What We Can Learn About Running from Barefoot Running: An Evolutionary Medical Perspective[1]

Daniel E. Lieberman

Philip Blumin, Jonathan Lam, Joshua Yoon

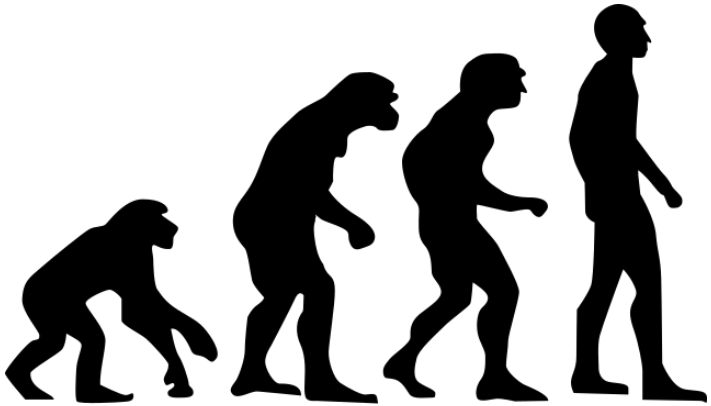
[1] Lieberman, Daniel E. "What we can learn about running from barefoot running: an evolutionary medical perspective." *Exercise and sport sciences reviews* 40.2 (2012): 63-72.

Introduction

- People’s and researcher’s perspectives on barefoot running
- Reasons why runners get injured a lot
  - Running is by nature an injurious activity
  - People are not acquainted to log distance running to do biomechanical abnormalities (asymmetries)
  - “Training errors”
- Barefoot running may help runners avoid injuries
- Author’s proposed hypothesis
  - Human bodies adapted to barefoot style
  - Generate less forceful impact peaks, which may strengthen feet

Why Does Evolution Matter

- Evolutionary field medicine
- Mismatch hypothesis
- Consequences shoes could have on injuries
  - Shoes limit proprioception
  - Modern shoes could encourage different running forms that human nature not used to
  - Shoes can lead to weak and inflexible feet
- Evolutionary medicine perspectives
  - Correct null hypothesis is that running barefoot is less injurious than running in a shoe

