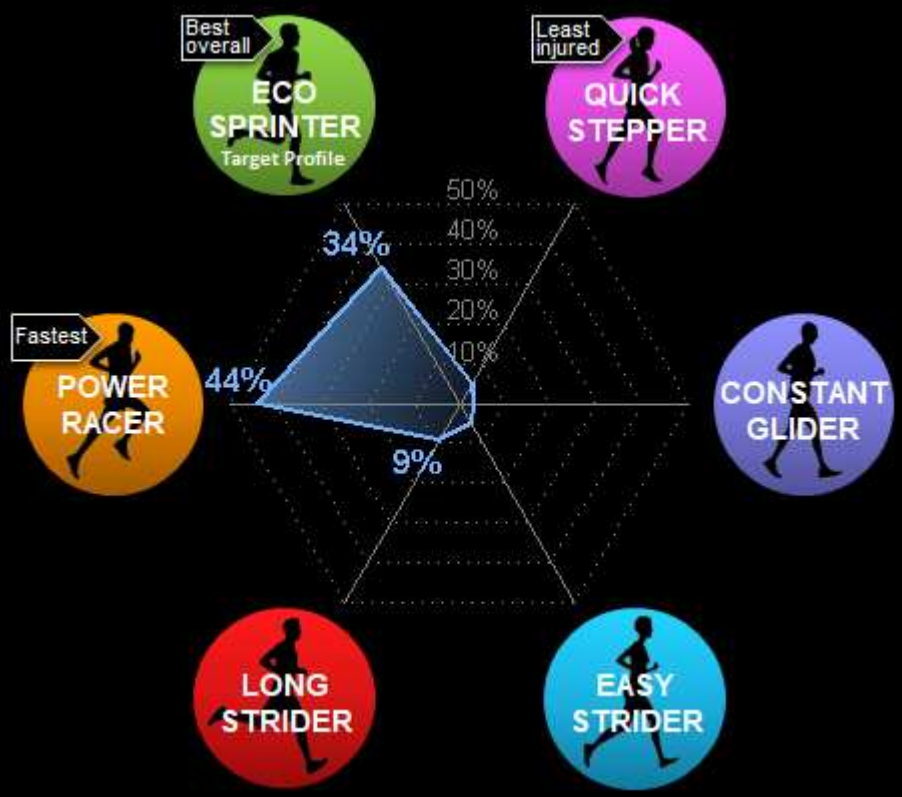
Test results for YASSINE RACHIK

Date: 20 Jan 2021 Time: 10:31 AM Speed: 19 km/h

MotionMetrix



Your profile

Our e-coach says:

Great technique for high speed running in the 0.8 − 5k distance range but the lower limbs are exposed to extreme vertical peak forces. For maintained economy with reduced injury risk at 21k and above, increase cadence to supress vertical displacement and peak force. Do regular strength training of ankles to sustain the loads long term.

Note from your service provider:

No note written

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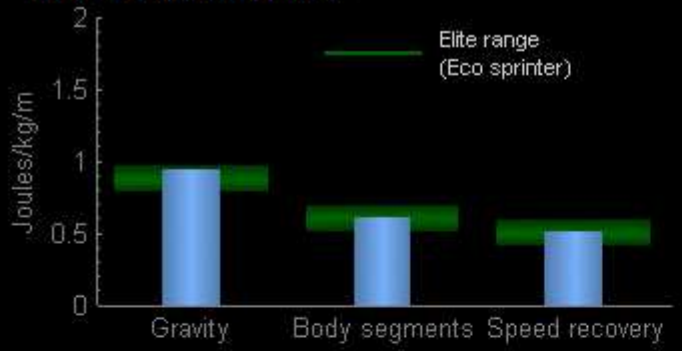
MotionMetrix

RUNNING PERFORMANCE @ 19 km/h

MECHANICAL WORK



ELASTIC EXCHANGE

Excellent: >35%
Good: 25-35%
Average: 15-25%
Poor: <15%

ECONOMY

2.69
Joules/kg/m

● Runner Profile ○ Stride Parameters

▶ = Current value
▶ = Reference value
= Elite range (Eco sprinter)
✕ = Center of Mass

Strike Type

Pelvic Tilt

Cadence

89.9 /min

Contact Time

0.186 s

Forward Lean

3.8 °

Overstride

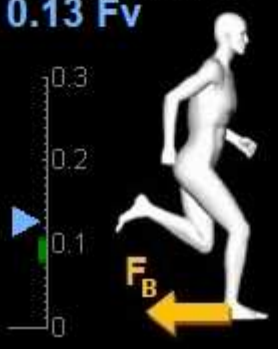
188 mm

Vertical Displacement

82.4 mm

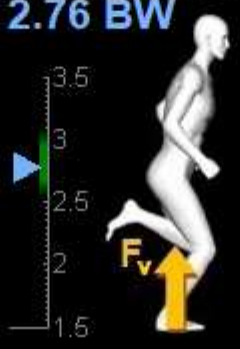
Braking Force (max)

0.13 Fv



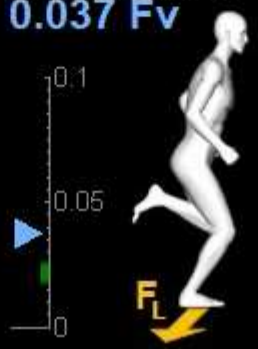
Vertical Force (max)

2.76 BW



Lateral Force (max)

0.037 Fv



Stride Rating: 4.2 /5.0

Cadence	★★★★★
Contact Time	★★★★★
Forward Lean	★★★★★
Vertical Displ.	★★★★★
Overstride	★★★★★
Braking Force	★★☆☆☆
Vertical Force	★★★★★
Lateral Force	★☆☆☆☆

