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Effect of hypoxic training with elevation training mask on VO_2 max

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Abstract
The underlying mechanisms of hypoxic training with elevation training mask are still a very vast discipline of research work and has been proved and implemented by the trainers and coaches. The purpose of the study was to find out the effect of Hypoxic training with elevation training mask on VO_2 max. Thirty physically fit individuals (age 17-22) of Baraboni club of Asansol, West Bengal, India were selected as participants of the study where they were randomly divided into three groups of 10 each. Twelve weeks training was imparted to experimental group I (with mask), experimental group II (without mask). Group III acted as the control group. To understand the effect of hypoxic training on VO_2 max, ANCOVA was used. A significant difference was found in VO_2 max after the training among the three groups. Group I performed significantly better than without group II and group III. Group II was better than group II but poor than group I.

Keywords: VO_2 max, Elevation training musk, altitude training, physiological.

Introduction
Altitude/hypoxic training is a common and popular practice among various athletes, coaches, and sports scientists for improving exercise performance at the sea-level. The most typical altitude/hypoxic training methods proposed include living high-training high (LHTH) or living high-training low (LHTL). Recently, various living low training high (LLTH) methods such as intermittent hypoxic training (IHT), repeated sprint training in hypoxia (RSH), and resistance training in hypoxia (RTH) has become an increasingly popular altitude/hypoxic practice, where athletes live at or near sea-level but train at 2,000 to 4,500 m simulated hypobaricor normobaric hypoxic conditions (Feriche, B., Garcia-Ramos *et al*., 2014) [4, 10].
Among the various LLTH altitude/hypoxic training methods, IHT may be of interest to athletes and coaches because this training method commonly involves shorter hypoxic exposure time and duration. Such hypoxic exposure typically last < 3 hours, two to five times per week, for 2 to 6 weeks (McLean *et al*., 2014). Theoretically, the stress from hypobaric or normobaric hypoxic exposure, in addition to the training stress, will compound the training adaptations experienced with normal aerobic training and will lead to greater improvements in aerobic exercise capacity (Czuba *et al*., 2011) [3, 12]. IHT may trigger various biochemical and structural changes in skeletal and cardiac muscles that favor oxidative process; that is, IHT may enhance erythropoietic, metabolic, and haemodynamic functions, which results in the stimulation of serum erythropoietin synthesis, elevated red blood cell volume, improved exercise economy, increased blood flow, and thus enhances oxygen transporting and utilizing capacity of the blood (Czuba *et al*., 2011; Geiser *et al*., 2001; Hamlin *et al*., 2010) [3, 12, 11]. However, the efficiency of IHT for the enhancement of aerobic exercise capacity in various athletes at sea-level is controversial. Several studies reported improved aerobic exercise capacity by enhanced oxygen transporting or utilizing capacity of the blood after IHT (Czuba *et al*., 2011; Ponsot *et al*., 2006) [3, 12].
Another tool used to stimulate increased exercise performance is Elevation training mask. The Elevation training mask (ETM), also known as an altitude mask or ventilator training mask, claims to enhance athletic performance by increasing endurance and VO_2 max; in addition to improving lung function.

The ETM is also said to simulate altitude and to induce a normobaric hypoxic condition. The ETM provides adjustable resistances during inspiration with a set resistance on expiration in order to simulate high-altitude training (between 914m to 5,486m). The design of the mask restricts the oxygen flow using flux valves that limit the amount of air entering the mask, and therefore, the lungs. Furthermore, The Elevation Training Mask 2.0 is a proven tool for simulating the effects of training in high-altitude environments. Byadjusting the mask's intake valves with the addition of the included air restriction caps, you can quickly customize the intensity setting from a 3,000' elevation (4-hole caps) up to 6,000' (2-hole caps) and 9,000' (1-hole caps)

While the Training Mask is a great way to prepare for high altitude sports and climbing, it's also beneficial to just about any type of athlete from any discipline. Training with the mask can:

- Condition the lungs by creating pulmonary resistance
- Strengthen the diaphragm
- Increase surface area and elasticity in alveoli
- Increase lung capacity
- Increase anaerobic thresholds
- Decrease workout time

The Elevation Training Mask 2.0, including clinical tests by the Northern Alberta Institute of Technology and studies by the American Council on Exercise. The central scientific principle is "Diaphragm Resistance Technology." This effectively means that the mask promotes increased lung capacity by forcing you to inhale fuller deeper breaths as you train. When your body adapts to the resistance, your lungs begin to transport oxygen more efficiently. Long term result: improved lung and diaphragm strength and increased stamina. Increases strength and power (anaerobic performance) (James P Morton, Nigel T Cable, 2005 [13].

The study attempted to investigate the effect of hypoxic training with Elevation training mask on VO_2 max of physically fit individuals.

Methods and Materials

Selection of subjects: The participants of the study were chosen from Baraboni club of Asansol, West Bengal, India. The age of subjects were ranged between 17 to 22 years. They were randomly divided into three groups of 10 each. Group I acted as Experimental group (with mask), Group II acted as Experimental group II (without elevation training mask) and group III acted as the Control group.

Selection of variables: VO_2 max was the dependent variable and Twelve Weeks of Training programme with the help elevation training mask 2.0 was the independent variable.

Criterion Measures: VO_2 max was determined in ml/kg/min

Experimental Design: Pretest–Posttest Randomized-Groups Design was used as design of the study.

Administration of the Tests and Collection of Data: Pre-tests were conducted on all the experimental and control groups. Coopers 12 minute run/ walk test was conducted to assess VO_2 max of the participants.

Statistical Technique: To find out the effects of Intermittent Hypoxic training on selected physiological variables and hematological variables Analysis of covariance (ANCOVA) was used for interpreting the results as recommended by Clarke and Clarke, 1984.The data were analyzed with the computer using SPSS (11.5) statistical package. The level of significance was chosen at 0.05.