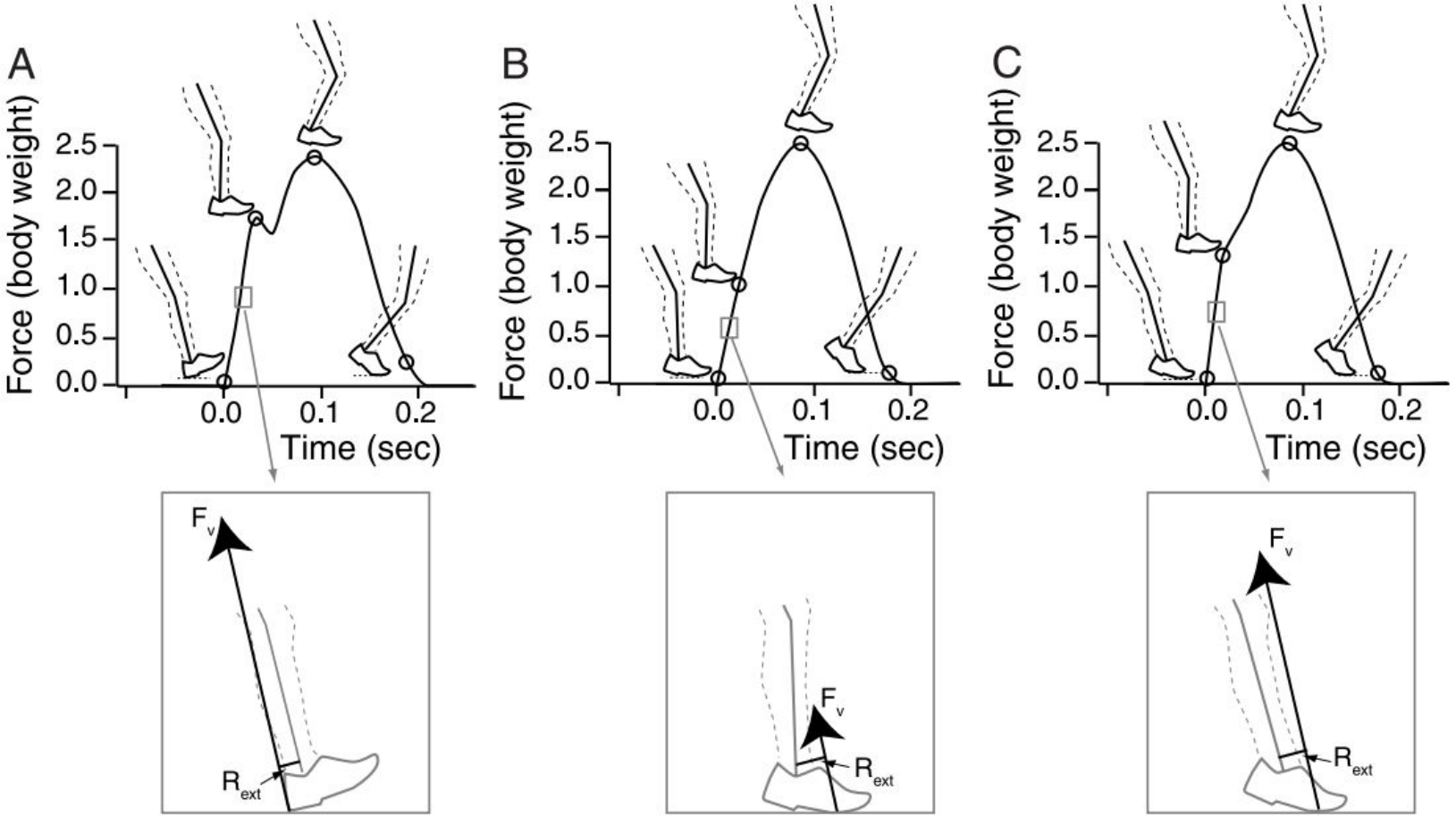


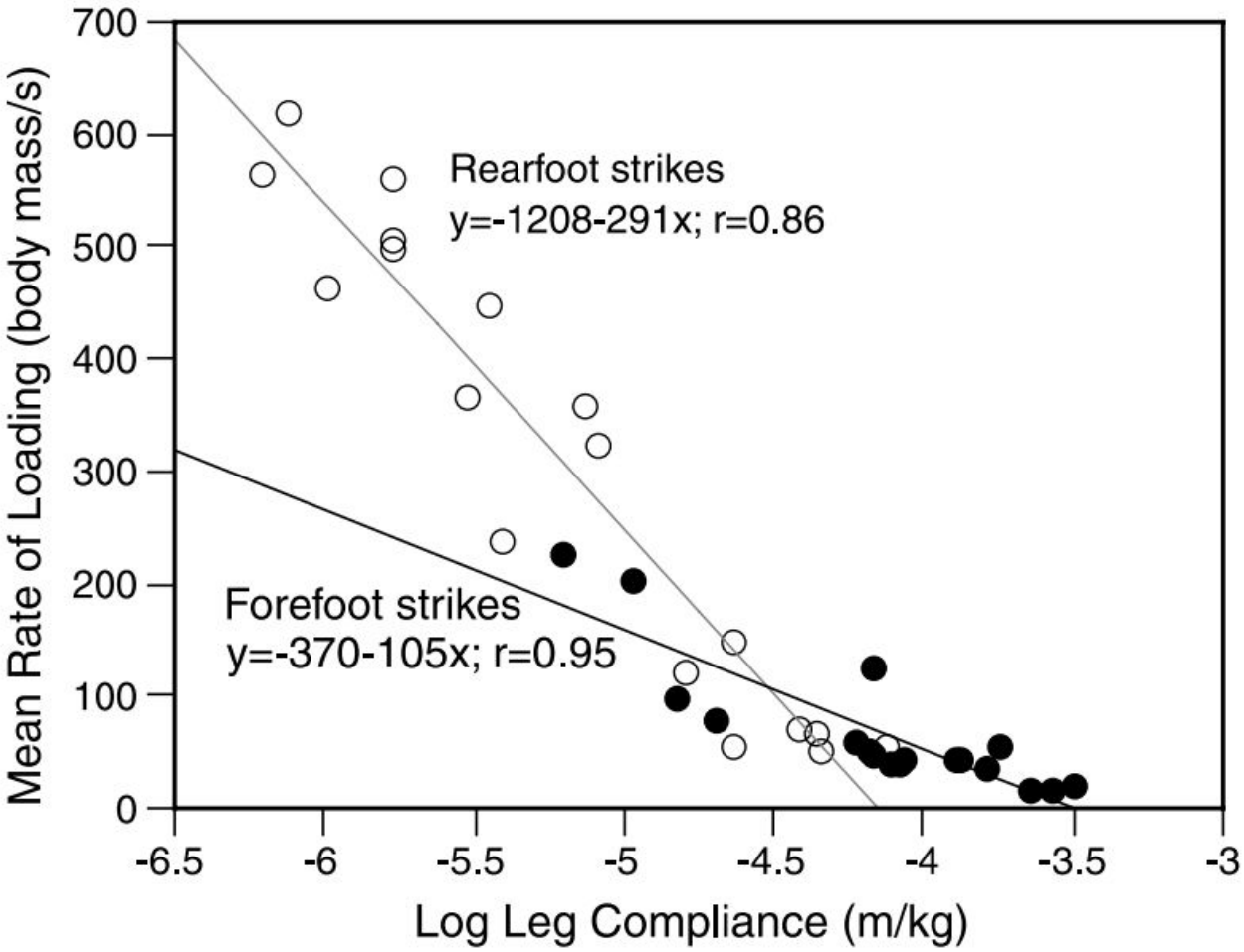
What Do We Know About Barefoot Running?

