BIOMECHANICAL CHANGES WITH INCREASED SPEED IN ELITE MIDDLE-DISTANCE RUNNERS

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INTRODUCTION

- Previous research on world-class 800m and 1500m athletes showed that the best athletes reduced flight time at the end of the race, which increased cadence and duty factor, and reduced leg stiffness.
- These responses occur as the athletes try to run as fast as possible despite considerable fatigue.
- The aim of this study was to examine changes in spatiotemporal and joint kinematic variables in non-fatigued elite middle-distance runners at different speeds.

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BRIEF RESEARCH REPORT
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Biomechanics of World-Class 800 m Women at the 2017 IAAF World Championships

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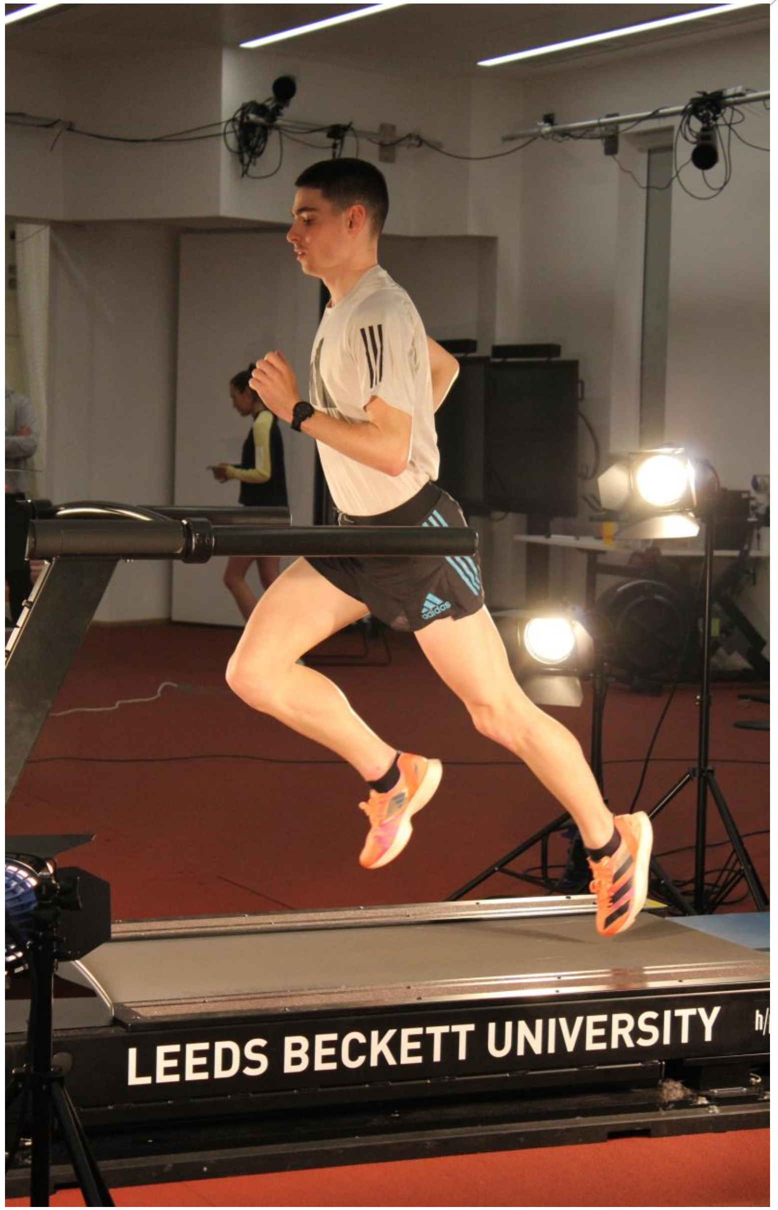
ORIGINAL ARTICLE
WILEY

Changes in running biomechanics during the 2017 IAAF world championships men's 1500 m final

Brian Hanley[1] | Athanassios Bissas[2] | Stéphane Merlino[3] | Geoffrey T. Burns[4]

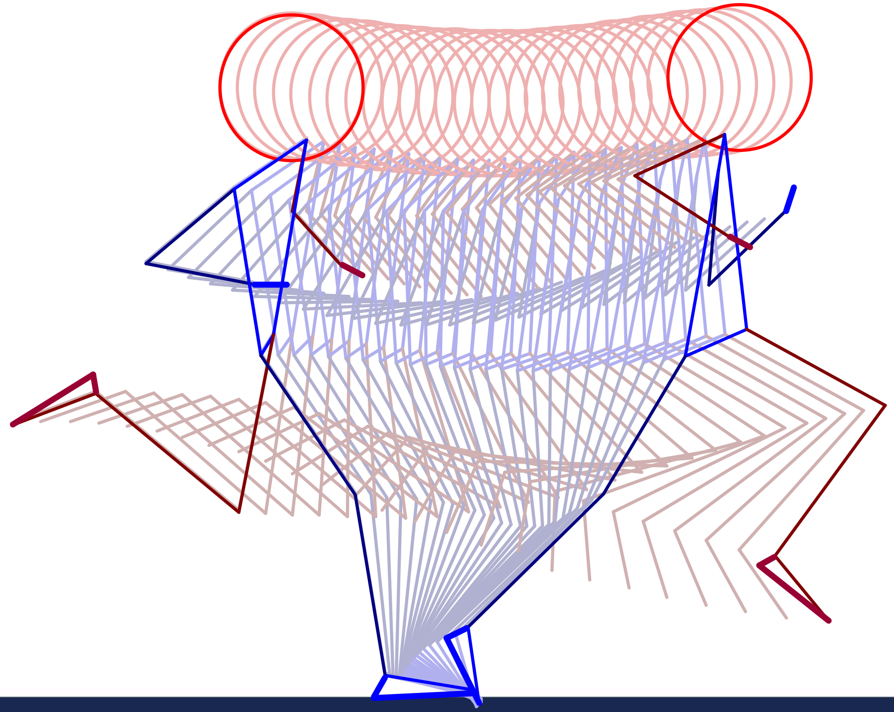
METHODS

- Fifteen male and two female middle-distance runners took part.
- Men: 800m (n=8) – 1:49 / 1500m (n=13) – 3:46
- Women: 800m – 1:58 / 1500m – 4:01
- Kinetic and spatiotemporal data were collected using a h/p/cosmos Gaitway-3D instrumented treadmill at 12, 16, 20 and 24 km/h (incremental, with 3 min rest).
- Two Fastec cameras (200 Hz) were used to record video data from both left- and right-hand sides.
- Hip-ankle and knee-ankle distances and joint angular data were calculated using the 2D still image measurement tool in SIMI Motion.

