NSCA 2016 TACTICAL
STRENGTH AND CONDITIONING ANNUAL TRAINING

APRIL 25 – 28, 2016 | SAN DIEGO, CA
SAN DIEGO MARRIOTT MISSION VALLEY

FIT TO SERVE. STRENGTH TO PERFORM.

NSCA NATIONAL STRENGTH AND CONDITIONING ASSOCIATION
Elevation Training Masks vs.
Classic Altitude Training: A Comparison

Brian Warren MS, CSCS, USAW
Overview

• Basic Definition/Examples of Altitude
• Background/History of Altitude Training
• Popular Altitude Training Methods
• Altitude & Air Relationship
• Physiological Adaptations
Overview

- Elevation Training Mask Info/Claims
- Personal Research Conducted
- Limitations
- Practical Implications for Tactical Populations
Basic Definitions, Background of Altitude, & Altitude Training
What is Altitude? Where Does it Start?

• The height of a point in relation to sea level
  – Low altitude
    • ~1,000 - 4,000 ft.
      – Minimal effects, if any, on well-being
    – Moderate altitude
      • 4,000 -10,000 ft.
        – Effects on well-being in unacclimated people
        – Performance and aerobic capacity ↓
– High altitude
  • 10,000 – 20,000 ft.
    – Acute mountain sickness
  – Severe altitude
    • 20,000 ft.+
    – Severe hypoxic effects
History

- 1644: Torricelli develops mercury barometer
- 1648: Pascal demonstrates reduced $P_b$ at high altitudes
- 1777: Lavoisier describes $O_2$ and other gases that contribute to $P_b$
- 1801: Dalton’s law of partial pressures
- Late 1800s: Effects of hypoxia on body recognized
History

- First acknowledged at 1968 Olympic Games in Mexico City (~7,250 ft.)
  - Due to multiple records being broken.
- Practiced by endurance athletes to gain an edge against competition
Altitude Training Methods
Hypobaric Chamber

• Created to minimize exposure to harsh climates while still being able to train for competitions at higher elevations
• Low pressure
• Low oxygen saturation
Normobaric Hypoxia

- Normal pressure
- Low oxygen saturation

- Both chambers are not very practical for tactical population
Intermittent Hypoxic Training

- Alternating intervals of breathing hypoxic air, followed by breathing ambient air
- Procedure repeated 45-90 min/day over a few weeks
Live High/Train Low

• Live High
  – Exposed to elevation majority of time
  • Allows EPO, RBC adaptations to occur over time

• Train low
  – To keep training intensity, NM adaptations ↑
Altitude & Air Relationship
The Air We Breathe

- Ambient pressure at sea level is
  - 760 mmHg (barometric pressure)
  - % gasses in air are
    - 20.93% O\textsubscript{2}
    - 0.03% CO\textsubscript{2}
    - 79.04% N\textsuperscript{+}
Dalton’s Law

• Gives us the partial pressures of gasses
  – At 760 mmHg, 20.93% O₂ exerts 159 mmHg
    • \((0.2093 \times 760 = 159)\)

• Differences in pressure allow gasses to move in the body
Henry’s Law

- Gasses dissolve in liquids in proportion to their partial pressure and solubility
- The oxygenation of Hb to form oxyhemoglobin depends entirely on the pp of $O_2$ in solution
Is There REALLY Less $O_2$?

<table>
<thead>
<tr>
<th>Location</th>
<th>Altitude (ft) (m)</th>
<th>Barometric pressure $P_b$ (mmHg)</th>
<th>% $O_2$ in the air</th>
<th>Partial pressure of oxygen $PO_2$ (mmHg) in the air</th>
<th>Typical temperature ($^\circ$C) ($^\circ$F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (sea level)</td>
<td>0 (0)</td>
<td>760</td>
<td>20.93</td>
<td>159</td>
<td>15 (59)</td>
</tr>
<tr>
<td>Miami, FL</td>
<td>5,202 (1,610)</td>
<td>631</td>
<td>20.93</td>
<td>132</td>
<td>9 (47)</td>
</tr>
<tr>
<td>Denver, CO</td>
<td>7,251 (2,210)</td>
<td>585</td>
<td>20.93</td>
<td>122</td>
<td>2 (36)</td>
</tr>
<tr>
<td>Mexico City</td>
<td>14,108 (4,300)</td>
<td>430</td>
<td>20.93</td>
<td>90</td>
<td>-11 (-12)</td>
</tr>
<tr>
<td>Mt. Everest</td>
<td>29,028 (8,048)</td>
<td>253</td>
<td>20.93</td>
<td>53</td>
<td>-43 (-46)</td>
</tr>
</tbody>
</table>