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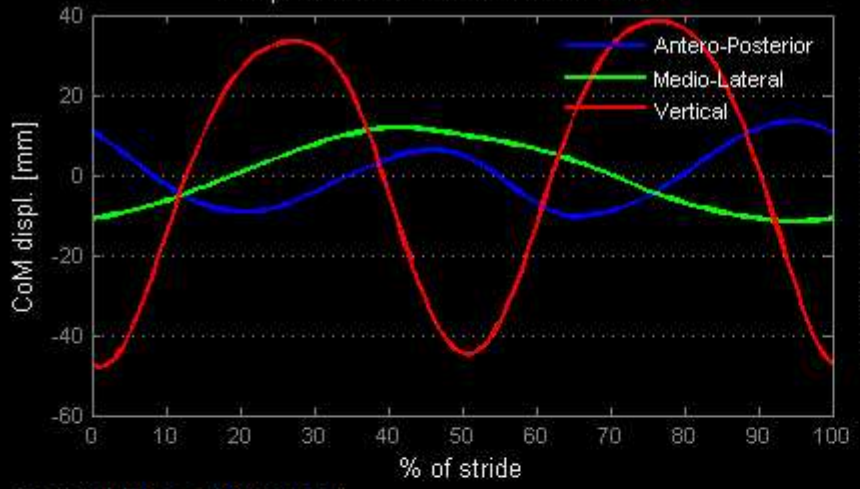
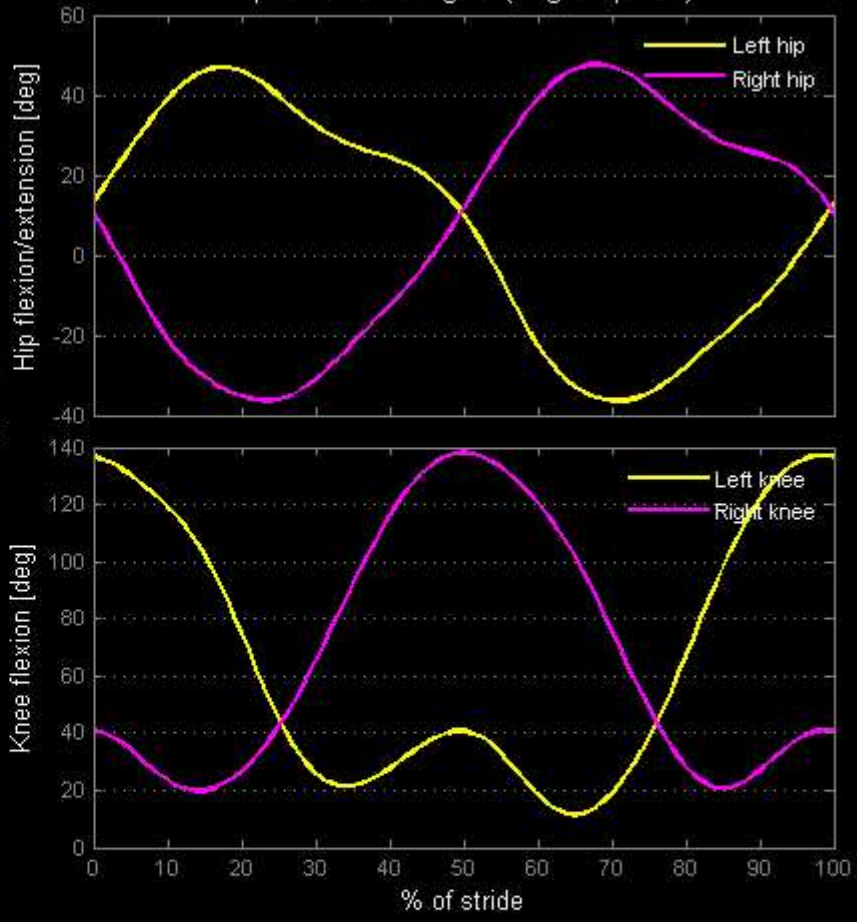
MotionMetrix

GAIT CHARACTERISTICS @ 19 km/h

Displacement of the Center of Mass



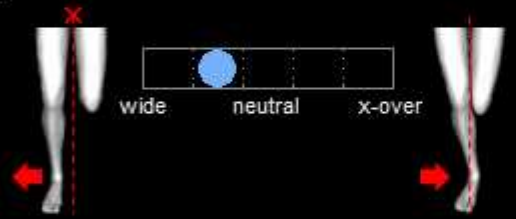
Hip and Knee angles (sagittal plane)



Frontal Plane Alignment

Step Separation

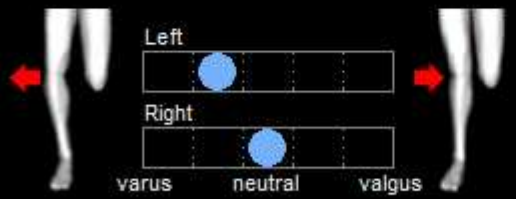
58 mm



Knee Alignment @ mid-stance

Left: **-0.4 °**

Right: **1.7 °**



Sagittal Plane Parameters	Mean (Left/Right)	ref. Mean (L/R)	Elite Mean	diff Elite
Max Thigh Flexion [deg]	47.2 (46.8/47.6)		44.9	2.3
Max Thigh Extension [deg]	36.4 (36.4/36.4)		35.0	1.4
Shank angle @ touch-down [deg]	4.0 (3.2/4.8)		4.5	-0.5
Knee Flexion @ touch-down [deg]	22.4 (22.8/22.0)		17.8	4.5
Max Knee Flexion @ stance [deg]	40.9 (40.7/41.1)		37.7	3.2
Max Knee Flexion @ swing [deg]	137.5 (137.1/138.0)		124.0	13.6
Symmetry Rating	★★★★★			