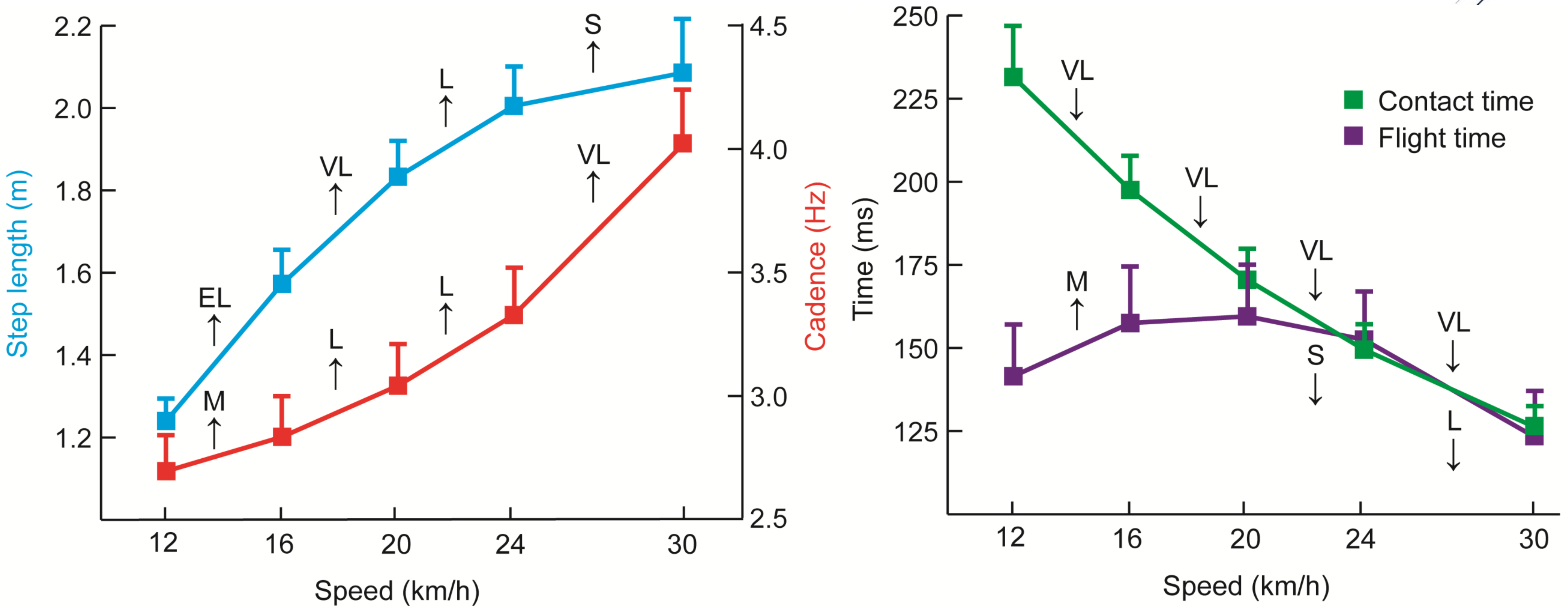


METHODS

- The participants also ran overground (60 m), with OptoJump Next used between 20-50 m to record spatiotemporal data from faster racing speeds (30.02 ± 0.85 km/h).
- Alongside spatiotemporal variables, leg stiffness (k_{leg}) was estimated using the methods presented by Morin et al. (2005).
- One-way repeated measures ANOVA was conducted with repeated contrast tests used to identify differences between analysed speeds. Effect sizes for significant differences between laps were calculated using Cohen's *d* and were small (S: 0.20 – 0.59), moderate (M: 0.60 – 1.19), large (L: 1.20 – 1.99), very large (VL: 2.00 – 3.99) or extremely large (EL: ≥ 4.00) (Hopkins et al. (2009).
- Pearson's *r* was used to measure associations.

