Investigation of the effects of exercise on the changes in arterial oxygen saturation and psychomotor performance seen during moderate hypoxia

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Hypoxia

- Decreased partial pressure of oxygen in the atmosphere
- Inadequate oxygen supply to the tissues
- Slow decompression or Rapid decompression
Hypoxia

- Impaired novel task performance at and above 5,000ft

Above 10,000-15,000 feet:
- Prolonged reaction times
- Impaired performance
- Euphoria
- Decreased self criticism
• Hyperventilatory response
Alveolar carbon dioxide tension (mmHg) vs. Altitude (feet)

- Point C indicates a change in tension as altitude increases.
- Point D shows a further decrease in tension at higher altitudes.

As altitude increases, the alveolar carbon dioxide tension decreases.
Pulse oximeters

- % Saturation of haemoglobin with oxygen
- Non-invasive measurement
  - Finger mounted
  - Recently marketed to pilots
- “Surrogate method of measuring the degree of hypoxia”
Cerebral blood flow

- ↓ CO₂ causes cerebral vasoconstriction
- ↓ cerebral blood flow
- ↓ oxygen supply to the brain

AS LONG AS ARTERIAL PO₂ > 40 mmHg
Hyperventilatory response

- ↑ oxygen saturation of the blood

- HYPERVERVENTILATION IS EFFECTIVE AT INCREASING ARTERIAL OXYGEN SATURATION

- ↓ arterial CO$_2$ = ↓ cerebral blood flow in the absence of severe hypoxia
Flying = exercise

• Workload of pilot conducting ‘normal’ flying routine equivalent to light exercise
• Approx. 30 W

• Other crew ↑ workload

• ?exacerbate any reduction in performance
Those at risk

- Those that fly above 13,000ft without supplemental oxygen supplies

- Recreational Flyers:
  - Gliders
  - Microlights
  - Light Aircraft

- Military:
  - Helicopter operations
Method

- 7 subjects (21 – 23 years)
- Ground and simulated altitude of 15,000ft
- Rest and exercise (30 Watts)
- Completed a psychomotor performance task = NASA Multi-Attribute Task Battery
- Arterial oxygen saturation
- Symptom questionnaire
- and others
Method
Results
Indicate whether you experienced any of the symptoms below by circling NO or YES to each item. If answer is YES, circle the number which best describes the severity of the symptom.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Slight</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Headache</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Light-headedness/dizziness</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Nausea</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Weakness</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Sweating</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Visual disturbance</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Muscular incoordination</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Muscle cramps</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Fatigue</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Numbness</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
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<tr>
<td>11</td>
<td>Tingling</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Apprehension</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>Euphoria</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
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<tr>
<td>14</td>
<td>Irritability</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>Inability to think clearly</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>Any other symptoms?</td>
<td>NO</td>
<td>YES</td>
<td>1</td>
</tr>
</tbody>
</table>

**NUMBER OF SYMPTOMS** 1  **SYMPTOMS SCORE** 3
Conclusions

• No significant effect on psychomotor performance or arterial oxygen saturation was found between rest and exercise at ground or altitude sessions.

• This study does not confirm that exercise has a detrimental or favourable effect on the impact of hypoxia.
BUT:

- ↑ in number and severity of hypoxia related symptoms
- Physiological differences including slight differences in arterial oxygen saturation
- Pulse oximetry is an unsatisfactory indicator of mental performance when breathing air at altitude
- Use in aviation should be discouraged
Acknowledgements

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