Muscles on the move: Analysing the sprint start

Jeroen Aeles

KU LEUVEN

The use of a musculotendinous stretch-shortening cycle: a comparison between young and elite sprinters during the first stance of the acceleration phase

By Jeroen Aeles

Co-Authors
Prof. Dr. Benedicte Vanwanseele
Prof. Dr. Ilse Jonkers
Prof. Dr. Christophe Delecluse
Dr. Sofie Debaere

HMB
Human Motion Biomechanics

KU LEUVEN

Why study this?

- First stance ≠ other stance phases during sprint
- Joint stiffness ↔ horizontal COM velocity in running and sprinting [1,2]
- Δ Muscle-Tendon Length ↔ more / less optimal force production [3,4]
- Power generation in knee: Youth athletes < Elite athletes

[1] Butler et al., 2003; [2] Charalambous et al., 2012;

[3] Guissard et al., 1992; [4] Mero et al., 2006

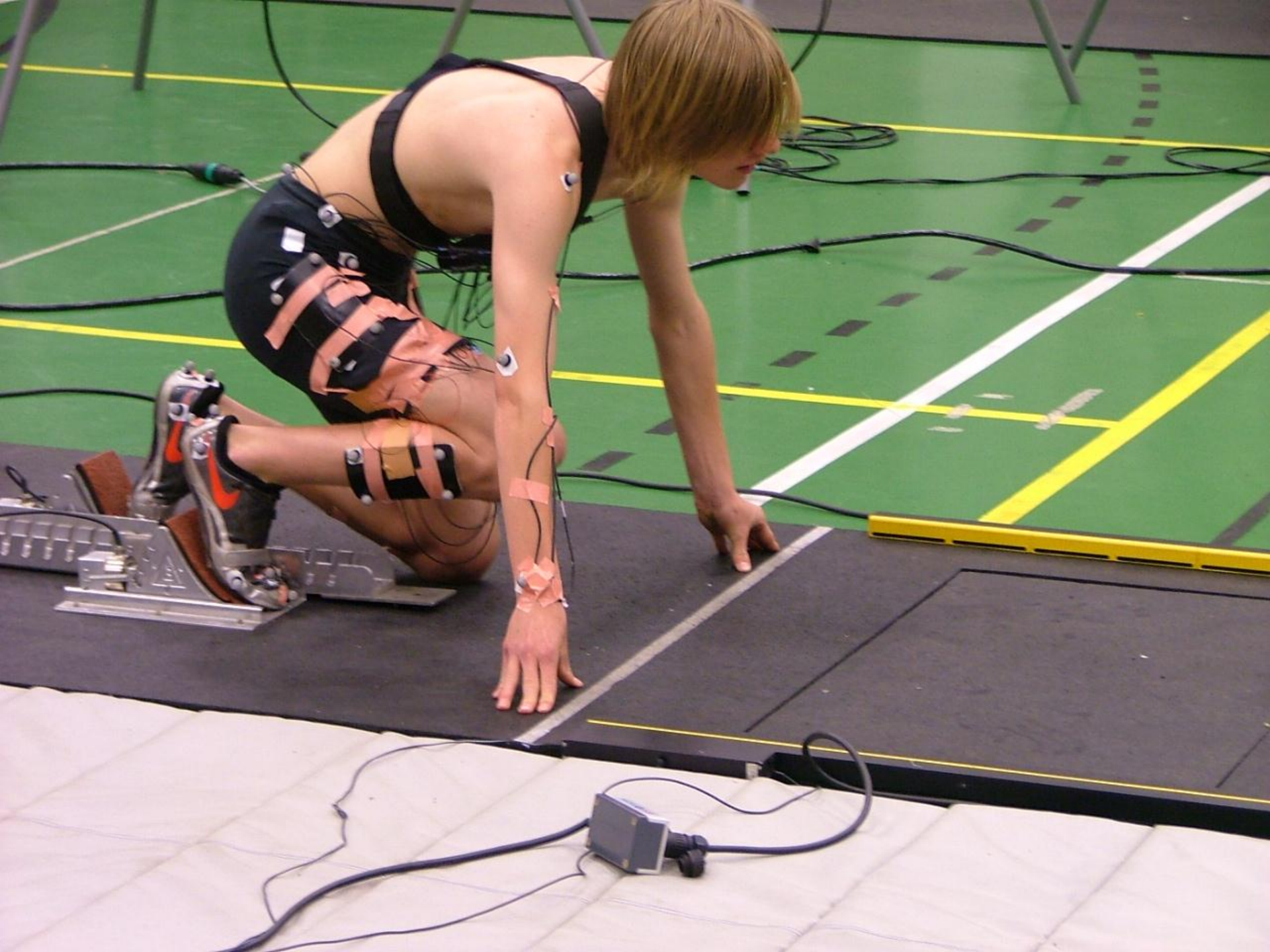
KU LEUVEN

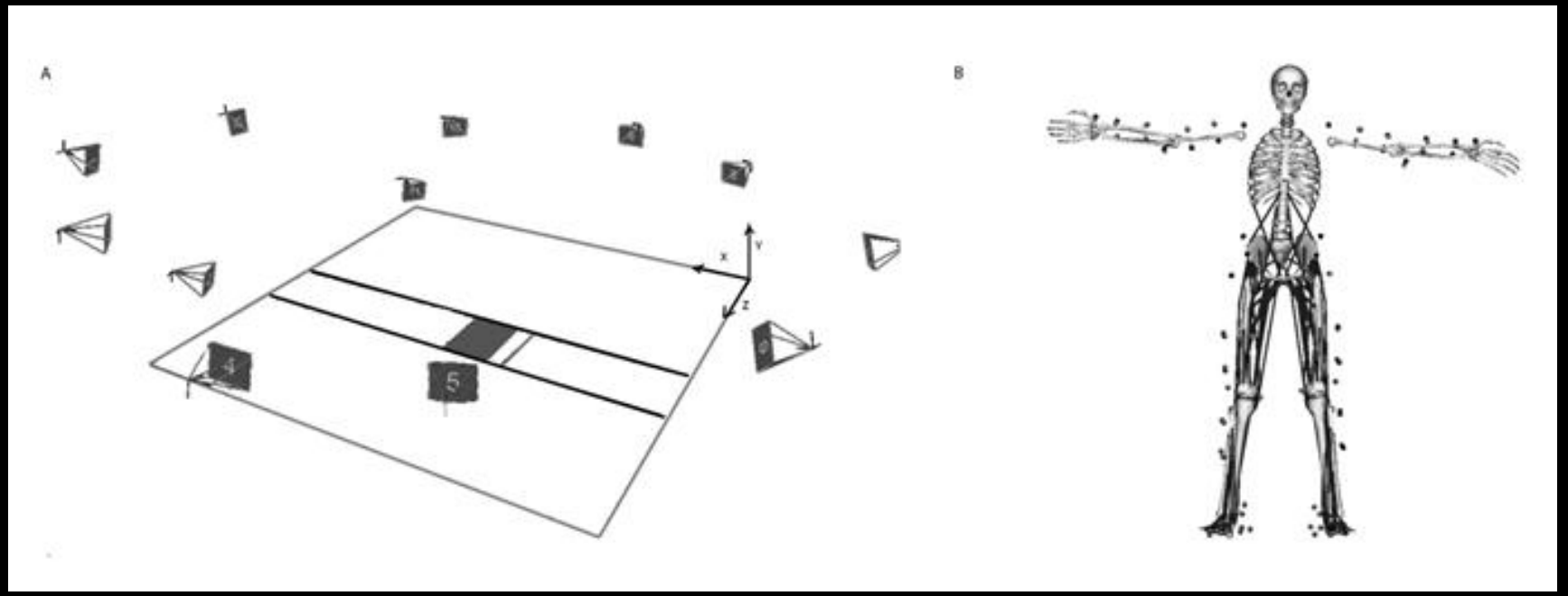
Aims of the study

- Calculate joint stiffness at the ankle and knee joint
- Analyse muscle-tendon complex deformation characteristics

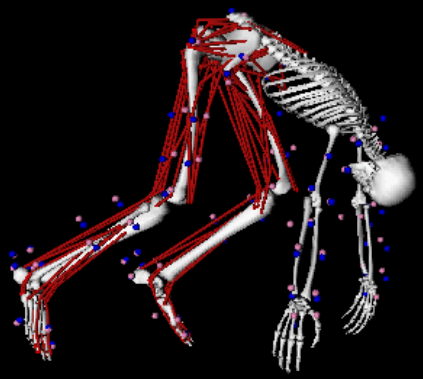
... during the first stance following a sprint start

