EUROPEAN COLLEGE OF SPORT SCIENCE
SPORT SCIENCE
IN THE HEART OF EUROPE
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The impact of different footwear on running kinematics and jumping stabilization in young healthy athletes

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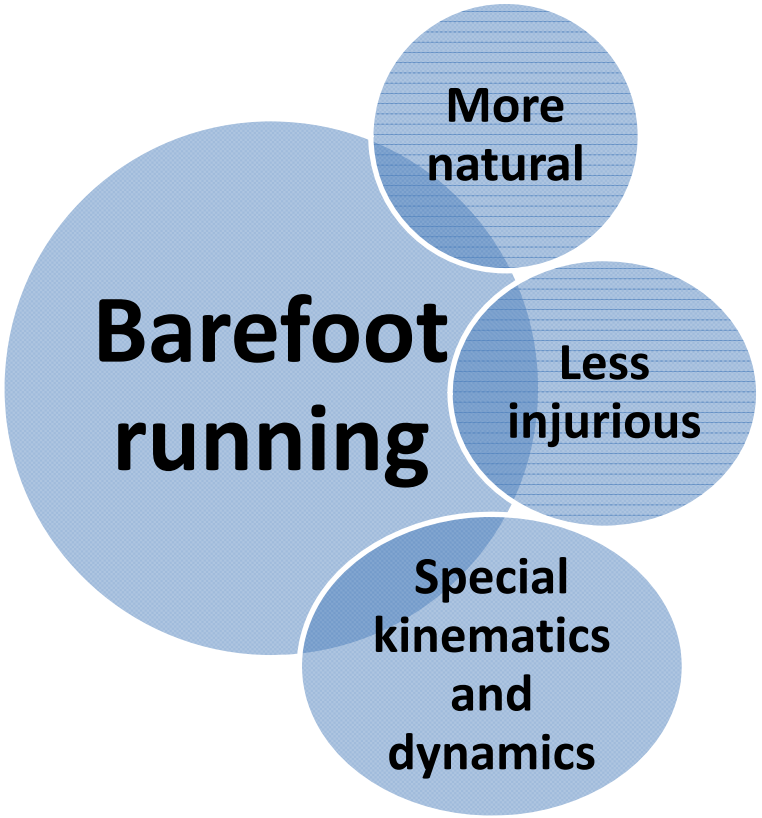
Barefoot-like shoe designs



Nike free®

Influences concepts in sport shoe development

Leguano®

Vibram fivefingers®

Barefoot vs. shoe running kinematics

Lieberman DE, Venkadesan M, Werbel WA, Daoud AI, D'Andrea S, Davis IS, Mang'eni RO, Pitsiladis Y. Foot strike patterns and collision forces in habitually barefoot versus shod runners. *Nature. 2010;463(7280):531-5.*

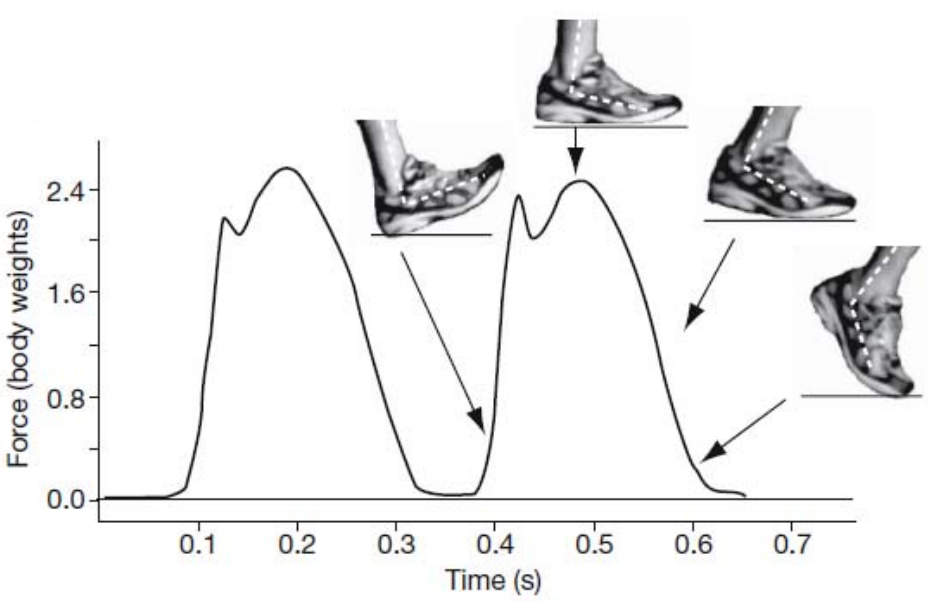
Barefoot running (forefoot touchdown)

Shoe running (heel first)