α = Hip flex/ext
β = Knee flexion
γ = Shank angle

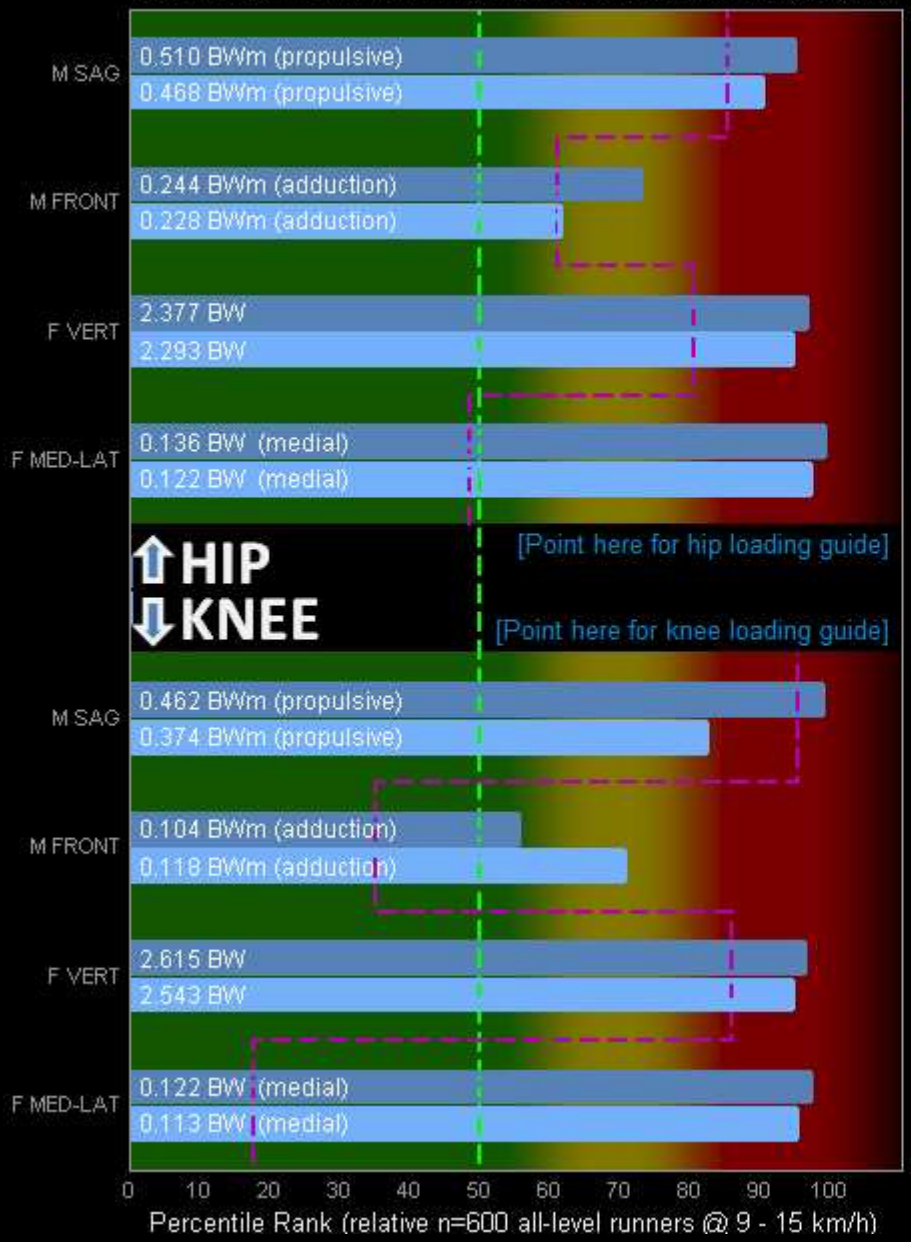
Test results for YASSINE RACHIK

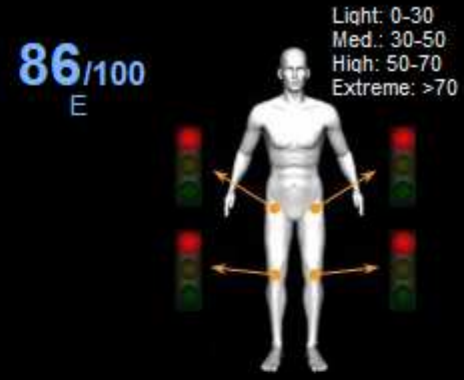
Date: 20 Jan 2021 Time: 10:31 AM Speed: 19 km/h

MotionMetrix

JOINT LOADING @ 19 km/h

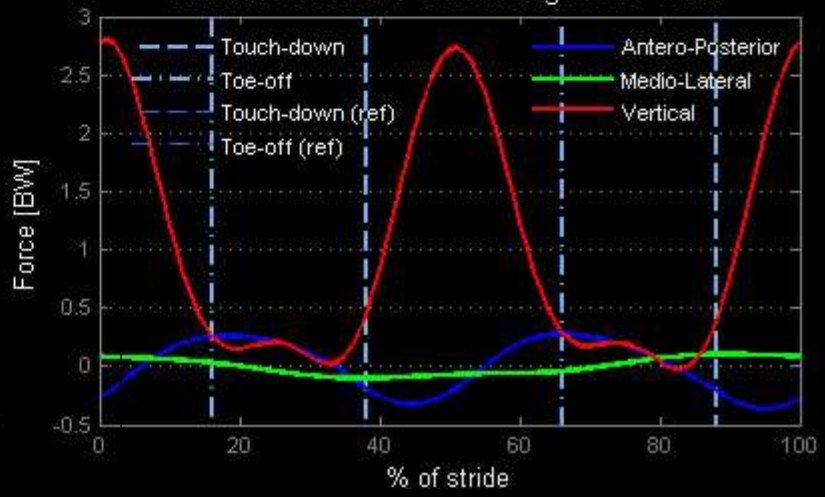
Joint Torques and Forces (max, normalized to bodyweight)