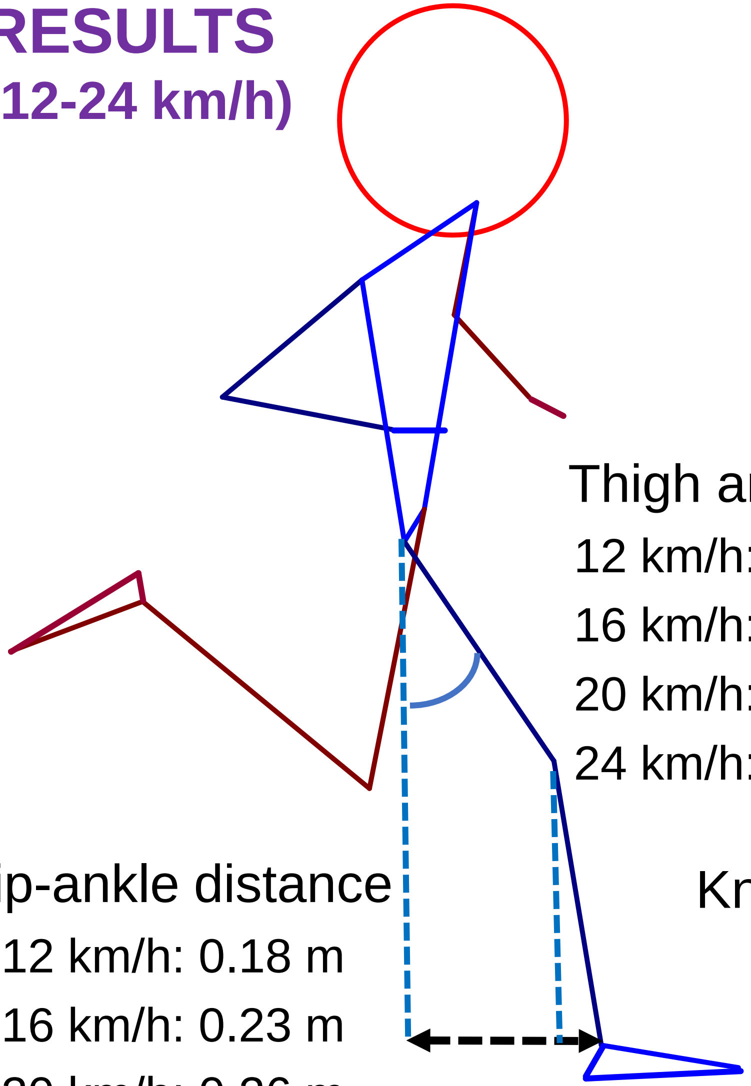


RESULTS: Spatiotemporal variables (mean + SD)



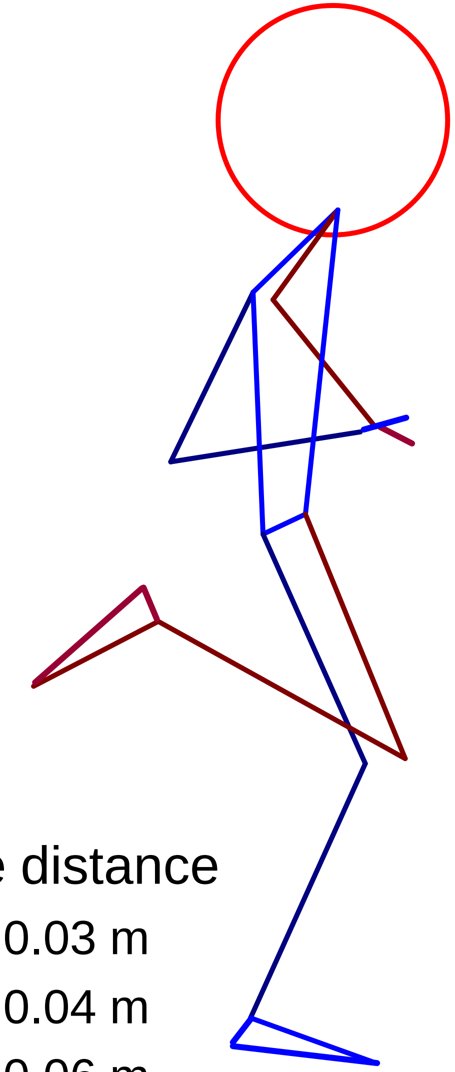
Duty factor: 0.311 0.279 0.258 0.247 0.254

RESULTS
(12-24 km/h)

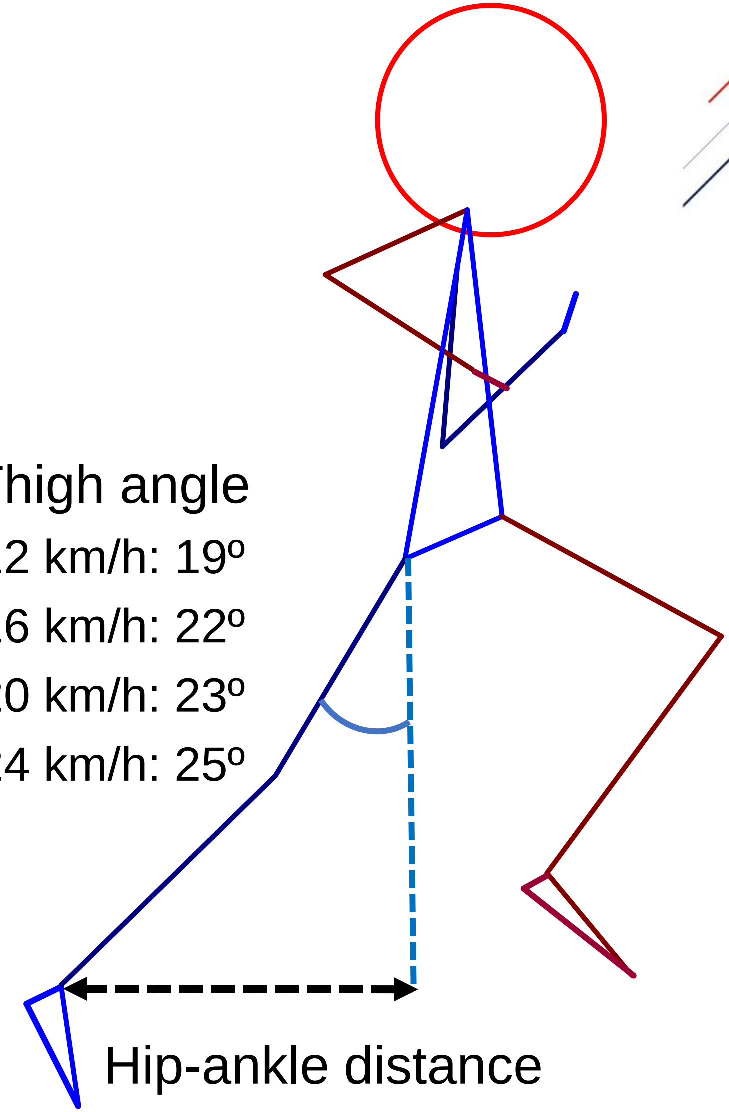


Thigh angle
12 km/h: 21º
16 km/h: 25º
20 km/h: 27º
24 km/h: 29º

Hip-ankle distance
12 km/h: 0.18 m
16 km/h: 0.23 m
20 km/h: 0.26 m
24 km/h: 0.27 m