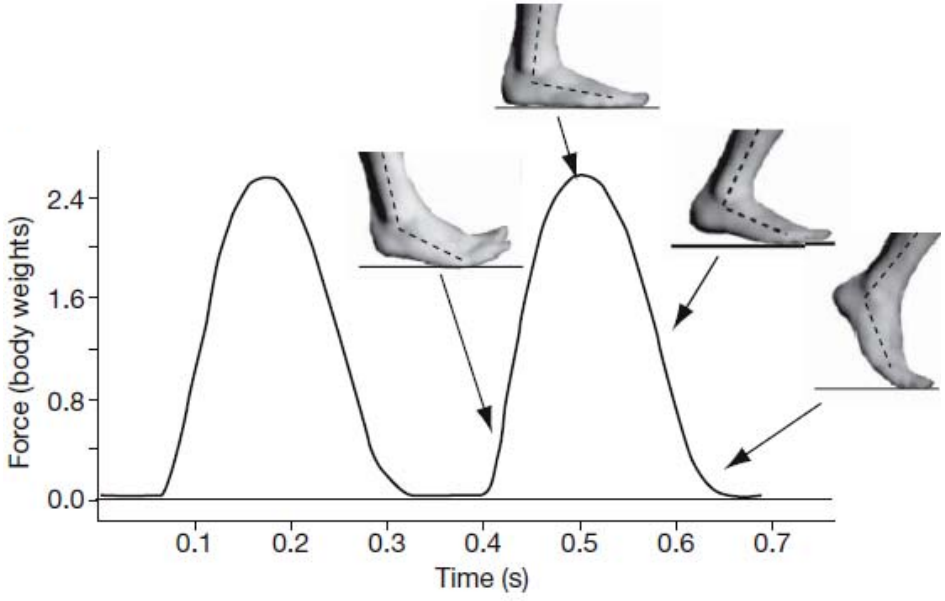
Jungers 2010 (Photos courtesy of D. E. Lieberman)

Barefoot vs. shoe running kinematics

Vertical ground reaction forces



Shoe running



Barefoot running

(Lieberman et al 2010)

Barefoot-like shoe designs

- The development of minimal (barefoot-like) footwear has recently gained increasing attention.
- Questionable whether they are sufficient for simulating barefoot situations

Objective:
To compare running kinematics and jumping stabilization time between barefoot and different footwear situations of increasing flexibility.

Methods

- 35 healthy athletes with experience in long distance running (25.0±7.3 km per week)
  - *22 men, 13 women*
  - *age: 27.9±5.1 years*
  - *height: 179.1±6.8 cm*
  - *mass: 73.9 ±9.8 kg*

- barefoot, (a) Asics GT-2160®, (b) Nike free 3.0® and (c) running socks (Leguano® barefoot shoes) conditions in randomized order

Outcomes

A) Running kinematics

2 min treadmill running at 8, 10 and 12 km*h-1 in each condition

- 3-D ankle and knee joint kinematic analysis (Vicon Motion Systems)
- cadence

Outcomes

B) Postural control

1. unilateral jump-landing task on a force plate
   - time to stabilization (TTS)
   - Peak ground reaction force