Loading Property	value	ref. value
Max loading @ joint	Right Hip (F MED-LAT)	
Left/right preference [%]	48.3/51.7	
Bilateral asymmetry [%]	4.5	
Symmetry Rating	★★★★☆	

Ground Reaction Force acting on the COM



Loading vs stride parameter dependence

Hip Sagittal Moment (M SAG)
- increases with Max hip extension
- decreases with Overstride
- decreases with Forward lean

Hip Frontal Moment (M FRONT)
- decreases with Step width
- increases with Vertical displacement

Hip Vertical Force (F VERT)
- increases with Vertical displacement
- increases with Knee flex @swing
- decreases with Cadence

Hip Mediolateral Force (F MEDLAT)
- increases with Step width
- increases with Body length

Knee Sagittal Moment (M SAG)
- decreases with Shank angle @landing
- increases with Knee flex @landing
- increases with Vertical displacement

Knee Frontal Moment (M FRONT)
- decreases with Step width
- increases with Knee varus alignment
- decreases with Cadence

Knee Vertical Force (F VERT)
- increases with Vertical displacement
- increases with Max knee flex @swing
- decreases with Cadence

Knee Mediolateral Force (F MED-LAT)
- increases with Shank angle @landing
- increases with Step width

Quick Reference Guide – Runner Profiles

MotionMetrix

ECO SPRINTER (Best overall)

- MotionMetrix's target profile for optimal long-distance performance (green elite range fields in app)
- Active compact stride with great elastic bounce
- Best compromise between speed capacity, running economy and injury risk
- Very common profile among elite 5 - 42k runners
- Next lowest injury risk after Quick Steppers

QUICK STEPPER (Least injured)

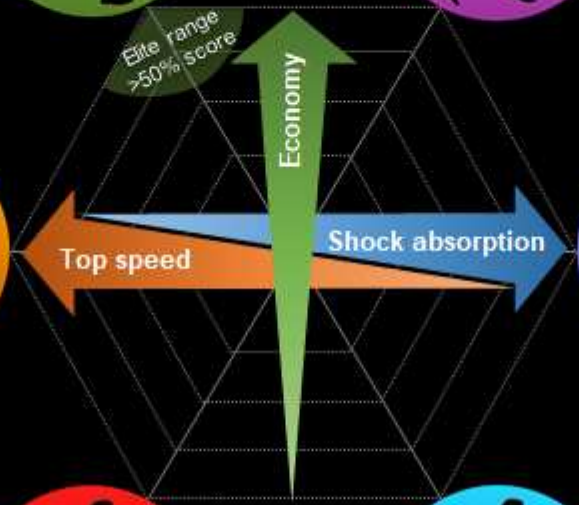
- Rapid footwork with good elastic bounce
- Good economy up to ~16 km/h that then drops due to excessive leg velocity (work to move the segments)
- Gentle loading due to small joint angles and peak forces
- Many top ultra runners and female marathoners belong to this category
- The least injured category among all six

POWER RACER (Fastest)

- Profile with highest top speed, very common among middle-distance elite runners
- Long powerful strides with short ground contact
- Stiff springy legs yielding great elastic bounce
- Large vertical peak force acting on the joints
- Highest injury risk, tough on lower leg and calf due to extreme ankle joint power generation

CONSTANT GLIDER

- Short strides with nearly constant ground contact
- Mild joint loading but limited bounce that prevents fast running
- Common among runners with limited flexibility, elasticity or strength
- Many elderly runners in this category
- Slowest category but among the least injured



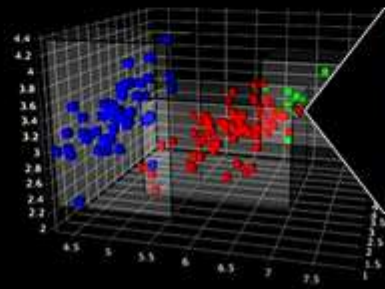
LONG STRIDER

- Long leaping strides powered by large muscular force
- Excessive overstride and ground contact time
- Common style among strong athletically built runners and mostly male
- Decent sprint capabilities but poor economy due to excessive braking/propulsion
- Next highest injury risk, tough on the knees

EASY STRIDER

- Easygoing style, follows the law of least resistance
- Most common profile among all six
- Characterized by overstride and a tendency to a seated posture
- Soft knee during support, sensitive to different footwear
- Low to average speed capacity and running economy at medium injury risk

Occurrence	6.3%	22.9%	12.8%	11.6%	29.6%	16.80%
10k race time (mean)	40:12	43.42	45:50	49:30	46:30	45:12
10k race time (top 10%)	30:23	32.29	36:15	41:12	36:06	37:20
Injury rate (2 years)	84%	62%	59%	64%	75%	77%
Primary injury sites	1) lower leg 41%	1) knee 27%	1) knee 46%	1) knee 52%	1) knee 35%	1) knee 37%
	2) calf 28%	2) foot 21%	2) lower leg 24%	2) lower leg 21%	2) achilles 17%	2) hamstrings 17%
	3) knee 22%	3) lower leg 15%	3) calf 23%	3) achilles 17%	3) hamstrings 16%	3) hip 15%
Shoe pref. (light/stable)	75%/25%	63%/37%	55%/45%	30%/70%	15%/85%	10%/90%
Distr (men/women)	55%/45%	44%/56%	39%/61%	31%/69%	61%/39%	65%/35%



The six fundamental runner profiles have been derived by cluster analysis on a large bio-mechanical dataset (N > 1000) of runners. Information about performance and injuries have subsequently been obtained from interviews with runners belonging to the set.

