Effects of Hypobaric and Normobaric Hypoxia on Heart Rate and Blood Oxygen Saturation

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ABSTRACT

There has been recent debate on the difference in physiological response between exposure to normobaric hypoxia (oxygen fraction altered) and hypobaric hypoxia (barometric pressure altered). **Purpose:** To determine the effects of normobaric normoxia (NN), hypobaric hypoxia (HH), and hypobaric hypoxia (NH) on heart rate and arterial oxygen saturation (SaO₂) after exercise. **Methods:** Fifteen recreationally active participants (eight males and seven females) completed three separate 1 h cycling bouts at 70% of their peak aerobic capacity. Following each trial, participants recovered in the supine position for 4 h in NN (975 m), HH (4420 m), or NH (4420 m). SaO₂ was collected pre-, mid-, and post-exercise, as well as in each hour of subsequent recovery. Heart rate was monitored continuously throughout the trials. **Results:** There were no differences in SaO₂ or heart rate pre-, mid- or immediately post-exercise between the three trials (p > 0.05). However, during recovery, SaO₂ was lower in the HH and NH compared to NN (p < 0.001), and HH was lower than NH in hours 1, 3 and 4. During recovery, heart rate remained elevated in both hypoxic conditions relative to NN (p < 0.05), and heart rate in HH remained elevated relative to NH. **Conclusion:** These data indicate that post-exercise heart rate and SaO₂ are influenced by the method of achieving hypoxia and that caution should be made when translating results between these methods. Further research is needed to examine how these recovery parameters may influence performance and other physiological parameters.

INTRODUCTION

- After exercising, recovery in hypoxic conditions may elicit differing responses compared to that of lowland recovery, which are not completely understood. Additionally, the type of hypoxia exposure may produce further physiological differences.
- The ability of the body to return heart rate and blood oxygen saturation (SaO₂) to baseline levels is an important aspect of recovery.
- Hypoxia has been shown to alter the rate of recovery of both heart rate and blood oxygen saturation (SaO₂), but the difference between hypobaric and normobaric hypoxia has not been explored.
- The purpose of this research was to determine the effect of recovery in hypoxic environments on heart rate and blood oxygen saturation (SaO₂).

METHODS

- 15 recreationally active participants (8 male, 7 female) completed an initial visit to determine body composition and peak aerobic capacity (VO₂peak) while cycling.
- Participants completed three experimental trials of 1 h cycling at 70% of (VO₂peak) followed by 4 h of recovery.
- Participants recovered for 4 h in one of three different conditions (normobaric normoxia, hypobaric hypoxia, or normobaric hypoxia).
- Participants returned to the laboratory to complete the other two trials after a 14 day separation in between each trial.
- Blood oxygen saturation was measured via a pulse oximeter on the left hand pre-exercise, during exercise, and post-exercise as well as each hour of subsequent recovery.
- Heart rate was measured continuously throughout the trial using a chest strap (Polar Electronic, Lake Success, NY).

RESULTS

**Figure 1.** Heart Rate during exercise and recovery of the NN, HH, and NH trials. *p < 0.05 between all trials. Data are mean ± SE.

**Figure 2.** SaO₂ during exercise and rest of the NN, HH, and NH trials. †p < 0.05 between all trials. †p < 0.05 from NH and HH. Data are mean ± SE.

**Table 1. Participant descriptive data**

<table>
<thead>
<tr>
<th>Age (y)</th>
<th>24 ± 4</th>
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<tbody>
<tr>
<td>Height (cm)</td>
<td>178 ± 12</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72.5 ± 13.8</td>
</tr>
<tr>
<td>Body Fat (%)</td>
<td>14.5 ± 6.8</td>
</tr>
<tr>
<td>VO₂peak (L · min⁻¹)</td>
<td>3.60 ± 0.83</td>
</tr>
<tr>
<td>Power at VO₂peak (W)</td>
<td>274 ± 72</td>
</tr>
</tbody>
</table>

Data are mean ± SE

CONCLUSIONS

- During hypoxic conditions, heart rate remains elevated compared to normobaric normoxia. Furthermore, heart rate is elevated in hypobaric hypoxia compared to normobaric hypoxia.
- SaO₂ decreases well below initial baseline levels when participants recover from exercise in hypoxic conditions compared to normobaric normoxia with hypobaric hypoxic producing the greatest decreases.
- Future studies should examine the impact of hypobaric and normobaric hypoxia recovery on performance.
- Funded by Department of Defense United States Army Medical Research and Material Command.