- Use habitually shod runners (people running in shoes) for previous studies
- Findings
  - Shod runners likely to rearfoot strike (RFS) while running on **soft surfaces like grass**
  - Shod runners likely to forefoot strike (FFS) and midfoot strike (MFS) when running on **hard surfaces**
  - Habitual barefoot runners have relatively short strides and a fast stride rate regardless of speed
    - Over 170 steps per minute
    - Short stride explains why barefoot runners land on foot more vertically aligned with knee and hip

Footstrike

- Rear vs. mid. vs. front footstrike (RFS, MFS, FFS)
- RFS causes **much higher initial ground reaction force**
  - Running shoes greatly decrease rate of loading but not as much peak load
- Barefoot runners tend to MFS or FFS
- RFS: **stiff ankle**, high impulse/rate of reversal of momentum
- FFS: **compliant ankle**, controlled dorsiflexion
- Several ways to modify lower extremity compliance other than using shoes
  - E.g., shorter strides, more knee flexion, less overstride


A
B
C
Force (body weight)
2.5
2.0
1.5
1.0
0.5
0.0
0.0
0.1
0.2
Time (sec)
F_v
R_ext


Mean Rate of Loading (body mass/s)
700
600
500
400
300
200
100
0
-6.5
-6
-5.5
-5
-4.5
-4
-3.5
-3
Log Leg Compliance (m/kg)
Rearfoot strikes
y=-1208-291x; r=0.86
Forefoot strikes
y=-370-105x; r=0.95

Stride Rate and Length

- Elite shod runners: 170-180 steps per minute (spm)
- Nonelite shod runners: 150-160spm
  - Why? We don’t know
- Nonelite barefoot runners: 175-182spm

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Why shorten stride?

- Tends to avoid RFS
- Knee, ankle tends to be more flexed and compliant
- Requires less plantarflexion to FFS

Anatomical Adaptations

Calluses form on toe and heel due to stimulation from friction

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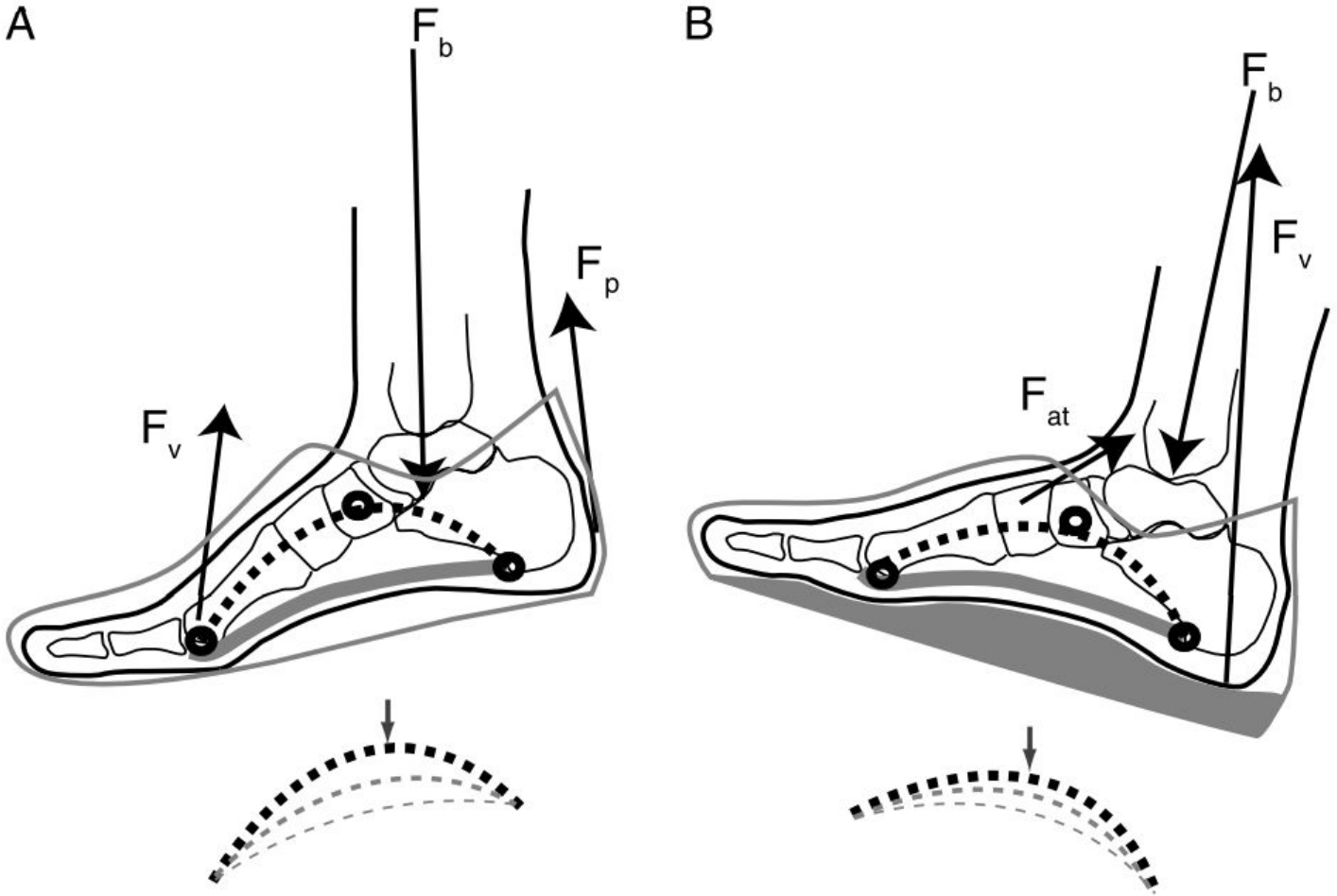
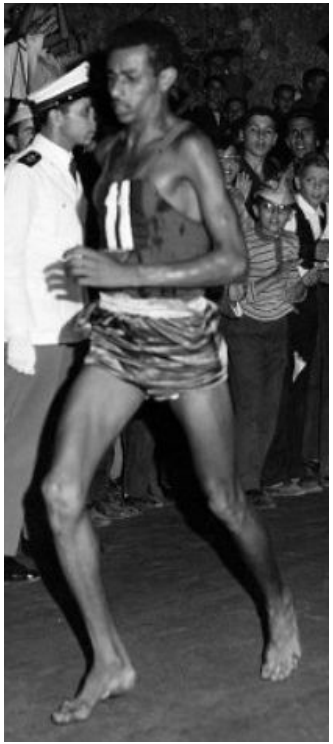
FFS/MFS cause more eccentric loads than RFS → stronger plantar muscles