Quick Reference Guide – Running Parameters

MotionMetrix

Mechanical Work (*W*)

Unit: Joules/kg/m = energy cost per kilo body mass during 1 meter of forward transport

Total mechanical work: $W_{tot} = W_{gravity} + W_{segments} + W_{speed}$

$W_{gravity}$ = work to elevate the body against gravity
- ✓ Decreases with reduced vertical displacement
- ✓ Decreases with running speed

$W_{segments}$ = work to reposition the body segments
- ✓ Decreases with reduced cadence
- ✓ Increases quadratically with running speed

W_{speed} = work to recover speed loss
- ✓ Decreases with reduced overstride/braking
- ✓ Increases with running speed

✓ **Best work strategy at high speeds is to lower cadence to suppress $W_{segments}$ since it grows quadratically with speed**

Elastic Exchange (ε)

Unit: % = fraction of total work stored and released as "free" elastic energy in muscles and tendons

ε = elastic energy exchange coefficient
- ✓ Increases with increased vertical force and reduced contact time
- ✓ Increases slightly with speed

✓ **Best strategy for improved elastic exchange is to employ a "bouncy" stride with low overstride.**

✓ **Maximum elastic exchange you can get is 50 %.**

Running Economy (*RE*)

Unit: Joules/kg/m = enery cost per kilo body mass during 1 meter of forward transport

$$RE = W_{tot} \times (1 - \varepsilon)$$

✓ **Running economy is the most important factor for long distance running performance**

✓ **Minimised total work and maximised elastic exchange yield best running economy!**

Cadence

The number of steps per minute. Take shorter steps to reduce joint loading and prevent injuries. Take longer steps (without overstriding) to improve economy at higher speeds as it reduces $W_{segments}$. Tall (short) runners have lower (higher) optimal cadence.

Contact Time

The time each foot spends in contact with the ground. Make this time as short as possible for best running economy. Contact time can be improved by running drills and similar exercises that promote the elastic response from muscles and tendons.

Forward Lean

The forward lean angle of the trunk relative the vertical axis. A forward lean of 2-5 degrees is optimal. Smaller angles increases braking and larger angles obstruct elastic energy storage in the core muscles.

Overstride

The horizontal distance between the center-of-mass and the ankle when the foot strikes the ground. Excessive distance is called overstride and it causes increased braking and prolonged contact times, both detrimental for running economy.

Vertical Displacement

The range of up and down motion of the center-of-mass. If too small, it results in poor force generation and reduced elastic exchange. If too large, it amplifies $W_{gravity}$, the work done against gravity, and puts higher loads on the joints.

Braking Force

The amount of braking on the center-of-mass during the initial contact phase. Large braking forces cause greater loss of speed and increases W_{speed}, the work needed to recover speed during propulsion. Overstride contributes to increased braking force.

Vertical Force

The force generated to support body weight and launch it back into the air. High peak force generated in short time (a bouncy stride) promotes large elastic energy exchange and improved high speed economy at the expense of increased loading of the joints.

Lateral Force

The force acting sideways on the center-of-mass during ground contact. Large lateral force is associated with broad step width and large side-to-side motion, which makes you travel longer distance than necessary and increases lateral joint loading.

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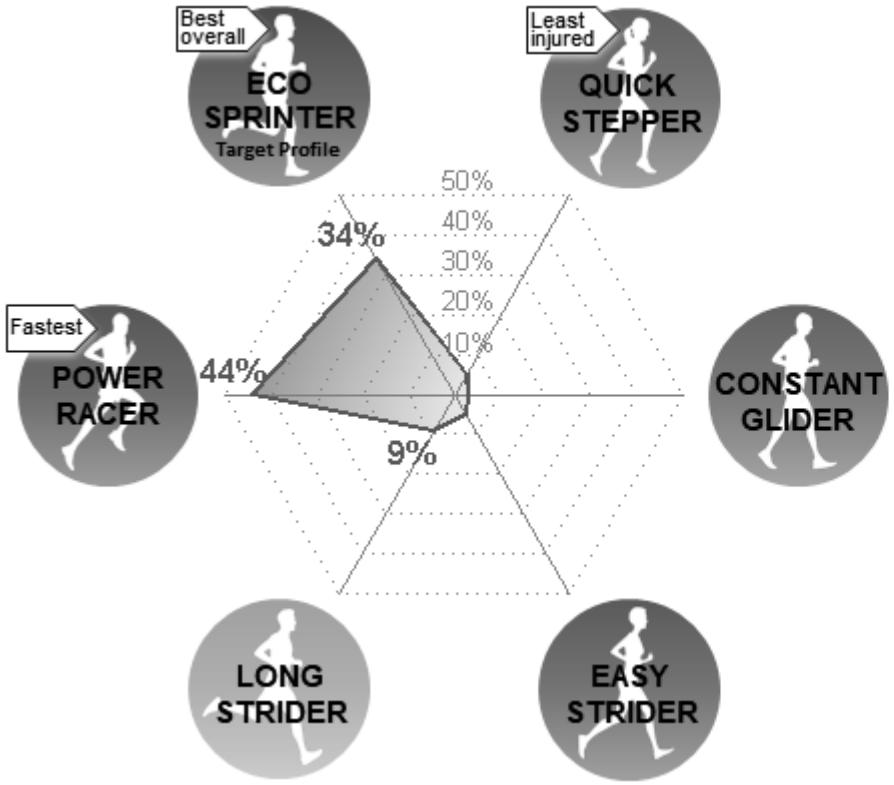

Your profile

POWER RACER

Info

- The fastest profile, common for elite middle-distance runners
- Long powerful strides with short ground contact
- Stiff springy legs yielding great elastic bounce
- Large vertical peak force acting on the joints
- Category with highest injury rate, tough on lower leg and calf

Occurrence	6.3%
Distribution (men / women)	55% / 45%
10k race time (mean / top 10%)	40:12 / 30:23
Injury incidence rate (2 years)	84%
Primary injury sites	1) lower leg 41% 2) calf 28% 3) knee 22%

Our e-coach says:

Great technique for high speed running in the 0.8 - 5k distance range but the lower limbs are exposed to extreme vertical peak forces. For maintained economy with reduced injury risk at 21k and above, increase cadence to supress vertical displacement and peak force. Do regular strength training of ankles to sustain the loads long term.