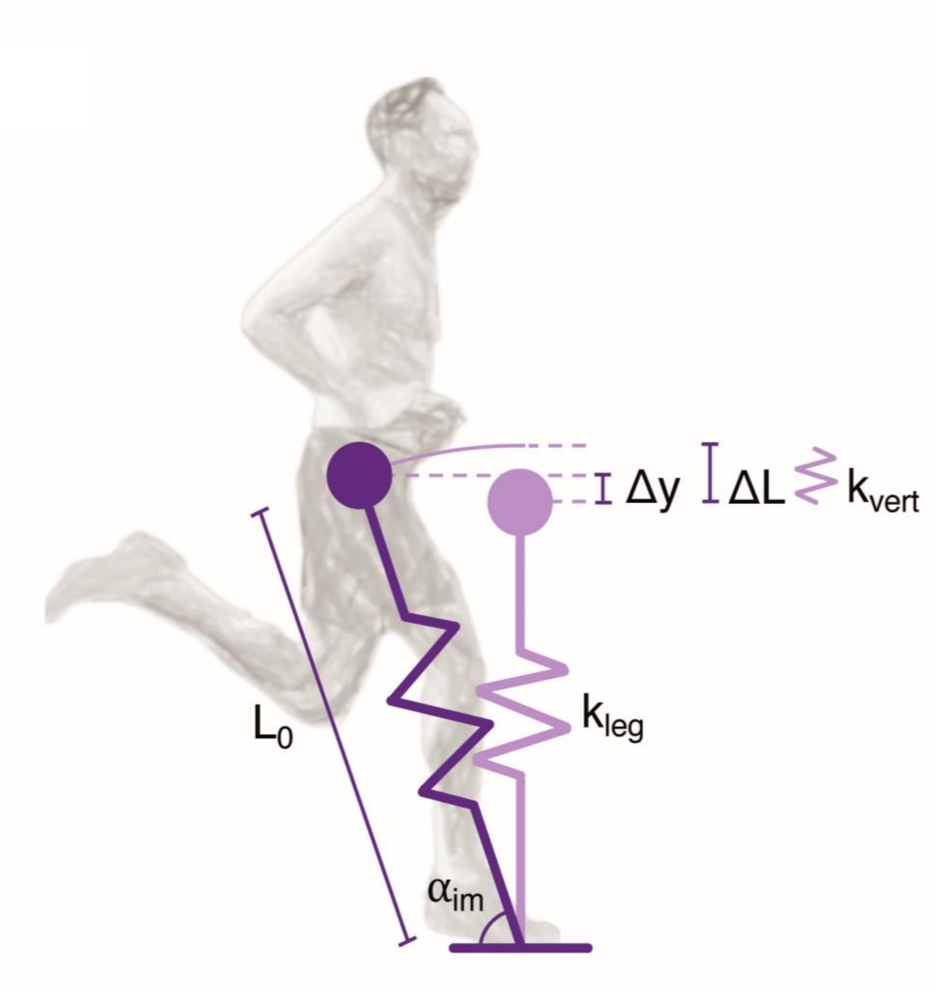
Knee-ankle distance
12 km/h: 0.03 m
16 km/h: 0.04 m
20 km/h: 0.06 m
24 km/h: 0.06 m



Thigh angle
12 km/h: 19º
16 km/h: 22º
20 km/h: 23º
24 km/h: 25º

Hip-ankle distance
12 km/h: 0.42 m
16 km/h: 0.46 m
20 km/h: 0.49 m
24 km/h: 0.50 m

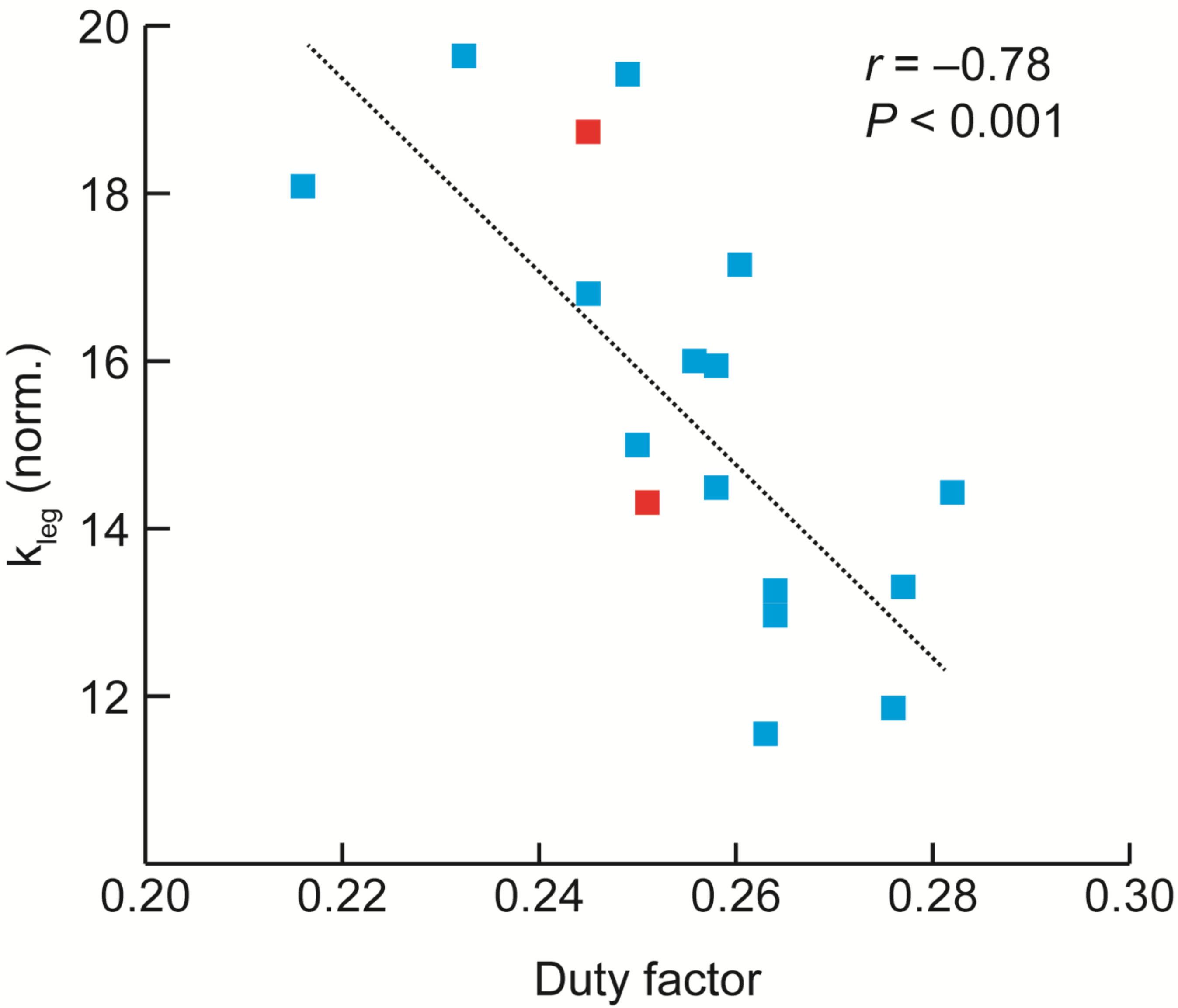
RESULTS: k_{leg} (normalised for weight and leg length)



