	Adj. Post-test Mean	44.446	45.421	43.051	16.36*
Stress (Points)	**Pre-test Mean ± S.D**	22.60 ± 1.06	22.27 ± 1.16	23.00 ± 1.07	1.68
	Post-test Mean ± S.D.	21.08 ± 1.09	20.07 ± 1.94	23.53 ± 0.98	24.52*
	Adj. Post-test Mean	21.016	20.318	23.268	23.65*

* Significant at .05 level of confidence. (The table value required for significance at .05 level of confidence with df 2 and 42 and 2 and 41were 3.21 and 3.23 respectively).

Table – 1 shows that pre-test means 'f' ratio of different altitude training group and control group on VO2max was 0.092, which is insignificant at 0.05 level of confidence. The post- and adjusted post-test mean 'f' ratio value of experimental group and control group was 7.73 and 16.36 which was significant at 0.05 level of confidence. The pre-testmeans 'f' ratio of different altitude training group and control group on stress was1.68, which is insignificant at 0.05 level of confidence. The post- and adjusted post-test mean 'f' ratio value of experimental groups and control group was 24.52and23.65, which was significant at 0.05 level of confidence.

Further to determine which of the paired means has a significant difference, ScheffẽS test was applied as post-hoc test. The result of the follow-up test is presented in Table - II.

Table II: Scheffĕ S Test for the Difference between the Adjusted Post-Test Means of VO2 Max and Resting pulse rate among Experimental Groups and control group

Adjusted Post-test Mean Difference on VO2 Max				
Experimental Group – I	***Experimental Group- II***	***Control Group***	**Mean Difference**	**CI**
44.446		43.051	1.395*	1.057
44.446	45.431		0.975	1.057
	45.431	43.051	2.370*	1.057
Adjusted Post Mean Difference on Stress				
21.016		23.268	2.250*	1.10
21.016	20.318		0.698	1.10
	20.318	23.268	2.948*	1.10

** Significant at 0.05 level of confidence.*

Table - II shows that the corrected post-test mean differences in VO_2max between experimental groups I and II and the control group were 1.395 and 2.370 respectively, respectively, and were significant at the.05 level of confidence. However, a mean difference of 0.975 was discovered between experimental groups I and II, which was insignificant. Table - II also shows that the corrected post-test mean differences in stress between experimental groups I and II and the control group were 2.250 and 2.948 respectively, respectively, and were significant at the.05 level of confidence. However, a mean difference of 0.698 was discovered between experimental groups I and II, and this difference was not statistically significant. The results of the study indicate that VO2 max is significantly increased and stress level has decreased by training at sea and moderate level altitudes. The result of the study also indicates that there was an insignificant difference between the training groups on selected criterion variables.

CONCLUSIONS

The aim of the study is to find out the effect of different altitude trainingon VO2max and stress in middle distance runners. The twelve weeks training programme improves the VO2 max and decrease the stress significantly when compared with the control group. Findings of Subramani and Chelladurai (2019), [32], and Farswan and Yadav, (2020) [33], supports the results of the present study, in which the VO2 max was significantly increased after the training at different altitude level.The stress significantly decreased after different altitude training was in accordance with Stellingwerff, T. *et al.*, (2019) [34], and Subramaniand Chelladurai (2016) [35].

REFERENCE

1. Bailey, D. M., & Davies, B. (1997). Physiological implications of altitude training for endurance performance at sea level: a review. *British journal of sports medicine*, *31*(3), 183-190.
2. Chapman, R. F. (2013). The individual response to training and competition at altitude. *British Journal of Sports Medicine*, *47*(Suppl 1), i40-i44.
3. Chapman, R. F., Laymon Stickford, A. S., Lundby, C., & Levine, B. D. (2014). Timing of return from altitude training for optimal sea level performance. *Journal of Applied Physiology*, *116*(7), 837-843.
4. Epthorp, J. A. (2014). "Altitude training and its effects on performance - systematic review" *inJournal Of Australian Strength & Conditioning*, *22*(1).
5. Garvican, L., Saunders, P., & Telford, R. (2013). "*Altitude training" in Modern Athlete & Coach*, *51*(1).
6. Garvican-Lewis, L. A., Clark, S. A., Polglaze, T., McFadden, G., & Gore, C. J. (2013). Ten days of simulated live high: train low altitude training increases Hbmass in elite water polo players. *British journal of sports medicine*, *47*(Suppl 1), i70-i73.
7. Garvican-Lewis, L. A., Clark, S. A., Polglaze, T., McFadden, G., & Gore, C. J. (2013). Ten days of simulated live high: train low altitude training increases Hbmass in elite water polo players. *British journal of sports medicine*, *47*(Suppl 1), i70-i73.
8. Lundby, C., Calbet, J. A. L., Sander, M., Van Hall, G., Mazzeo, R. S., Stray-Gundersen, J., ... & Levine, B. D. (2007). Exercise economy does not change after acclimatization to moderate to very high altitude. *Scandinavian journal of medicine & science in sports*, *17*(3), 281-291.
9. Stray-Gundersen, J., & Levine, B. D. (2008). Live high, train low at natural altitude. *Scandinavian journal of medicine & science in sports*, *18*, 21-28.
10. Millet, G. P., Roels, B., Schmitt, L., Woorons, X., & Richalet, J. P. (2010). Combining hypoxic methods for peak performance. *Sports medicine*, *40*, 1-25.
11. Khodaee, M., Grothe, H. L., Seyfert, J. H., & VanBaak, K. (2016). Athletes at high altitude. *Sports health*, *8*(2), 126-132.
12. Oguri, K., Du, N., Kato, Y., Miyamoto, K., Masuda, T., Shimizu, K., & Matsuoka, T. (2004). Effect of moderate altitude on peripheral muscle oxygenation during leg resistance exercise in young males. *Journal of sports science & medicine*, *3*(3), 182.
13. Dick, F. W. (1992). Training at altitude in practice. *International journal of sports medicine*, *13*(S 1), S203-S205.
14. Adams, W. C., Bernauer, E. M., Dill, D. B., & Bomar Jr, J. B. (1975). Effects of equivalent sea-level and altitude training on VO2max and running