Note from your service provider:
No note written

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MotionMetrix

RUNNING PERFORMANCE @ 19 km/h

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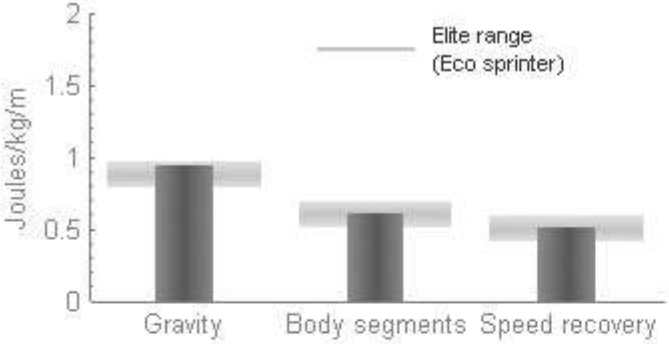

ELASTIC EXCHANGE

Excellent: >35%
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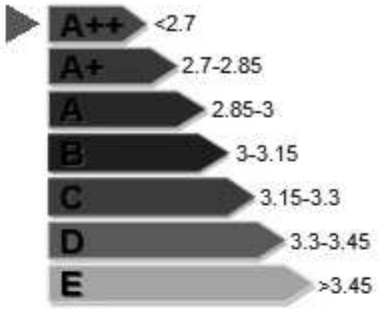
Average: 15-25%
Poor: <15%

ECONOMY

2.69
Joules/kg/m



● Runner Profile ○ Stride Parameters

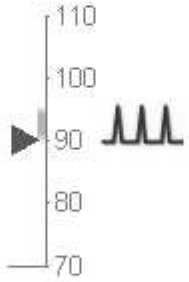
▶ = Current value
▶ = Reference value
| = Elite range (Eco sprinter)
× = Center of Mass

Strike Type

Pelvic Tilt

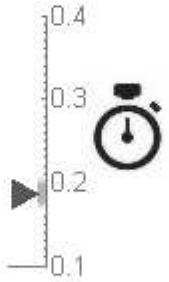
Cadence

89.9 /min



Contact Time

0.186 s



Forward Lean

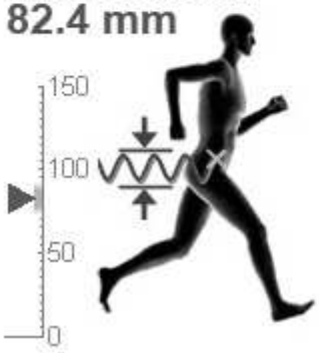
3.8 °

Overstride

188 mm

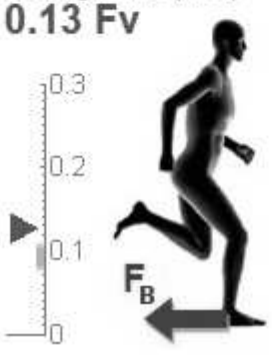
Vertical Displacement

82.4 mm



Braking Force (max)

0.13 Fv

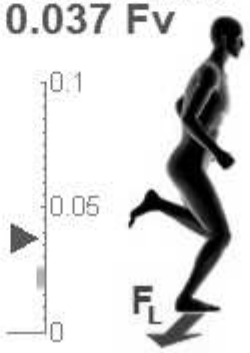


Vertical Force (max)

2.76 BW

Lateral Force (max)

0.037 Fv



Stride Rating: **4.2** /5.0

Cadence	★★★★★
Contact Time	★★★★★
Forward Lean	★★★★★
Vertical Displ.	★★★★★
Overstride	★★★★★
Braking Force	★★☆☆☆
Vertical Force	★★★★★
Lateral Force	★☆☆☆☆