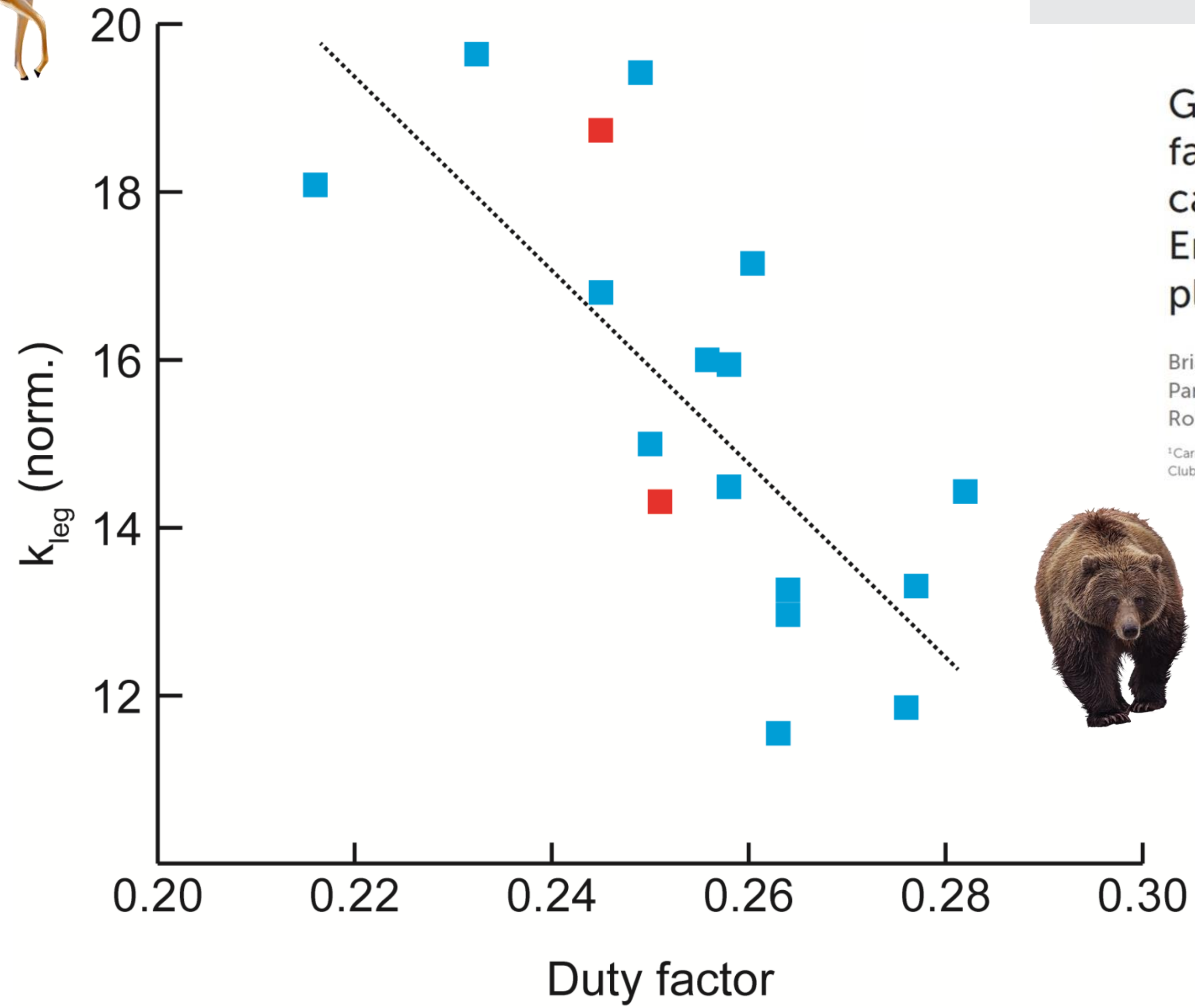
	k_{leg} using forces from treadmill	k_{leg} estimated (Morin et al., 2005)
12 km/h	16.5 (± 2.1)	15.9 (± 2.1)
16 km/h	16.2 (± 2.2)	15.8 (± 2.2)
20 km/h	16.2 (± 1.8)	16.0 (± 1.7)
24 km/h	16.5 (± 2.0)	16.3 (± 1.9)
30 km/h		15.5 (± 2.5)

RESULTS

- Leg stiffness (k_{leg}) vs. duty factor at 30 km/h (overground data) for men and women.



