Coaching Applications

The Effect of Intermittent Hypoxic Exposure plus Sea Level Swimming Training on Anaerobic Swimming Performance

Miller A.N.[1] and George K.[2]

Department of Biomolecular and Sports Science, Faculty of Health and Life Science, Coventry University, Coventry, UK. [1] Research Institute for Sports Science, Liverpool John Moore's University, Liverpool, UK.[2]

Abstract

A popular approach to altitude training is that of intermittent hypoxic exposure, otherwise known as "live-high train-low." The aim of the study was to determine whether 3 weeks of intermittent hypoxic exposure would enhance sea level sprint swimming performance. Eight participants took part in the study and were split into two groups: experimental (EXP) and control (CON). For 3 days a week over a 3 week consecutive period, both groups rested for a total of 90 minutes per day in a hypoxic chamber, whilst undergoing their usual training programme. The experimental group rested in a hypoxic chamber at a simulated altitude of 2300m, whilst the control group rested in a hypoxic chamber at sea level conditions (0-500m). All participants underwent a total of 3 performance tests (100m sprint) 1 week prior to the hypoxic exposure, 2 days post exposure (Post 1) and 9 days post exposure (Post 2). A blood lactate sample was taken at rest, immediately after, 3 and 7 minutes after each time trial. The results revealed that there was no difference in time for 100m performance, stroke count or stroke rate. There was an increase over time for blood lactate. This amount of intermittent hypoxic exposure was not sufficient to improve 100m sprint time in these eight competitive swimmers.

Introduction

An increasingly popular approach to altitude training is that of intermittent hypoxic exposure, which is otherwise known as "live – high train-low." The aim of this method is to expose participants to a sufficient altitude level and allowing beneficial adaptations due to the restricted availability of oxygen to improve both altitude and sea level performance, while maintaining good quality training. In some athletes, a lack of proper training adaptation and / or decreased exercise intensity due to increased altitude can lead to a relative detraining effect. Intermittent hypoxic exposure (IHE) allows the athlete to effectively live high, train low, where brief periods of hypoxic exposure are interspersed with prolonged sea level stays and the level of training can be maintained.

Previous work with intermittent hypoxic exposure

Previous work has found improvements in sea level 1.5km swimming performance following intermittent hypoxic exposure for a total of 90 minutes per day, 5 days per week, over a 3 week period. Research has shown that well-trained athletes can use short periods of "live-high train-low" to prepare for the intense demands of competition. In addition, substantial improvements have been found in swimming performance lasting 1-10 minutes following exposure to intermittent hypoxic exposure.

Although previous findings have attributed enhancements following simulated altitude exposure to increases in anaerobic energy system capacity, the effects of altitude training on sprint performance have not been reported as much as the effects on longer distance events.

Research has suggested that well-trained athletes can use short periods of "live-high train-low" to prepare for the intense demands of competition and evidence has been provided that improvements in performance after "live-high train-low" exposure may be associated with an increase in anaerobic capacity. Given the importance of anaerobic metabolism and efficiency to performance even in highly trained endurance athletes, further investigation of possible anaerobic adaptations is clearly warranted.

The purpose of the present study was to evaluate to what extent intermittent hypoxic exposure in a hypoxic chamber for 1 ½ hours per day, 3 days per week over 3 weeks combined with sea level training can enhance sprint swimming performance.

Methods

Following ethical approval, eight male competitive swimmers participated in this study. Informed written consent was obtained from each participant before the start of the study, which informed them of the purpose the study, the extent of their involvement and their right to terminate participation at any time. Participants were allocated to one of two groups, hypoxia (H) and normoxia (N). The first trial was performed one week before the start of the hypoxic exposure and the post-exposure time trials were completed 2 and 9 days after the hypoxic exposure.

<u>Hypobaric chamber exposure</u>
A hypobaric chamber was used for this experiment. All participants rested in the chamber for 1 ½ hours per day, 3 days per week over 3 weeks. Under hypoxic conditions, participants rested in a normobaric hypoxic chamber at a simulated altitude of 2300m for 1 ½ hours per day, 3 days per week over 3 weeks. Under normoxic conditions, participants rested in a normobaric hypoxic chamber at a simulated altitude of 0-500m (sea level) for 1 ½ hours per day, 3 days per week over 3 weeks.