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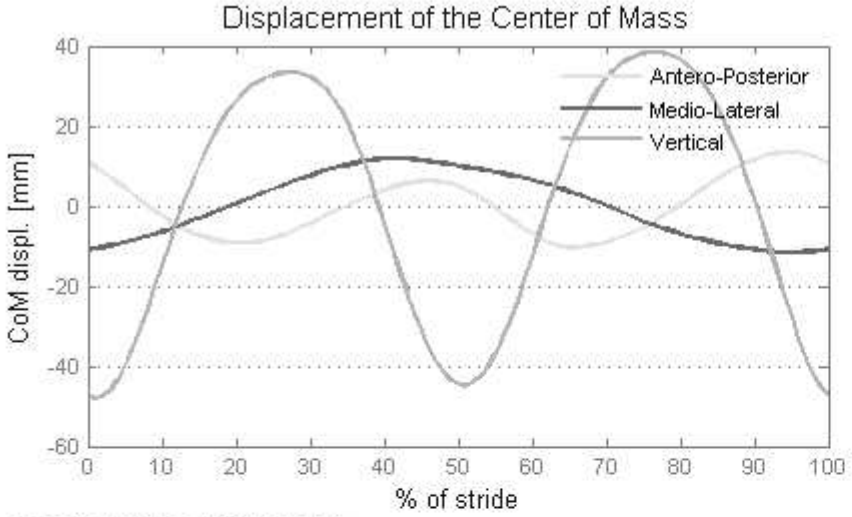
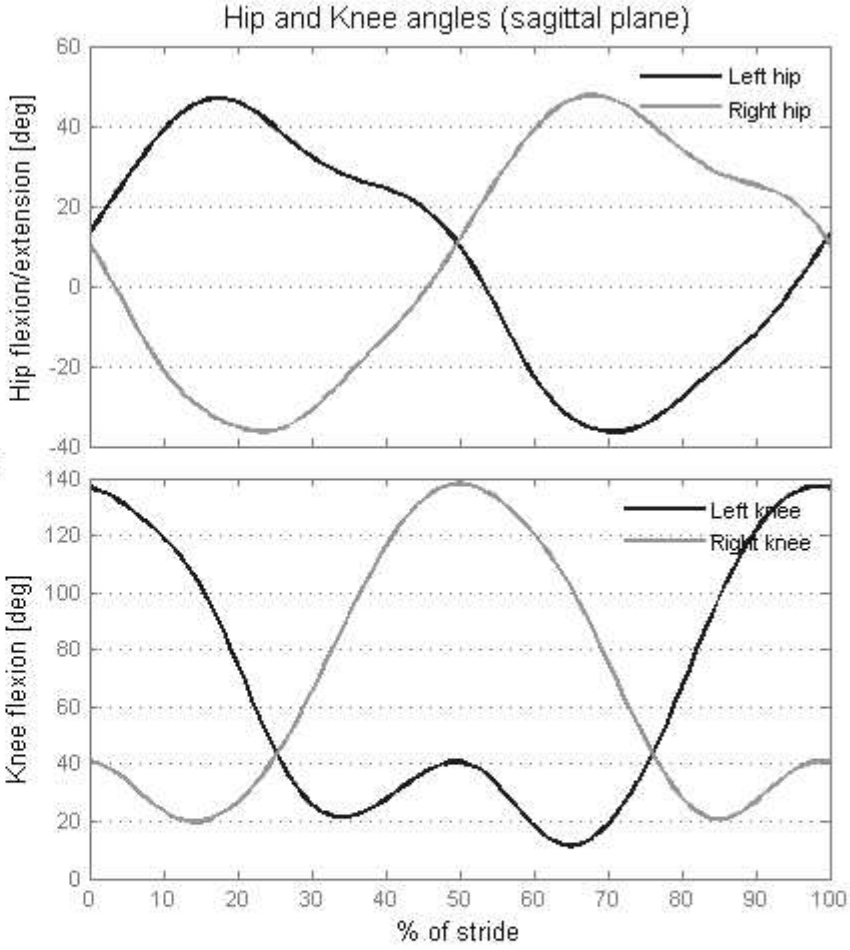
GAIT CHARACTERISTICS @ 19 km/h

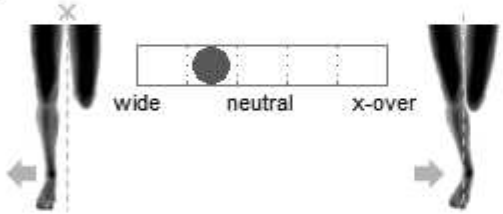




Frontal Plane Alignment

Step Separation

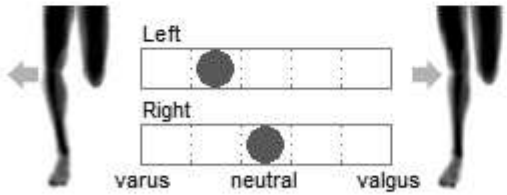
58 mm



Knee Alignment @ mid-stance

Left: **-0.4 °**

Right: **1.7 °**



Sagittal Plane Parameters	Mean (Left/Right)	ref. Mean (L/R)	Elite Mean	diff Elite
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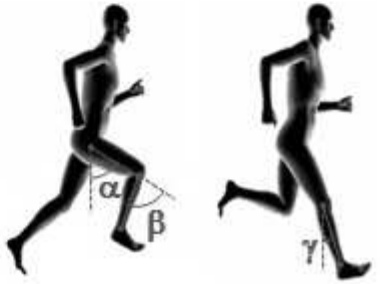
Max Thigh Extension [deg]	36.4 (36.4/36.4)		35.0	1.4
Shank angle @ touch-down [deg]	4.0 (3.2/4.8)		4.5	-0.5
Knee Flexion @ touch-down [deg]	22.4 (22.8/22.0)		17.8	4.5
Max Knee Flexion @ stance [deg]	40.9 (40.7/41.1)		37.7	3.2
Max Knee Flexion @ swing [deg]	137.5 (137.1/138.0)		124.0	13.6
Symmetry Rating	★★★★★			



