The Profiling and Preparation of an Elite Junior Miler

Scott Christensen
December 2010
"The 800 and 1500 meter events are physiologically very close, but very distant psychologically" Peter Coe.
Successful racing in the fast end of the combined zone (800 and 1500) relies on managing oxygen and......
The toleration of disassociated Lactic Acid \((C_3H_5O_3^- + H^+))\)
# Anaerobic and Aerobic Energy Contributions

<table>
<thead>
<tr>
<th>Event</th>
<th>Aerobic</th>
<th>Anaerobic Glycolytic</th>
<th>Anaerobic Alactic</th>
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<tbody>
<tr>
<td>800 meters</td>
<td>40%</td>
<td>55%</td>
<td>5%</td>
</tr>
<tr>
<td>1500 meters</td>
<td>50%</td>
<td>48%</td>
<td>2%</td>
</tr>
<tr>
<td>3200 meters</td>
<td>70%</td>
<td>30%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>5000 meters</td>
<td>80%</td>
<td>20%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Wilmore and Costill 1985
Physiological Definition of “Elite” in Endurance Events

• A genetic/trained physiological shift in an athlete to a greater contribution by the aerobic energy system at a combined zone race distance.

• Example: 3000 meter race.
  • General Population = 70% aerobic/30% anaerobic
  • Paula Ratcliffe = 85% aerobic/15% anaerobic
VO₂ Kinetics to Steady State
@16 km/hour
Jones and Berger 2008

Comparison of VO₂ Response

\[
\begin{array}{c|c|c|c|c|c|c|c|c}
\text{Time (seconds)} & -120 & -60 & 0 & 10 & 30 & 60 & 120 & 180 & 240 \\
\hline
\text{VO₂ (mL min}^{-1}) & 0 & 500 & 1000 & 1500 & 2000 & 2500 & 3000 & \\
\end{array}
\]

PR
GP
It Is All About Preparation

“If given 8 hours to cut down an oak tree, I would spend the first 6 hours sharpening my axe.”

Abraham Lincoln
Preparation Considerations for the Training Periods of the Elite Miler

- Determining goals, objectives, and physiological parameters.
- \( v\text{VO}_2 \) max pace [date]
- vAT pace [date]
- vLT pace [date]
- Psychological needs of the athlete are prioritized.
# Goals and Objectives

<table>
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<tr>
<th></th>
<th>800 Meters</th>
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<th>VO2</th>
<th>5000 Meters</th>
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<td>600-800</td>
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<td>Physiological Parameters</td>
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<td>55.93</td>
<td>61.08</td>
<td>4:25.30</td>
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</tbody>
</table>
Training Sprinters vs. Distance Runners

[Rate vs. Economy]

WR Mean Time per 100 m vs. Distance

mean time/100 m (s)

distance (m)
Designing the elements of the 1500 macrocycle so that the best performances are at the end of the season should be the number one objective.
Specific Periods Within the 1500 Meter Macrocycle

• The **Preparation Period** focuses on the athlete as an endurance runner.
• The **Competition Period** focuses on the athlete as a miler.
• The **Transition Period** allows the athlete to prepare for the next stage of development.
Training Modalities for Middle Distance Runners

• The Long Run  IMPORTANT
• Tempo Run  IMPORTANT
• Strength Run  IMPORTANT

• Recovery/Base Run  CRITICAL
• VO_{2\text{max}} Run  CRITICAL
• Interval Run  CRITICAL
• Repetition Run  CRITICAL
The Multi-Paced Training Scheme

- Based on a 12 day microcycle.

- The long run, tempo run, strength run, recovery run, and races are included within the 12 days.

- The 12 day cycle also includes one day each of five distinctively varied paces that predominantly deliver ATP through the anaerobic energy system.
The 5 Paces of the Multi-Paced Training Scheme for the 800/1500.

- $\text{VO}_2 \text{ max Run (800-3200 meters)}$
- Special Endurance 2 (500-600 meters)
- Special Endurance 1 (300-500 meters)
- Speed Endurance (150 meters)
- Speed (30-60 meters)

Frank Horwill, Peter Coe, and Sebastian Coe
**VO$_2$ max Field Tests**

- *Buchfuhr* protocol: 10 min to exhaustion. (d)

- *Astrand* protocol: 2 miles at exhaustive pace. (t)

- *Taylor* protocol: 65% of date pace exhaustive 400 meters. (p)
Long Run

- Outer reach of fitness level is the goal
- Fatty acid rather than carbohydrate is the primary energy source
- Done at the **aerobic threshold**, 70% \( \text{VO}_2\text{ max} \) pace
- Pace consideration when done in a group
- Extent is 20% of weekly mileage throughout the macrocycle
Fuel Depletions and Limits

Glycogen Utilization in Working Muscle

% glycogen content vs. Exercise time (min)

- Light exercise
- Moderate exercise
- Heavy exercise

Tempo Run

- Extent of work is beyond 1500 race distance to 15 K.
- Intensity is done closer to the lactate threshold
- Duration dictates pace:
  - 6K-7K at 92% of VO$_2$ max.
  - 8K-9K at 90% of VO$_2$ max.
Anaerobic/Lactate Threshold

- The speed at which $\text{H}^+$ ions begin accumulating.
- Measured by lactate concentrations.
- About 15K pace (4.2 m/s) is the training mark, or 85% of $\text{VO}_2\text{ max}$ velocity.
- Tempo runs are done as a percentage of $\text{VO}_2\text{ max}$ velocity.
Strength Run

• Greater applied force against resistance is the goal.
• Any running is strength work.