2. Single-leg stance
   - Center of pressure sway velocity

Results

Treadmill running kinematics

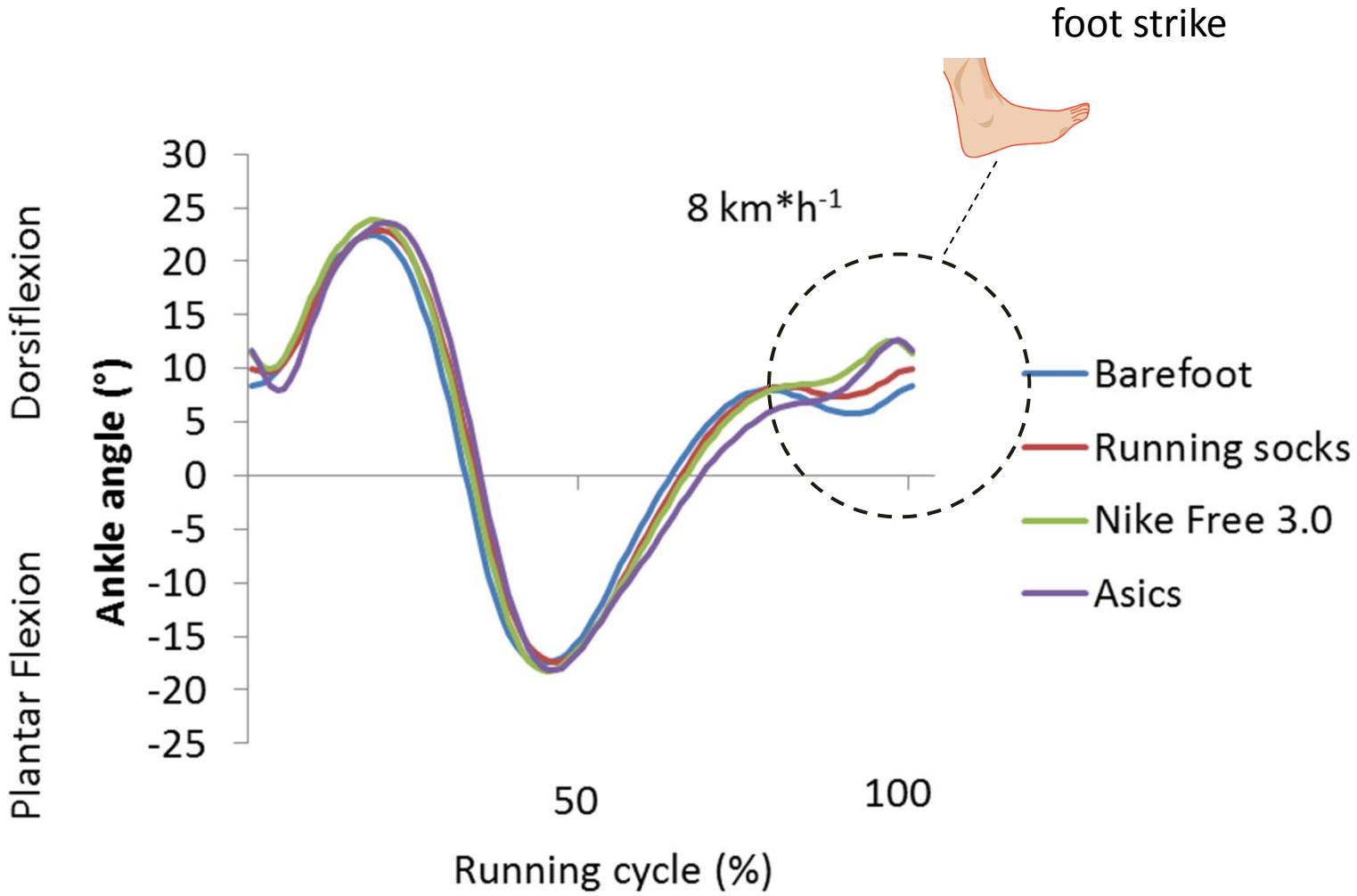
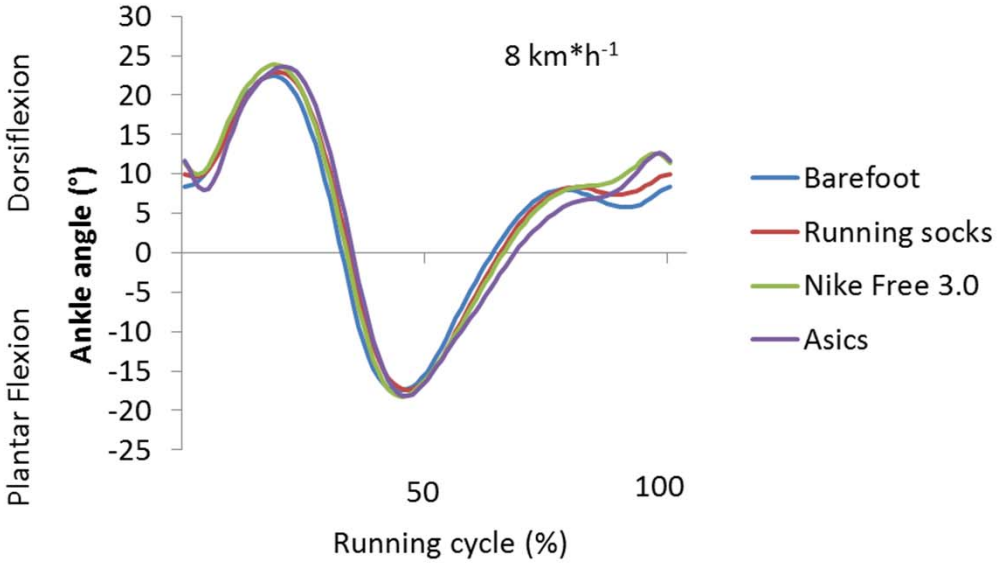
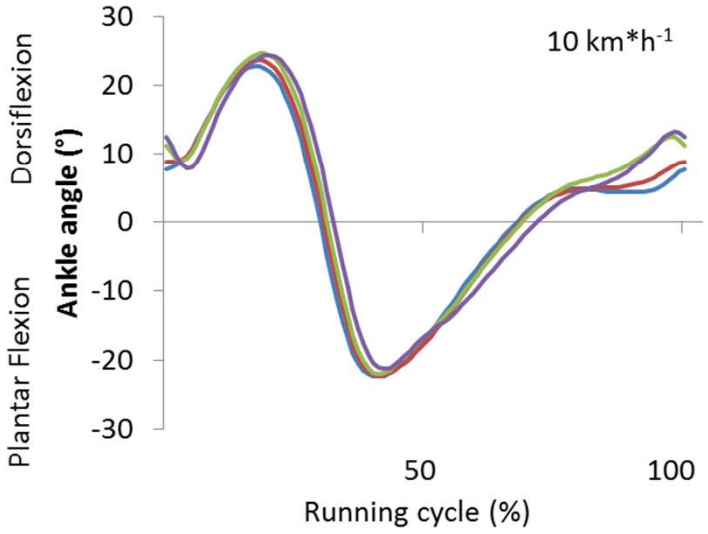