α = Hip flex/ext
β = Knee flexion
γ = Shank angle

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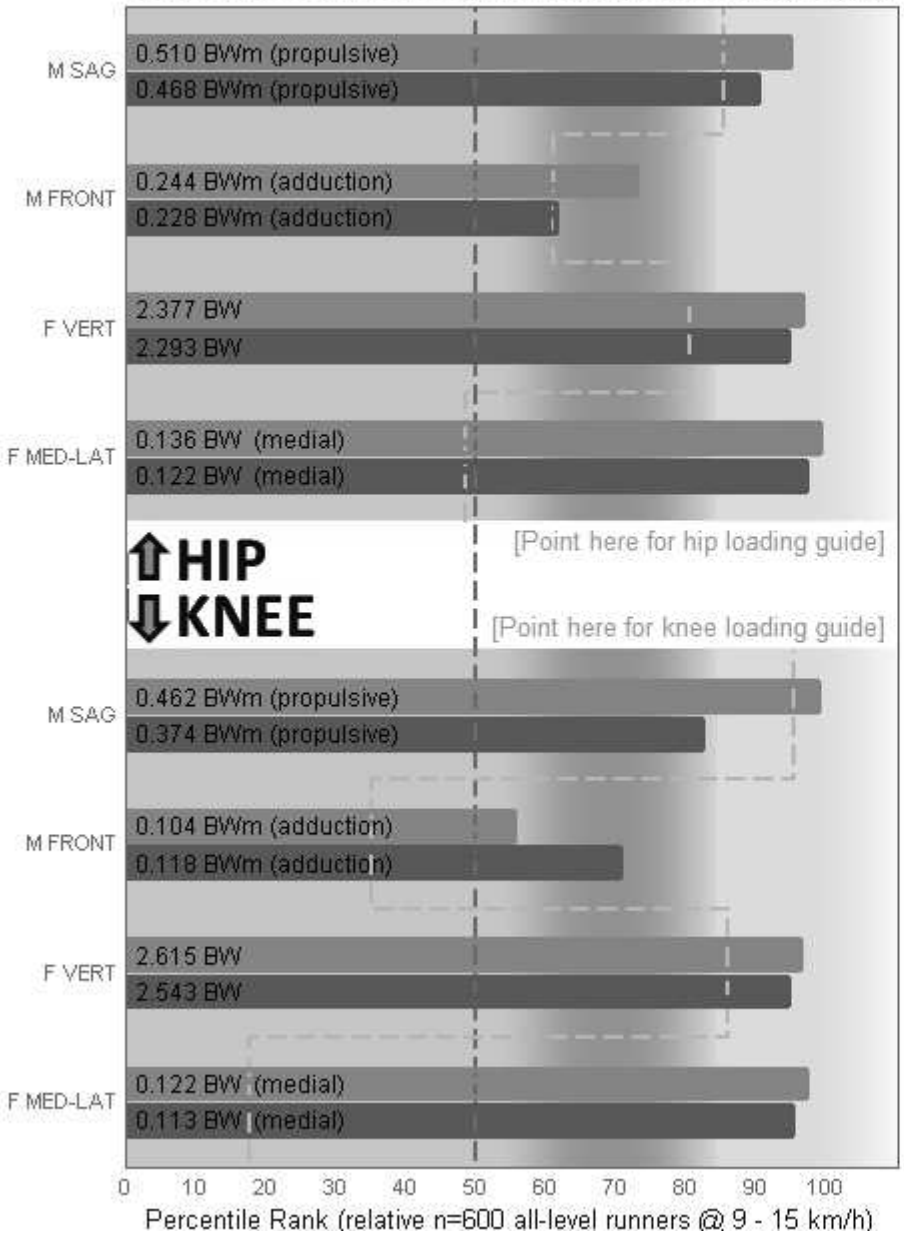
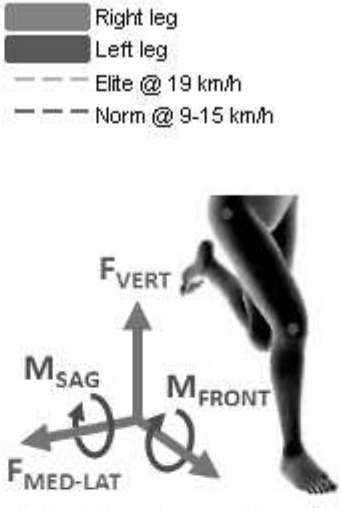
JOINT LOADING @ 19 km/h

Joint Torques and Forces (max, normalized to bodyweight)

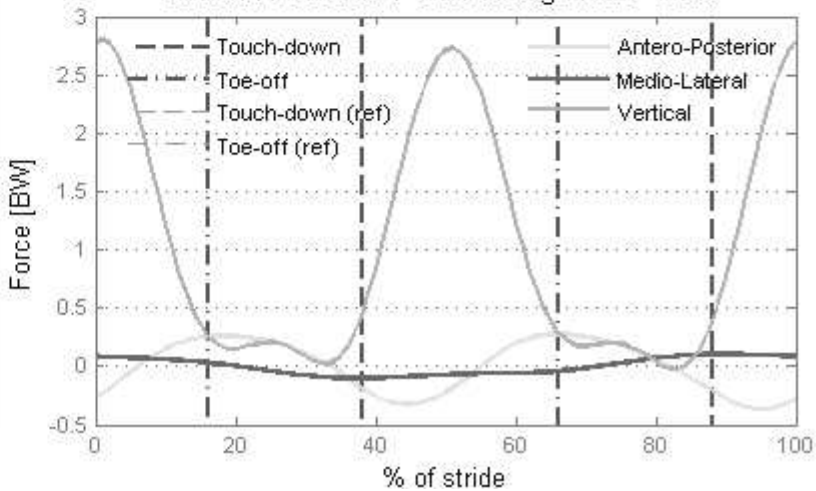




86/100
E

Loading Property	value	ref. value
Max loading @ joint	Right Hip (F MED-LAT)	
Left/right preference [%]	48.3/51.7	
Bilateral asymmetry [%]	4.5	
Symmetry Rating	★★★★☆	

Ground Reaction Force acting on the COM



Loading vs stride parameter dependence

Hip Sagittal Moment (M SAG)
- increases with Max hip extension
- decreases with Overstride
- decreases with Forward lean

Hip Frontal Moment (M FRONT)
- decreases with Step width
- increases with Vertical displacement

Hip Vertical Force (F VERT)
- increases with Vertical displacement
- increases with Knee flex @swing
- decreases with Cadence

Hip Mediolateral Force (F MEDLAT)
- increases with Step width
- increases with Body length

Knee Sagittal Moment (M SAG)
- decreases with Shank angle @landing
- increases with Knee flex @landing
- increases with Vertical displacement

Knee Frontal Moment (M FRONT)
- decreases with Step width
- increases with Knee varus alignment
- decreases with Cadence

Knee Vertical Force (F VERT)
- increases with Vertical displacement
- increases with Max knee flex @swing
- decreases with Cadence

Knee Mediolateral Force (F MED-LAT)
- increases with Shank angle @landing
- increases with Step width