- Both the plantar flexors (posterior leg muscles) and sole muscles
- Foot arch gets stretched more due to FFS than RFS


A
F b
F p
F v
B
F b
F v
F at

Performance

- FFS runners hold many world records



Abebe Bikila

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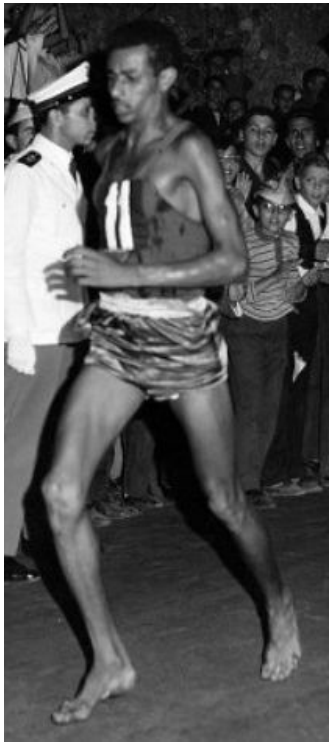
- Shoe Mass: Increases running cost by 1% for every 100g per unit per mass



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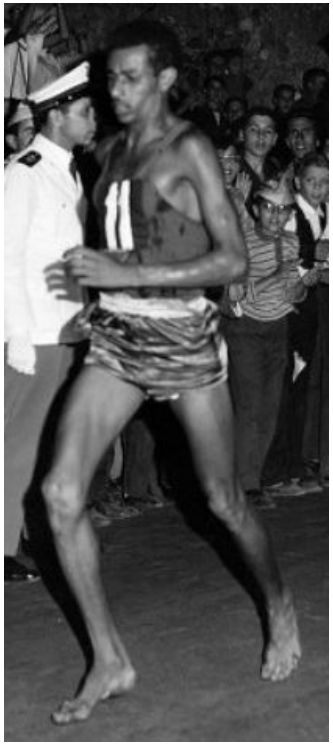
- Shoe Mass: Increases running cost by 1% for every 100g per unit per mass
- Running in minimal shoes is 2.4% - 3.3% more economical than running in standard running shoes



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- Shoe protection vs Foot Sensors and Proprioception

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- Questions:
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  - “How much does the lack of prioprioception in a minimal shoe affect running form?”
  - “Can we identify which runners are most likely to benefit from or should avoid barefoot running?”

Conclusion

- Barefoot runners have the following characteristics:
  - more proprioceptive feedback
  - shorter strides
  - higher stride frequency
  - avoid RFS and lessen impact peaks,
  - strong feet