Differences in Exercise Economy between Minimalistic and Conventional Footwear

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“Every morning in Africa, a gazelle wakes up. It knows it must outrun the fastest lion or it will be killed. Every morning in Africa, a lion wakes up. It knows it must run faster than the slowest gazelle, or it will starve. It doesn’t matter whether you’re a lion or a gazelle – when the sun comes up, you’d better be running.”

-(McDougall, 2009, p. 13)
Inspiration: Tarahumara

www.nytimes.com/2009/10/27/health/27well.html?_r=1

www.chrismcdougall.com
Pre-Modern Running Shoe

- Minimalistic in structure
  - Very thin-soled
  - No motion control
  - No heel pad or arch

- Promoted strong feet
  - Lower incidence of knee injuries
Modern Running Shoe

- Invented by Nike in 1972
- Continually “improving” shoe technology
  - “Rear foot control”
  - “Cushioning”
  - “Shock distribution”
  - “Heel stabilization”
  - “Arch support”

www.nikerunning.nike.com
Running Injuries

- 79% of runners injured each year
- Rates are NOT improving, despite the supposed improvements in shoe technology

- “How come my foot hurts?”
  - “Because running is bad for you”
- “Why is running bad for me?”
  - “Because it makes your foot hurt”
The Problem

- Altered biomechanics
  - Knee flexion torque $\uparrow$ 36%
  - Knee varus torque $\uparrow$ 38%
  - Hip internal rotation torque $\uparrow$ 54%

- Altered physiology
  - Weakened intrinsic musculature
  - Little/no elastic recoil from muscles & tendons
  - $\uparrow$ impact & ground reaction force
The Problem

- “Top-of-the-line” shoes = 123% more likely to be injured
- >$95 shoes more than twice as likely as <$45

www.donnaluder.com/footmechanic/shapesize/
www.vibramfivefingers.com
Human Foot

- 26 bones
- 33 joints
- 12 tendons
- 18 muscles
Why Minimalistic?

- Mimics barefoot running
- Protects feet from small hazards
- Stresses feet and provides no support
Is “barefoot” better?

- Stronger feet = greater injury resistance
- More elastic energy = better exercise economy…?

- Barefoot offers no metabolic advantage.
- 4.6% greater VO₂ response in shoes than barefoot.
- Shoes: 2.1% lower VO₂ than barefoot
- 150g shoes: no change, 350g shoes: 3.4% higher VO₂
The Experiment

- Vibram FiveFingers shown to accurately mimic barefoot metabolic response

Asics Gel
Nimbus-12
340g

Vibram
FiveFingers
KSO
161g

www.onlineshoes.com
www.usvibramshoes.com
Goal

- Discover whether it is more metabolically efficient, in terms of exercise economy, to run in conventional running shoes or minimalistic footwear.
Hypothesis

• Based on a combination of studies and my own level of comfort with running “barefoot,” I hypothesized that it would be between two and five percent more efficient for me to run “barefoot” than shod.
Methodology

- Establish VO$_{2\text{max}}$ on treadmill
- Run 2 sessions per day x 3 days
  - First session: Asics running shoes
  - Second session: Vibram FiveFingers
- Session length: 15 minutes
- Rest period: 15-20 minutes
Methodology

- Treadmill settings:
  - 7.0 mph
  - 0.0% incline

- Information collected every minute
- Data analyzed for minutes 6-15 (steady state)
  - Oxygen uptake (VO$_2$)
  - Heart rate (BPM)
  - Rate of perceived exertion (6-20)
Results

- **Average metabolic cost**
  - Running Shoes: 66.95% of VO$_{2\text{max}}$
  - Vibram FiveFingers: 63.54% of VO$_{2\text{max}}$
  - **Difference**: 3.41%

![Average Running Economy Graph]

Percent of VO$_{2\text{max}}$
Results

- **Average heart rate**
  - Running Shoes: 149 bpm
  - Vibram FiveFingers: 155 bpm
  - Difference: 6 bpm (3.03% of APMHR 198)
Results

- Average rate of perceived exertion (RPE)
  - Running Shoes: 11
  - Vibram FiveFingers: 12.7
  - Difference: 1.7 (12.14% of 6-20 scale)
Conclusion

• For me, it is about 3.41% more efficient, in terms of exercise economy, to run in minimalistic footwear (or barefoot) than it is to run in conventional shoes.

• These results are personal and could vary among other runners with different biomechanics and predispositions.

• This carries important implications in potential racing scenarios...
References:


References (continued):


Thank you!