<u>Evaluation of performance</u>
The swimmers performed three 100m performance time trials. Before each time trial, participants were asked to achieve the best time possible. Time was recorded

to the nearest 0.1s and stroke count and stroke rate (strokes/min) were recorded every 25m. An ear lobe blood sample was taken at rest, immediately after, 3 and 7 minutes after each 100m race for blood lactate analysis.

Results

There was no difference in time for 100m performance, stroke count or stroke rate. Table 1 shows the mean values for the four performance measures for both groups.

Table 1. Performance measures pre intermittent hypoxic exposure and 2 and 9 days post intermittent hypoxic exposure for the experimental (hypoxia) and placebo (normoxia) groups.

	Hypoxia (n = 4)			Normoxia (n =4)		
	Pre IHE	Post 1	Post 2	Pre IHE	Post 1	Post 2
100m	56.95	57.47	57.07	57.56	57.75	57.70
S.Count	37.00	37.25	37.75	38.25	38.25	8.00
S.Rate	56.70	56.05	56.00	54.75	55.00	54.50
Blood La	8.43	9.08	7.91	8.14	8.20	8.12

Values are means; *n* = 4 for Hypoxia and *n* = 4 for Normoxia.

There was no difference for blood lactate between the hypoxic and the normoxic groups, however there was a difference in blood lactate over time. Figure 1 shows an increase in blood lactate over time for both the hypoxic and normoxic groups pre IHE.

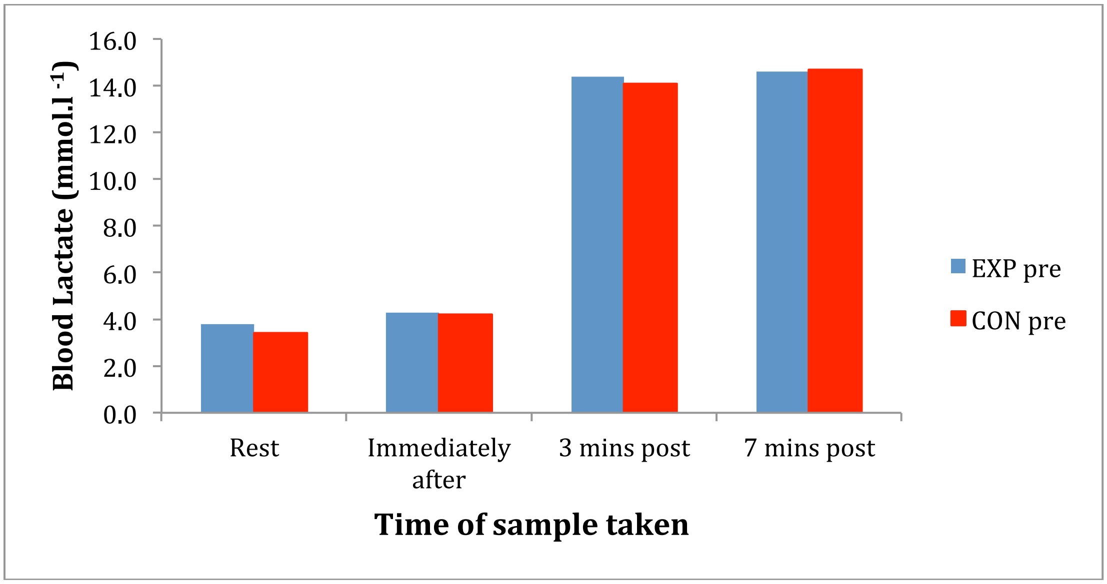

Figure 1: Lactate concentration pre intermittent hypoxic exposure for experimental (hypoxia) and control (normoxia) groups.

Figure 2 shows blood lactate values 2 and 9 days post intermittent hypoxic exposure for normoxic and hypoxic groups. Blood lactate levels in the hypoxic group were higher immediately after the 100m swim compared with the normoxia group. Lactate levels were higher in the normoxic group compared with the hypoxic group 3 minutes post exercise.