RESULTS



Aerial and Terrestrial Patterns: A Novel Approach to Analyzing Human Running

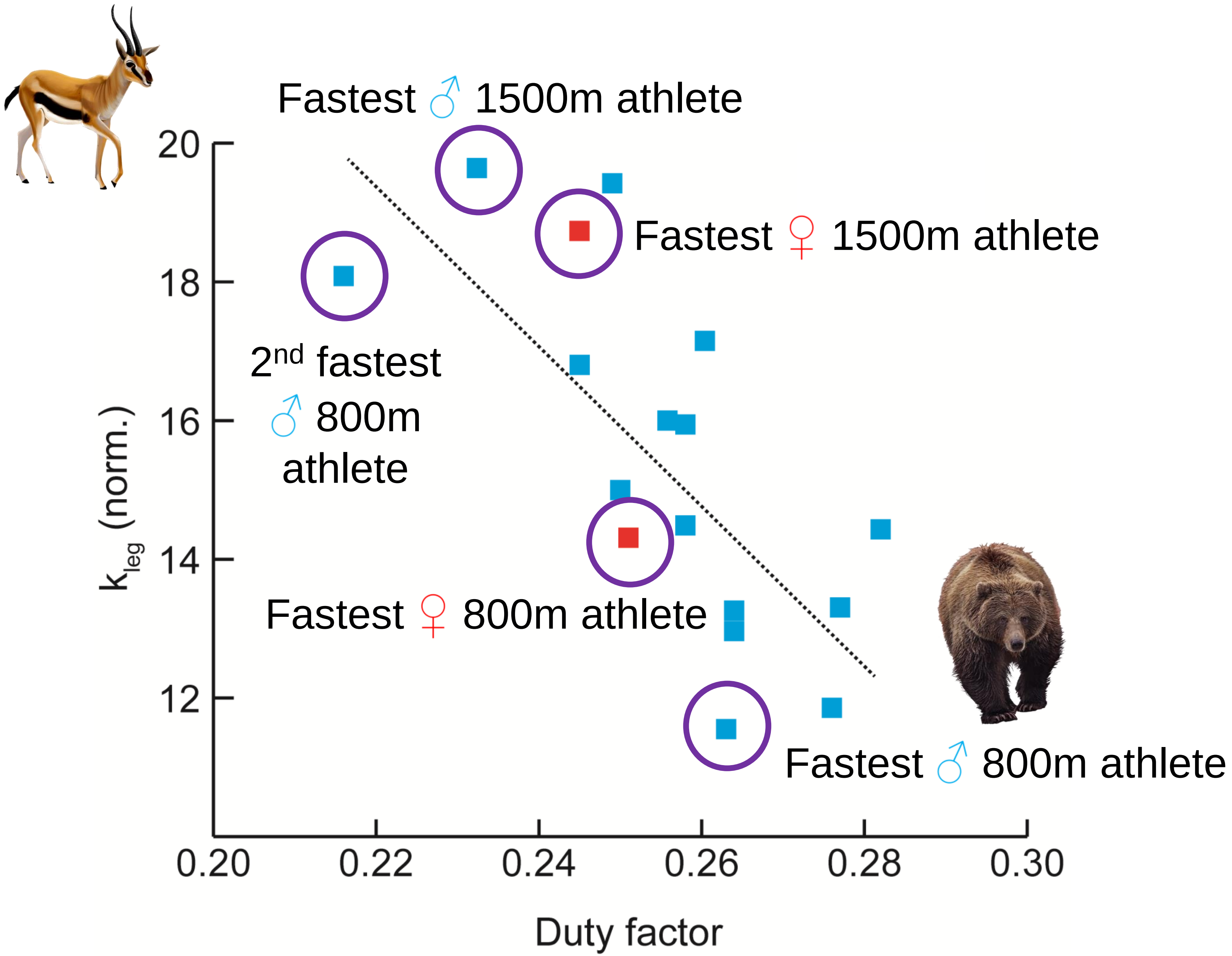
C. Gindre[1], T. Lussiana[1,2], K. Hebert-Losier[3], L. Mourot[2,4]

Grizzlies and gazelles: Duty factor is an effective measure for categorizing running style in English Premier League soccer players

Brian Hanley[1]*, Catherine B. Tucker[1], Liam Gallagher[1], Parag Parelkar[1], Liam Thomas[1], Rubén Crespo[2] and Rob J. Price[2]

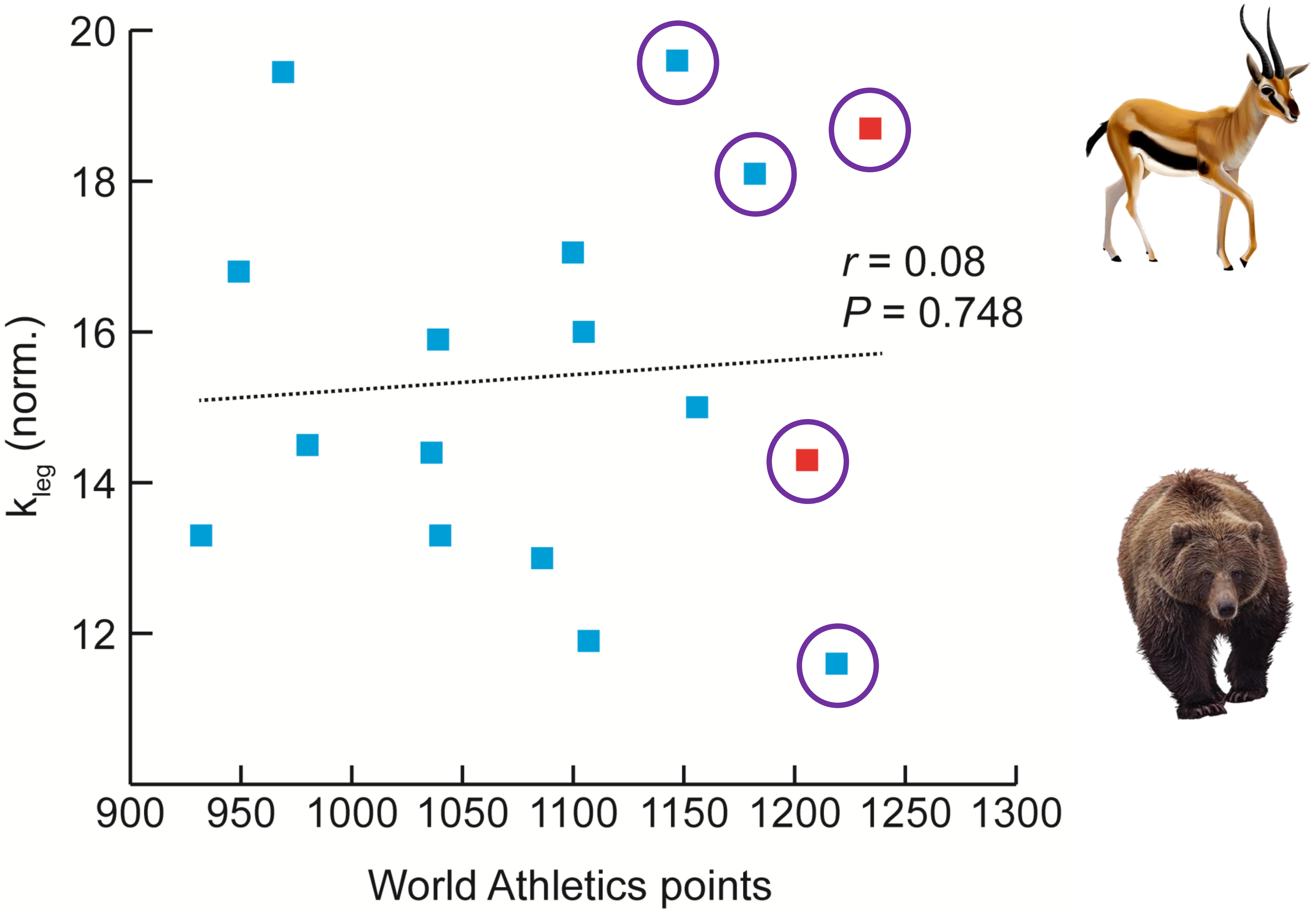
[1]Carnegie School of Sport, Leeds Beckett University, Leeds, United Kingdom, [2]Leeds United Football Club, Leeds, United Kingdom