Note: The table compares the barometric pressure, percentage of oxygen in the air, partial pressure of oxygen in the air, and typical temperature at various altitudes including sea level, Miami, Denver, Mexico City, and Mt. Everest.
Physiological Adaptations
Physiological Adaptations

• Erythropoietin (EPO)
  – Natural hormone in kidneys
  – Stimulates RBC production

• Red Blood Cells (RBC)
  – Increase in number
  – Greater O₂ carrying capability
Physiological Adaptations

- ↑ Hemoglobin
- ↑ Hematocrit
- ↑ VO$_2$max
- ↑ Time to exhaustion

- May result in increased work capacity & performance
ETM Information & Claims
Elevation Training Mask

Claims that benefits may include:

- ↑ lung capacity
- ↑ anaerobic threshold
- ↑ energy production
- ↑ mental focus
- ↑ mental & physical stamina
- ↑ oxygen efficiency
Elevation Training Mask

- Patented resistance training device that creates pulmonary resistance
- Adjustable resistance during inspiration
- Fixed resistance during expiration
- Claims to simulate 3,000-18,000 ft. above sea level
Elevation ‘simulated’

ALTITUDE AIR RESISTANCES

Air flow out

9,000 ft
6,000 ft
3,000 ft

*Figure is calculated with both left and resistance caps

Resistances are based on experiences

ALTITUDE AIR RESISTANCES

AIR FLOW OUT

18,000 ft
15,000 ft
12,000 ft

* Figure is calculated with only (L) side open

flux valve must be turned around to shut off (r) inlet

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everyone stronger
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Personal Research
Research

• The Effects of an Elevation Training Mask on VO₂max of Male ROTC Cadets
• Pilot study to determine future research
• Purpose Statement
  – Investigate the Effects of an Elevation Training Mask on VO₂max of Male ROTC Cadets
  – Statistical significance set at $p \leq 0.10$
• Research Hypothesis
  – There will be a significant difference between the VO₂max in cadets that wore the ETM during training and cadets that did not
Research

• n=14
• Baseline- 45 mL/kg/min
  – Avg. VO₂ max for this demographic
• Training Frequency/Duration
  – 7 weeks, 3d/wk, ~ 60 minutes
    • Day 1, 2 mile run
    • Day 2, BW Circuit
    • Day 3, ≥4 miles
  – Pre-determined by ROTC
## Results

<table>
<thead>
<tr>
<th>Volunteer ID#</th>
<th>VO₂pretest (mL/kg/min⁻¹)</th>
<th>VO₂posttest (mL/kg/min⁻¹)</th>
<th>Control VO₂ pre-test (mL/kg/min⁻¹)</th>
<th>Control VO₂ post-test (mL/kg/min⁻¹)</th>
<th>Experimental VO₂ pre-test (mL/kg/min⁻¹)</th>
<th>Experimental VO₂ post-test (mL/kg/min⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>51.96</td>
<td>51.01</td>
<td>48.41 ± 2.91</td>
<td>49.24 ± 3.28</td>
<td>49.69 ± 3.33†</td>
<td>50.74 ± 2.71‡</td>
</tr>
<tr>
<td>2</td>
<td>49.94</td>
<td>53.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>50.85</td>
<td>51.48</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>49.60</td>
<td>51.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>46.18</td>
<td>46.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>46.24</td>
<td>44.32</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>44.08</td>
<td>46.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group averages</th>
<th>Absolute change in VO₂ (mL/kg/min⁻¹)</th>
<th>Relative % change in VO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.83 ± 0.37</td>
<td>1.7 ± 0.13</td>
</tr>
<tr>
<td>Experimental</td>
<td>1.05 ± 0.62</td>
<td>2.1 ± 0.19</td>
</tr>
</tbody>
</table>

| Control vs. Experimental | 1.50 ± 0.17 | 23.5 ± 0.46 |

* Values are reported as mean ± SD

**Control = did not receive treatment; Experimental = received treatment

† Experimental group shows no significant difference from control group after pretest (p = 0.46)

‡ Experimental group shows no significant difference from control group after posttest (p = 0.34)
Limitations

- Small sample size
- Type of training
- Compliance
- Frequency/duration of exposure
- Specific progression of resistance
- CO₂ re-breathing
- No blood analysis
Practical Implications

- Tactical athlete would need as much exposure as possible
- Experiment with different progressions
- Not much research showing advantage of use
Conclusion

• May teach proper breathing
  – ↑ diaphragm strength
• PPO₂ does not change when mask is worn
• Only restricts air intake
• Not possible to mimic altitude training like claims suggest
• More research is needed with this device to understand effectiveness
References

- Dreger, R. W., & Paradis, S. (2013). A comparison of high-intensity interval training with a self-contained breathing apparatus (scba) and the elevation training mask. NAIT.