• **Hills are the main target workout.**
  • Hills are done in 4 microcycle blocks of time.
  • 35-45 second bouts of work.
  • 4 minute jog of incomplete recovery.
  • Sets of 6-8.
Recovery Run

• Recovery has many aspects and may simply be adding base mileage at the aerobic threshold pace. **Shorter in distance than the long run.**

• Energy system recovery and muscle repair are the biggest concerns.

• **20 min run at minimum.**
A Critical Understanding of VO2 max is Necessary for the 800/1500

- Aerobic power improves due to cardiovascular development.
- Cardiac Output (Q) = HR x SV
- VO2 max = HR x SV x A-vO2 diff
- HRmax = 207 – 0.7 x age
- VO2 max pace HR is ~88% of HRmax
### Percentage of VO$_2$ max as a Function of Race Velocity

<table>
<thead>
<tr>
<th>Event</th>
<th>% of VO$_2$ max</th>
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</thead>
<tbody>
<tr>
<td>800 Meters</td>
<td>120-125%</td>
</tr>
<tr>
<td>1500-1600 Meters</td>
<td>112-114%</td>
</tr>
<tr>
<td>3000-3200 Meters</td>
<td>102-100%</td>
</tr>
<tr>
<td>5000 Meters</td>
<td>97%</td>
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</table>
VO₂ max Training Study
12 week Training Period
(Helgerud et al, 2007)

- LSD: CR for 45 min @70% VO₂ max
- LT: CR for 25 min @85% VO₂ max
- 15/15: 47 reps @90% HR max, 15 s rest
- 4*4 min: 4 min repeats @ VO₂ max

Workout repeated twice per week, 40 mile weeks.
% Change VO$_2$ max & Stroke Volume
(12 Weeks)
Helgerud et al, 2007, MSSE
### Pre/Post Physiological Changes

<table>
<thead>
<tr>
<th></th>
<th>Pre LSD</th>
<th>Post LSD</th>
<th>Pre LT</th>
<th>Post LT</th>
<th>Pre 15/15</th>
<th>Post 15/15</th>
<th>Pre 4*4</th>
<th>Post 4*4</th>
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</thead>
<tbody>
<tr>
<td><strong>VO\textsubscript{2} max</strong></td>
<td>55.8</td>
<td>53.8</td>
<td>59.6</td>
<td>60.8</td>
<td>60.5</td>
<td>64.4</td>
<td>55.5</td>
<td>61.4</td>
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<tr>
<td><strong>VE\textsubscript{O2}</strong></td>
<td>150.6</td>
<td>153.3</td>
<td>148.8</td>
<td>153.6</td>
<td>147.5</td>
<td>160.3</td>
<td>150.7</td>
<td>164.8</td>
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</table>
Deena Kastor’s \(v\text{VO}_2\) \(_{\text{max}}\) Development

- **Tested VO\(_2\) \(_{\text{max}}\):**
  - Age 22 (1995) \(\text{VO}_2\) \(_{\text{max}}\): 77.5 ml/kg/min
  - Age 27 (2000) \(\text{VO}_2\) \(_{\text{max}}\): 80.5 ml/kg/min
  - Age 32 (2005) \(\text{VO}_2\) \(_{\text{max}}\): 81.1 ml/kg/min

- **Tested VO\(_2\) uptake at Lactate Threshold:**
  - Age 22 (1995) : 61.8 ml/kg/min (79%)
  - Age 27 (2000) : 62.2 ml/kg/min (79%)
  - Age 32 (2005) : 67.3 ml/kg/min (82%)
A lab value and a field value.

Each bout of work is 400-3200 meters.

Total volume is 3200-8000 meters.

Done as an interval style workout.

Pace is date specific.

Rest equal to work.
Interval and Repetition Runs

- Used mainly for glycolytic and VO$_2$ max development.
- 30 meters to race distance.
- Barefoot grass runs.
- Rest dictates training effect.
- Efficiency early.
- Capacity late.
Glycolytic Training Parameters

- **Efficiency** work done first 2/3 of season.
- **Capacity** work done last 1/3 of season.
- **Efficiency** work done as interval runs.
- **Capacity** work done as repetition runs.
Recovery And Blood Lactate Levels

![Graph showing blood lactate levels during recovery with lines for active and passive recovery with graph labels: Recovery (min) on the x-axis and Blood Lactate (mmol/L) on the y-axis. The graph indicates a decrease in blood lactate levels over time for both recovery types.]
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Adapted from: Frank Horwill, Peter Coe, and Sebastian Coe
Improvements in Ground Contact Time

“If a distance runner can lessen their ground contact time by .02 seconds per stride, with all else being equal, there should be a ~5 second improvement in 1600 meter performance. This can be accomplished by strengthening the muscles of the foot.”