RESULTS



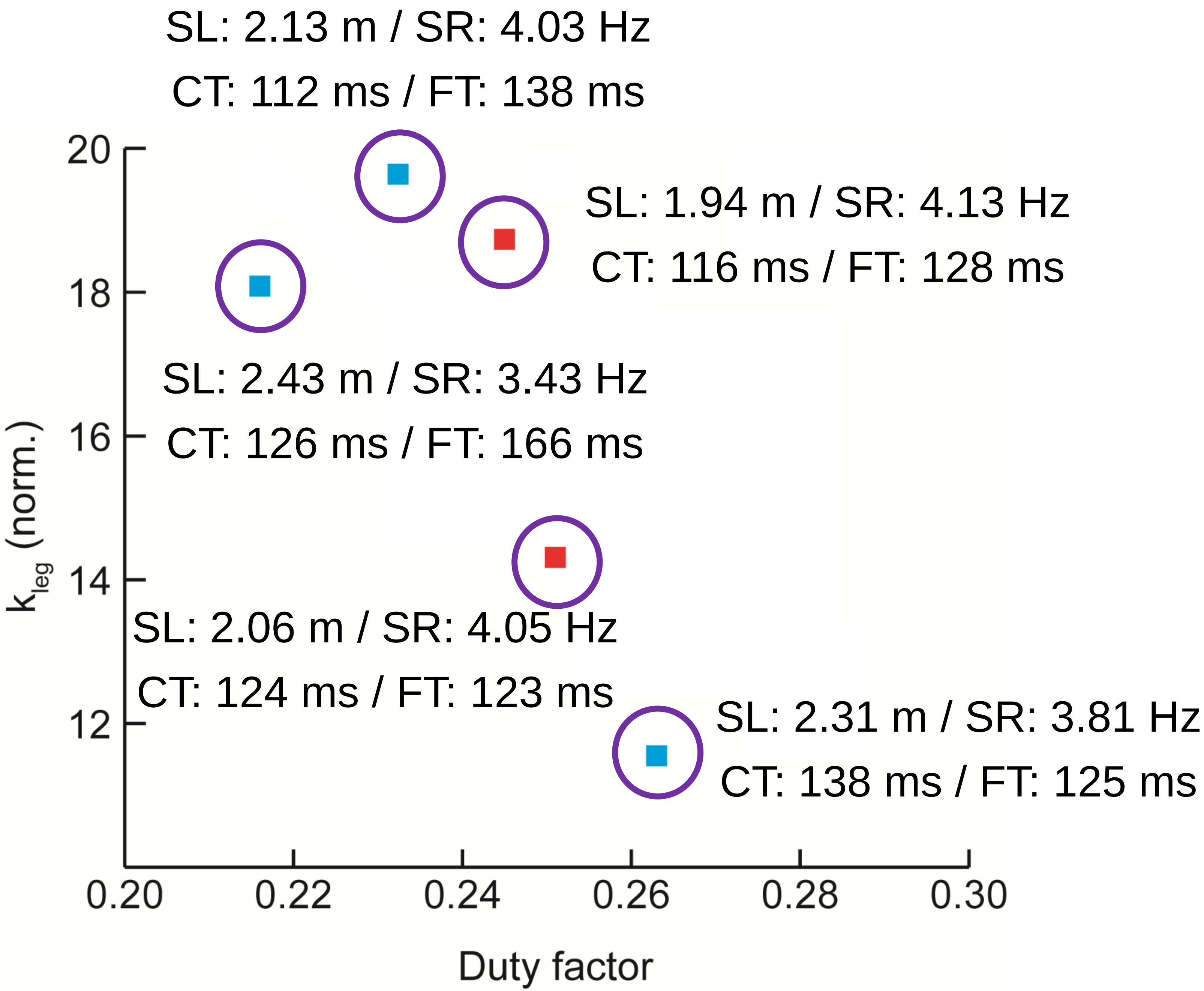
Fastest ♂ 1500m athlete
Fastest ♀ 1500m athlete
2nd fastest ♂ 800m athlete
Fastest ♀ 800m athlete
Fastest ♂ 800m athlete
20
18
16
14
12
k_{leg} (norm.)
0.20
0.22
0.24
0.26
0.28
0.30
Duty factor