performance. *Journal of Applied Physiology*, *39*(2), 262-266.
15. Levine, B. D., & Stray-Gundersen, J. (1997). "Living high-training low": effect of moderate-altitude acclimatization with low-altitude training on performance. *Journal of applied physiology*, *83*(1), 102-112.
16. Stray-Gundersen, J., Alexander, C., Hochstein, A., DeLemos, D., & Levine, B. D. (1992). Failure of red cell volume to increase to altitude exposure in iron deficient runners: 540. *Medicine & Science in Sports & Exercise*, *24*(5), S90.
17. Fulco, C. S., Rock, P. B., Muza, S. R., Lammi, E., Cymerman, A., Kambis, K. W., ... & Moore, L. (1998). Effect of menstrual cycle phase on muscle fatigue and physical performance during high altitude acclimatization. *Natick, MA: US Army Res. Inst*.
18. Klokker, M., Kharazmi, A., Galbo, H., Bygbjerg, I., & Pedersen, B. K. (1993). Influence of in vivo hypobaric hypoxia on function of lymphocytes, neutrocytes, natural killer cells, and cytokines. *Journal of Applied Physiology*, *74*(3), 1100-1106.
19. Savourey, G., Garcia, N., Besnard, Y., Hanniquet, A. M., Fine, M. O., & Bittel, J. (1994). Physiological changes induced by pre-adaptation to high altitude. *European journal of applied physiology and occupational physiology*, *69*, 221-227.
20. Kong, F. (2019). "Sleep Disorder at High Altitude. Sleep Medicine in Clinical Neurology"[Working Title], in IntechOpen.
21. Beidleman, B. A., Muza, S. R., Fulco, C. S., Cymerman, A., Ditzler, D. T., Stulz, D., ... & Sawka, M. N. (2003). Intermittent altitude exposures improve muscular performance at 4,300 m. *Journal of applied physiology*, *95*(5), 1824-1832.
22. Tsunekawa, K., Ushiki, K., Martha, L., Nakazawa, A., Hasegawa, R., Shimizu, R., ... & Murakami, M. (2022). Differences in stress response between two altitudes assessed by salivary cortisol levels within circadian rhythms in long-distance runners. *Scientific Reports*, *12*(1), 9749.
23. Wang, G. L., Jiang, B. H., Rue, E. A., & Semenza, G. L. (1995). Hypoxia-inducible factor 1 is a basic-helix-loop-helix-PAS heterodimer regulated by cellular O2 tension. *Proceedings of the national academy of sciences*, *92*(12), 5510-5514.
24. Álvarez-Herms, J., Julia-Sanchez, S., Gatterer, H., Corbi, F., Viscor, G., & Burtscher, M. (2020). Effects of a single power strength training session on heart rate variability when performed at different simulated altitudes. *High Altitude Medicine & Biology*, *21*(3), 292-296.
25. Retrieved from https://en.wikipedia.org/wiki/Endurance_training#cite_note-1 on 10-6-2019.
26. Retrieved from https://www.sports-training-adviser.com/endurancefitness.html on 14-6-2019.
27. Retrieved from https://www.busywomensfitness.com/exercise-benefits.html on 9-3-2016.
28. Baar, K. (2014). "Using molecular biology to maximize concurrent training" *Sports Med*, *44*, S117–S125.
29. Bompa, T., & Buzzichelli, C. (2015). *Periodization training for sports, 3e*. Human kinetics.
30. Noakes, T. D. (2003). "Physiological models to understand exercise fatigue and the adaptations that predict or enhance athletic performance" *in Scandinavian Journal of Medicine & Science in Sports*, *20*(2), 23-33.
31. Joyner, M. J., & Coyle, E. F. (2008). Endurance exercise performance: the physiology of champions. *The Journal of physiology*, *586*(1), 35-44.
32. Arumugam, S., & Chellathurai, P. (2019). Altitude Training Improves Cardio Respiratory Endurance and VO2 Max among Distance Runners. *Journal of Information and Computational Science*, *9*(8), 173-180.
33. Rupendra, F., & Rakesh, K. Y. (2020). Effects of endurance training at moderate and low altitudes on selected physiological variables. *Ilkogretim Online - Elementary Education Online*, *16*(4), 7832-7842.
34. Stellingwerff, T., Peeling, P., Garvican-Lewis, L. A., Hall, R., Koivisto, A. E., Heikura, I. A., & Burke, L. M. (2019). Nutrition and altitude: strategies to enhance adaptation, improve performance and maintain health: a narrative review. *Sports Medicine*, *49*, 169-184.
35. Brugniaux, J. V., Schmitt, L., Robach, P., Nicolet, G., Fouillot, J. P., Moutereau, S., ... & Richalet, J. P. (2006). Eighteen days of "living high, training low" stimulate erythropoiesis and enhance aerobic performance in elite middle-distance runners. *Journal of Applied Physiology*, *100*(1), 203-211.