Can we predict trail running performance?

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Outline

• Classic endurance model
• Prediction studies in trail running
• Strength factors
• Conclusion/ Future?

Sub 2 hour marathon attempt

Eliud Kipchoge

https://www.theguardian.com/sport/live/2017/may/06/sub-two-hour-marathon-attempt-in-monza

Maximal oxygen uptake $V_{O2}\text{max}$

Performance

Fractional utilization

Running economy

Classic endurance model

Muscle action- trail running

R. Balducci et al. Performance Factors in a Mountain Ultramarathon.
Int J Sports Med 2017

- 24 male runners, 75km (+3930m/-3700m)
- $MAS$ (max aerobic speed) x $V_{O2}\text{max}$ (incremental test)
- $F_{MAS}$ (Fraction of max aerobic speed - ratio between average speed during race and $MAS$)
- Neuromuscular fatigue:
  - knee extensors isometric maximal voluntary contraction (IMVC)
  - jump height counter movement jump
  - leg stiffness (measured through 10 consecutive maximal jumps)
- $RE$ (level and uphill (10%) Cr pre/post UM)
Balducci et al. Performance Factors in a Mountain Ultramarathon.
Int J Sports Med 2017

- 24 male runners, 75km (+ 3930m/-3700m)
- MAS (max aerobic speed) vVO2max (incremental test)
- Fmax (Fraction of max aerobic speed- ratio between average speed during race and MAS)
- Neuromuscular fatigue:
  - knee extensors isometric maximal voluntary contraction (MVC)
  - jump height counter movement jump
  - leg stiffness (measured through 10 consecutive maximal jumps)
- RE (level and uphill (10%) Cr pre/post UM)

\[ T = 11.852 \times FMAS - 37.195 \times MAS - 0.118 \times Kef + 2090.581 \] \( (R^2=0.98) \)


- n=23, 65km + 4000m
- Laboratory exercise test:
  - VO2max and peak power output in the graded exercise test correlated (mechanical power [W/kg])
- During race:
  - Heart rate at ventilatory thresholds

- power output that an athlete can produce (uphill exercise test) may represent an important factor in determining the ascent rate and performance time in uphill MUM
  - Predictive power 59%
Trail test

Incremental exercise test (inclination and velocity)

• Higher VO₂ max values compared to other exercise tests
• Velocity and inclination can be measured and calculated in mechanical power (W/kg)

• ? As measure of lower limb muscular strength and fatigability?
• ? Valuable in prediction of trail running performance?

Skeen et al. VO₂ max testing in trail runners: is there a specific exercise test protocol? Int J Sports Med 2019


• n=9, trail race 27km +1400m
• Exercise test
  – VO₂ max, %VO₂ max at VT
  – RE at 0 and 10%
• MVC con/ecc
  – Right knee extensors maximal voluntary concentric and eccentric torques
• Local fatigue index FI
  – [40 consecutive concentric contractions of the knee extensors]
Strength factors

**Correlated to performance:**

- Maximal mechanical power of the lower limbs (counter movement jump) \(*\text{Giovanelli et al. IJSPP 2014}\)
- Fatigue index (40 consecutive concentric contractions of the knee extensors) \(*\text{Ehrström et al. Med Sci Sport Med 2017}\)
- Peak power output in exercise test. \(*\text{Fornasiero et al. J Sports Sci 2017}\)
- Relationship between muscle strength/power. \(*\text{Lazzer et al. IJSPP 2015}\)

**Not correlated to performance:**

- Counter movement jump, leg stiffness. \(*\text{Balducci et al. Int J Sports Med 2017}\)

\[\text{VO}_2\text{max and } \% \text{VO}_2\text{max}\]

**Correlated to performance:**

- \(\text{VO}_2\text{max} (43\text{km} +3063\text{m})\) \(*\text{Giovanelli et al. IJSPP 2014}\)
- \(\text{VO}_2\text{max} (27\text{km} +1400\text{m})\) \(*\text{Ehrström et al. Med Sci Sport Med 2017}\)
- \(\text{VO}_2\text{max} (65\text{km} +4000\text{m})\) \(*\text{Fornasiero et al. J Sports Sci 2017}\)
- \(\text{vVO}_2\text{max}, \% \text{vVO}_2\text{max} (75\text{km} +3930\text{m})\) \(*\text{Balducci et al. Int J Sports Med 2017}\)
- \(\text{Hillre OV et al. 2011, Lazzer et al. 2012, di Francesco et al. 1986}\)

**Not correlated to performance:**

- \(\% \text{VO}_2\text{max}\) \(*\text{Ehrström et al. Med Sci Sport Med 2017}\)
Running economy/ energy cost of running

Cr level and uphill correlated to performance time:
- Cr level and uphill (5%) 65km positive/negative elevation 4000m. Vernillo et al. J Sports Sci 2015
- Cr level 43km + 3063m. Lazzer et al. USPF 2015
- Cr uphill (+10%) 27km +1400m. Ehrström et al. Med Sci Sport Med 2017

Cr not correlated to performance time:
- Cr level and Cr (+15%) 330km +24000m. Vernillo et al. Eur J Appl Phys 2014
- Cr level and Cr (+10%) 75km (+ 3930m/-3700m). Balducci et al. Int J Sports Med 2017
- Cr level 27km +1400m. Ehrström et al. Med Sci Sport Med 2017

Summary

Performance prediction in trail running is challenging
Parameters related to performance prediction:
- VO\textsubscript{2}max
- % VO\textsubscript{2}max
- Lactate thresholds
- RE/ Cr
- Local factors/ muscle strength, fatigue resistance, power
- Psychological, motivational...

Which model??? Which combination???