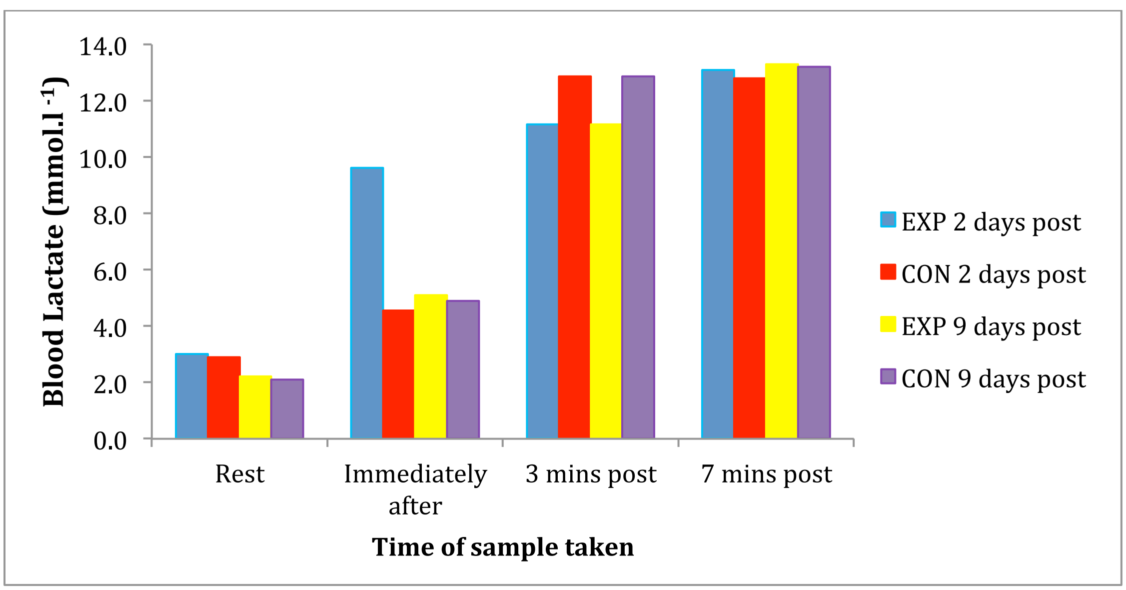

Figure 2: Lactate concentration 2 and 9 days post intermittent hypoxic exposure for experimental (hypoxia) and control (normoxia) groups.

Discussion

The aim of the study was to determine whether intermittent hypoxic exposure for 1 ½ hours per day, for 3 days over 3 weeks was sufficient to improve sprint swimming performance. The major finding of this study was that this amount of intermittent hypoxic exposure did not improve 100m swimming performance in this group of competitive swimmers nor did it reduce the rate of blood lactate production. This finding suggests that this dose of hypoxic exposure was not sufficient to have an effect on performance in this group of competitive swimmers.

Previous work with intermittent hypoxic exposure

Previous research in this area has dealt primarily with longer distance events as a result of altitude training. A study found that 15 days of intermittent hypoxic exposure at rest substantially improved sea level performance in a group of endurance based athletes. Two key differences between the present study and the few studies that have examined the effects of intermittent hypoxic exposure on sprint performance are the sample size and the amount of hypoxic exposure. These factors may have contributed to the difference in results between studies.

Blood Lactate

Research has shown a difference in blood lactate following 17 days of hypoxic exposure at a simulated altitude of 4000m-5000m for 3 to 5 hours per day. However in the present study, the swimmers were exposed to an altitude of 2300m and revealed no difference in blood lactate post intermittent hypoxic exposure. It is important to note that the level of hypoxic stimulus was much greater in previous studies mentioned, compared with the present study which may explain the non-significant findings for blood lactate post exercise.

Responders and non-responders to altitude

There has been the suggestion that elite athletes are more sensitive to minor changes to altitude than non-athletes and therefore, will exhibit more adaptations at a lower level of altitude. Since most swimmers are taken to altitude camps at a relatively low height, the variations in the acclimatization process may usually be noticeable between individuals. It is reasonable to expect that at moderate to low altitudes some athletes may not react at all whilst for others all of the adaptations of being exposed to altitude may be shown.

Limitations

The findings of this study are limited by its small sample size. Furthermore in the present study, the hypoxic stimulus during each session was 90 minutes. Research has demonstrated that a hypoxic stimulus of 30 minutes, 3-5 times per week suggest this altitude level was enough to improve sea level performance.

Conclusion

To conclude, this dose of intermittent hypoxic exposure was not sufficient to improve 100m performance in this group of competitive swimmers. These observations based on a small sample size need to be investigated in a larger group with individuals being exposed to longer exposures of hypoxia. In addition, future studies should include training in a hypoxic environment for an improvement for athletes involved in sprint specific events.