Ralph Mann  Ph.D.
Special Endurance 2 Work

*Done on the Grass*

- Used on a regular basis it *will* strengthen the muscles of the foot.

- Athletic fields or grassy parks can be set up with cones to provide a 500-600 meter course.
12 Day Multi-Paced Microcycle

- Day 1: VO$_2$ max
- Day 2: Hills
- Day 3: Long Run
- Day 4: Special 1
- Day 5: Recovery Run
- Day 6: Race
- Day 7: Special 2
- Day 8: Tempo Run
- Day 9: Recovery Run
- Day 10: Speed Endur.
- Day 11: Recovery Run
- Day 12: Speed
Cornerstone Workouts

• 4 * 1 mi @ VO_{2max} pace
• 7 * 800 @ VO_{2max} pace
• 8 * 90 sec runs on grass
• 8 * 400 with 3 min rest
• 6 * 150 with 4 min rest
• 8 * 400 with 45 sec rest
• 15 * flying 30 meters
• 4 * 500 with 15 min rest
• 8 * 200 with 8 min rest
• 2 * 3 * 300 with 3 min rest

• VO_{2max}
• VO_{2max}
• Special Endurance 2
• Special Endurance 2
• Speed Endurance
• Special Endurance 2
• Speed
• Special Endurance 2
• Special Endurance 1
• Special Endurance 1
**VO2 max Workout #1**

- Active 3 mile warm-up run.
- Extent is 4 * 1 mile.
- **Pace is** *PRESENT DAY* 3200 max effort.
- Use a conversion table or a Vdot (Jack Daniels) value to determine work effort from another race value.
- **Rest is equal to work.**
- 2 mile jog.
VO₂ max Workout #2

• Active 3 mile warm-up run.
• Extent is 7 * 800 meters.
• Pace is *PRESENT DAY* 3200 max effort.
• Use a conversion table or a V₉₀ (Jack Daniels) value to determine work effort from another race mark.
• *Rest is equal to work.*
• 2 mile jog.
Special Endurance 2 Workout #1

• 2 mile active warm-up.
• Using 5 cones set up a 500-600 meter course on the grass of several side by side soccer fields or a park.
• Have the runners barefoot during the repeats.
• Extent of run is 8 * 600 with near max effort.
• Vary the rest so that the athletes run all 8 at about the same time. Start with 3 minutes rest and gradually move to 4-5 minutes rest between.
• 2 mile jog.
Special Endurance 2 Workout #2

- 2 mile active warm-up.
- Several very fast strides.
- Extent of work is 8 * 400 meters at near max effort on the track.
- Rest is 3 minutes.
- Time goal is ~5 seconds faster than PRESENT DAY 1600 pace.
- 2 mile jog.
Speed Endurance Workout

- With a measuring wheel and can of spray paint, mark a dot on the track exactly 150 meters from the finish line.
- 2 mile very active warm-up.
- Extent of work is 6 * 150 meters on the track at max effort. Use a starting device.
- Rest is 4 minutes.
- Time goal is their PRESENT DAY 400 meter time multiplied by .35.
- 3 mile easy run.
Speed Workout

• 2 mile active warm-up.
• Several active strides.
• Flying 30 meter repeats on the track.
• Work is max effort.
• 4 minutes jog rest between repeats.
• Do up to 12 reps.
• 4 mile easy run.
Special Endurance 2 Workout #4

• Capacity work done as repetition running.
• 2 mile active warm-up.
• Several active strides.
• Extent of work is 4 * 500 at max effort.
• Rest is near complete at 15 minutes.
• Time goal is PRESENT DAY 800 pace multiplied by .59.
• 1 mile jog.
Special Endurance 1 Workout #1

- 2 mile active warm-up.
- Several very active strides.
- Extent of work is 8 * 200 at near max effort on the track.
- Rest is extensive at 8 minutes between repeats.
- Time goal is *PRESENT DAY* 400 meter pace multiplied by .47.
- 2 mile jog.
Special Endurance 1 Workout #2

- 2 mile active warm-up.
- Several very active strides.
- Extent of work is 2 sets of 3 repeats of 300 meters on the track.
- Rest is incomplete at 3 min between repeats and 5 minutes between the sets.
- Time goal is seasonal 800 goal pace multiplied by .35.
- 2 mile jog.
Regeneration Timeframe

24 hours
• Normal long runs, strength runs, recovery runs, moderate tempo runs, alactic runs

48 hours
• Races, long runs plus, lactate threshold runs, basic glycolytic, strong tempo runs, VO2 max

72 hours
• Long races, very strong glycolytic, very strong or long tempo runs
Training Effects

• Some physiological effects after 24 hours.
• Full physiological effects after 20 days.
• Periodize and sequence your workouts so they fit the race schedule.
• The body is very resilient when at a high fitness level.
• Watch for muscle trauma caused by too much testosterone.
More Endurance Information Available in the Following Book:

The Complete Guide to Track and Field Conditioning for Endurance Events.

By Scott Christensen

Athletesacceleration.com/trackandfieldendurance.html