RESULTS

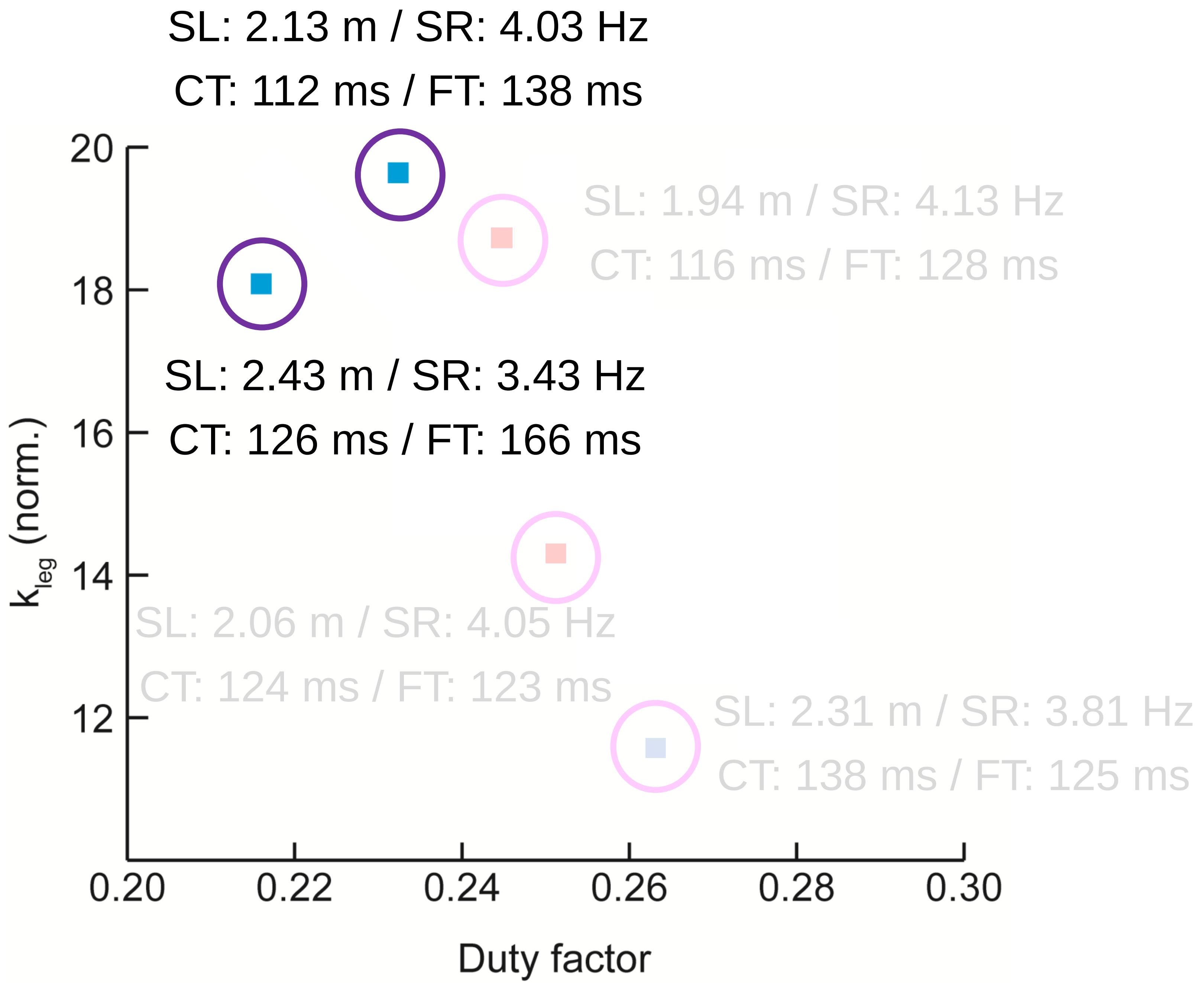


k_{leg} (norm.)
20
18
16
14
12
900
950
1000
1050
1100
1150
1200
1250
1300
World Athletics points
r = 0.08
P = 0.748

RESULTS


SL: 2.13 m / SR: 4.03 Hz
CT: 112 ms / FT: 138 ms
SL: 1.94 m / SR: 4.13 Hz
CT: 116 ms / FT: 128 ms
SL: 2.43 m / SR: 3.43 Hz
CT: 126 ms / FT: 166 ms
SL: 2.06 m / SR: 4.05 Hz
CT: 124 ms / FT: 123 ms
SL: 2.31 m / SR: 3.81 Hz
CT: 138 ms / FT: 125 ms
k_{leg} (norm.)
20
18
16
14
12
0.20
0.22
0.24
0.26
0.28
0.30
Duty factor

RESULTS



SL: 2.13 m / SR: 4.03 Hz
CT: 112 ms / FT: 138 ms
SL: 1.94 m / SR: 4.13 Hz
CT: 116 ms / FT: 128 ms
SL: 2.43 m / SR: 3.43 Hz
CT: 126 ms / FT: 166 ms
SL: 2.06 m / SR: 4.05 Hz
CT: 124 ms / FT: 123 ms
SL: 2.31 m / SR: 3.81 Hz
CT: 138 ms / FT: 125 ms
20
18
16
14
12
k_{leg} (norm.)
0.20
0.22
0.24
0.26
0.28
0.30
Duty factor

SUMMARY

- Middle-distance athletes increased running speed by prioritising large increases in step length at slower speeds, and by increasing cadence at faster speeds.
- Step length increases on the treadmill (12 → 24 km/h) occurred with longer hip-ankle distances at initial contact and toe-off, in conjunction with changes in thigh angle.
- There were very large decreases in contact time as athletes moved from slower to faster speeds, but flight time increased only from 12 → 16 km/h. As speed increased, there were large decreases in flight time.
- Leg stiffness was correlated with duty factor but was not a good guide of athlete ability. It might have more value as an indicator of spontaneous running style.
- There is variety in how elite athletes achieve race speeds.

Thank you for listening!

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