Results

Table 1: Descriptive statistics of VO_2 max among two Experimental groups and Control group

Mean	Experimental		Control Group	SS		df	MSS	F-Ratio
	Group-I (Mask)	Group-II (Without Mask)						
Pre-test	55.3720	54.5720	54.1720	A	7.467	2	3.733	2.110
				W	47.766	27	1.769	
Post-test	57.9720	55.8720	53.7720	A	88.200	2	44.100	43.415*
				W	27.426	27	1.016	
Adjust post test	57.579	55.951	54.086	A	53.261	2	26.631	63.868*
				W	10.841	26	.417	

*. The mean difference is significant at the 0.05 level.

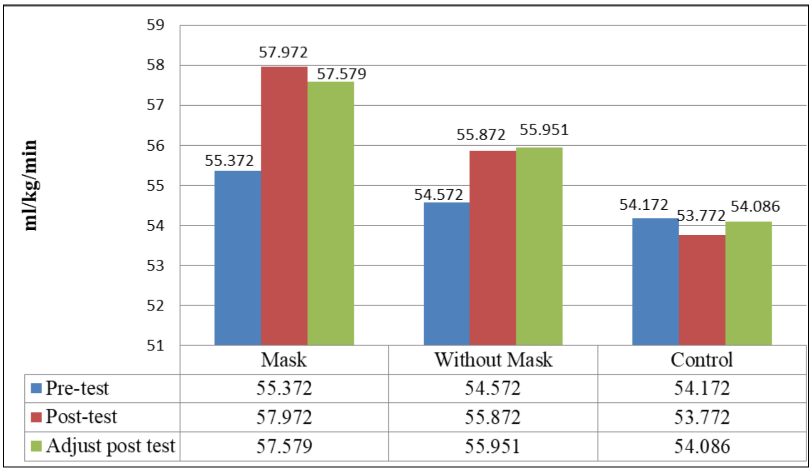

Fig 1: Graphical representation of VO2 max among two Experimental groups and one Control group

To identify the significant difference in VO_2 max among the groups ANCOVA for pre-test, post-test and adjusted posttest was applied. The obtained 'F' ratio for the pre-test was 2.110. It was found to be lower than the required F ratio of 3.35 for the degrees of freedom 2 and 27. Hence, it was inferred that the mean difference among three groups at pre-test on VO_2 max was statistically insignificant at 0.05 level of confidence.

In the post-test data analysis, the 'F' ratio was applied to test the significance of mean differences among the Mask Group, Without Mask group, and CG group on VO_2 max. The obtained 'F' ratio for the post-test was 43.415. The 'F' ratio needed for the significant differences on the mean, for degrees of freedom 2 and 27 was 3.35 at 0.05 level of confidence. Since the observed 'F' ratio on this variable was higher than the table value of 3.35, the mean differences among three groups at post-test of VO_2 max was statistically significant.

In the adjusted post-test data analysis, the 'F' ratio was applied to test the significance of mean differences among the Mask Group, Without Mask group, and CG group on VO_2 max. The obtained 'F' ratio was 63.868. Since the observed 'F' ratio was greater than the required table value of 3.37 for degrees of freedom 2 and 26 at 0.05 level of confidence, it was concluded that the performance of VO_2 max was significantly influenced by the treatments used in this study.

Table 2: Paired adjusted mean differences among two experimental group and one control group

Experimental group		**Control Group**	**Mean difference**	**Critical difference**
Group-I	**Group-II**	**Group-C**		
Mask group	**Without mask group**			
57.579	55.951		1.628*	
	55.951	54.086	1.865*	0.5935
57.579		54.086	3.493*	

Table 2 shows that there is a significant difference between all the three combinations i.e. between mask group and without mask group, between without mask group and control group, between mask group and Control Group. The mean values indicate that the mask group was the best among these three groups in terms of VO_2 max.

Discussion and Conclusion

Results indicate significant differences exist in VO_2 max among the groups. Since, the analysis of variance for VO_2 max in different groups was found significant, post hoc test was conducted to compare means of groups. As, the groups were of equal sample size, LSD test was used as post hoc. It was found that there was a significant difference between all the possible combinations i.e. between Mask group and without mask group, between Mask group and control group, between without Mask group and control group.

This indicates that both the experimental groups were significantly better than the control group. And Mask group was significantly better without mask group. The previous research works conducted with Elevation Training Mask (ETM) shows some contradictory findings. Siebenmann and Christoph Andreas (2012) At 4,559 meters altitude pulmonary vasodilation induced by the glucocorticoid Dexamethasone that elevates VO_2 max of individuals. Bryanne (2019) [15] found that VO_2 max was significantly improved in participants training with Elevation Training Mask than control group. There were some studies those found no effect of ETM in VO_2 max such as Brian (2017) and Matthew & Michael (2016) [16], though Matthew & Michael (2016) [16] discovered a slight, but not significant, increase in measured VO_2 peak and % VO_2 peak at anaerobic threshold.

In studies that intermittent hypoxic training (IHT), in most of the studies VO_2 max improved significantly (Miłosz Czuba, 2019; Morton and Cable, 2005; Truijens, 2003) [17, 13]. The Group-'A', training with mask is considered to be best in improving VO_2 max The results of the present study are also supported by Moscatelli, F (2020) *et al*. study. They did the study on "Effects of twelve weeks' aerobic training on motor cortex excitability". The finding of the study was significantly increase on G, RMT (resting motor threshold) and MPAI (motor evoked potential amplitude).

Conclusion

The study reveals that there is a difference in VO2 max among the groups. The results also illustrated that the improvement in performance using hypoxic training with elevation training mask was the highest.

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