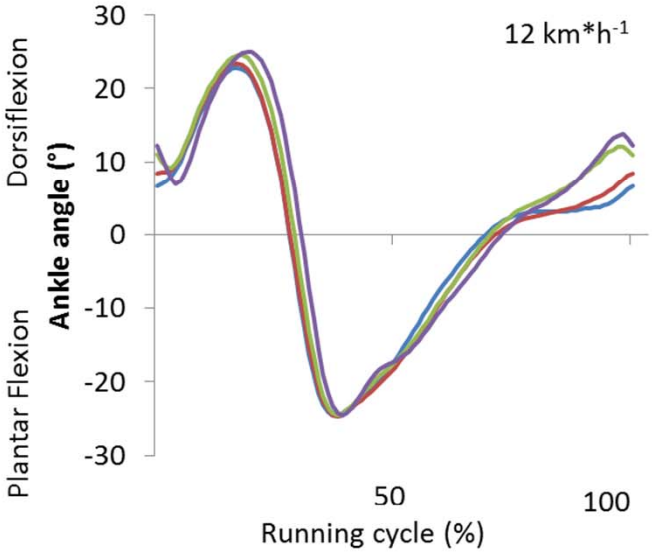
Figure: Mean ankle joint angle waves of all participants

Results

Foot strike kinematics on treadmill at running speeds (8–12km*h^{-1})







Results

Kinematics on treadmill at 12km*h^{-1}

Footwear	Dorsiflexion at foot strike (°)		Cadence (steps /min)
	left	right	
Barefoot	6.9 ± 4.8	7.0 ± 5.0	175 ± 9.79
Running socks	8.6 ± 6.1	8.1 ± 6.0	171 ± 8.28
Flexible shoe (Nike free 3.0)	10.9 ± 4.6	10.0 ± 5.1	169 ± 8.30
Standard shoe (Asics)	12.7 ± 5.2	11. 4 ± 4.8	165 ± 7.33

Significant interaction between footwear conditions in both outcomes ($p<0.01$)

Results

P-Values for dorsiflexion (left side) comparison between footwear conditions

Footwear	Barefoot	Running socks	Nike free 3.0	Standard shoe (Asics)
Barefoot		p=0.041	p<0.001	p<0.001
Running socks	p=0.041		p=0.049	p=0.001
Nike free 3.0	p<0.001	p=0.049		p=0.458
Standard shoe (Asics)	p<0.001	p=0.001	p=0.458	

Bonferroni corrected

Results

Jump landing and postural control

Footwear	Jump Landing TTS (s)		Peak GRF (N)			COP (cm/s)	
	Medial-lateral	Anterior-posterior	Medial-lateral	Anterior-posterior	Vertical	Medial-lateral	Anterior-posterior
Barefoot	2.93 ± 0.83	3.29 ± 0.43	131.2 ± 133.4	170.1 ± 143.6	1831.3 ± 469.6	1.31 ± 0.37	1.36 ± 0.37
Running socks	2.97 ± 0.84	3.22 ± 0.44	146.2 ± 159.8	184.8 ± 159.2	1899.4 ± 452.1	0.96 ± 0.26**	1.21 ± 0.29**
Nike free 3.0	3.08 ± 0.79	3.24 ± 0.47	143.9 ± 155.0	176.3 ± 153.3	1771.0 ± 429.7*	1.04 ± 0.31**	1.28 ± 0.35**
Asics	3.02 ± 0.45	3.26 ± 0.34	141.7 ± 145.3	182.2 ± 161.2	1700.9 ± 433.1*	0.99 ± 0.28**	1.27 ± 0.37**

*Significantly different from running socks ($p<0.05$)

** Significantly different from barefoot condition ($p<0.001$)

Conclusion

- less differences to barefoot running kinematics with increasing flexibility of footwear
- most barefoot-like condition was shown for the running socks followed by the Nike free 3.0 and Asics
- footwear situation seems to have no influence on sensorimotor control during jump landing

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Thank you

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