KU LEUVEN





KU LEUVEN



KU LEUVEN

GRF

Inverse kinematics

Joint angles → Inverse Dynamics

Joint moments

→ Muscle Analyses

Muscle-tendon lengths

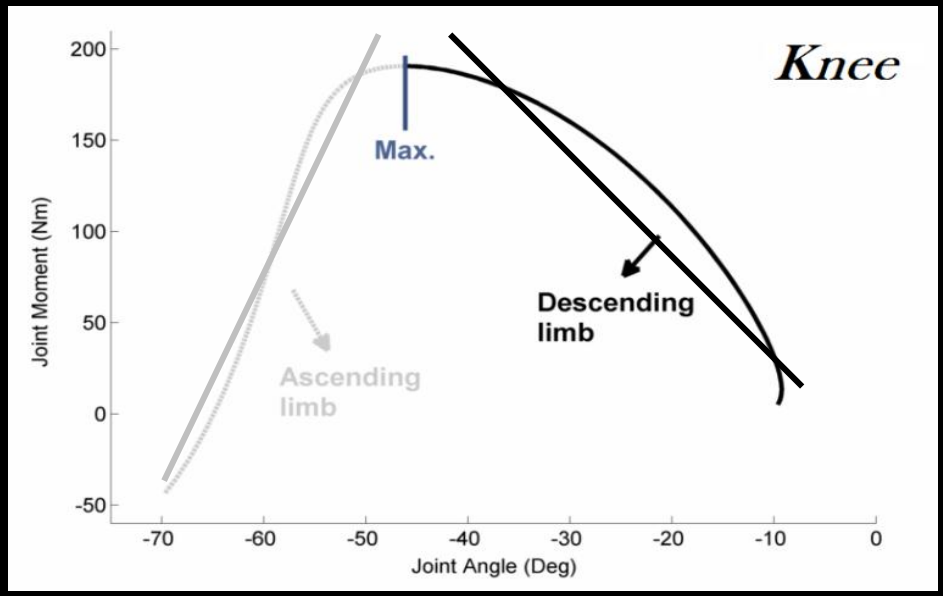
KU LEUVEN

Joint stiffness

Linear regression coefficient of the joint's Moment - Angle curve

Curve split at maximal moment

- ✔ K ascending limb
- ✔ K descendig limb



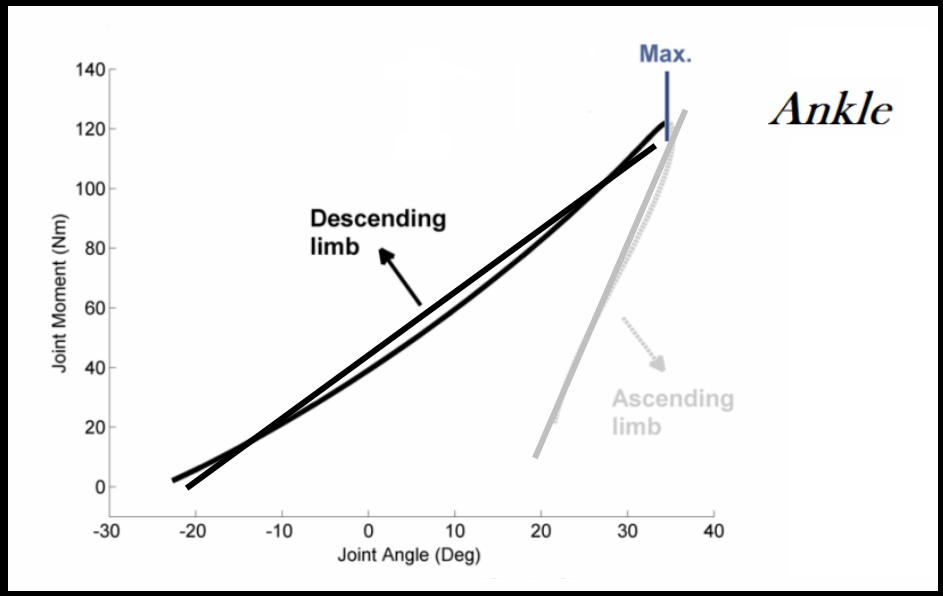
KU LEUVEN

Joint stiffness

Linear regression coefficient of the joint's Moment - Angle curve

Curve split at maximal moment

- ✔ K ascending limb
- ✔ K descendig limb



KU LEUVEN

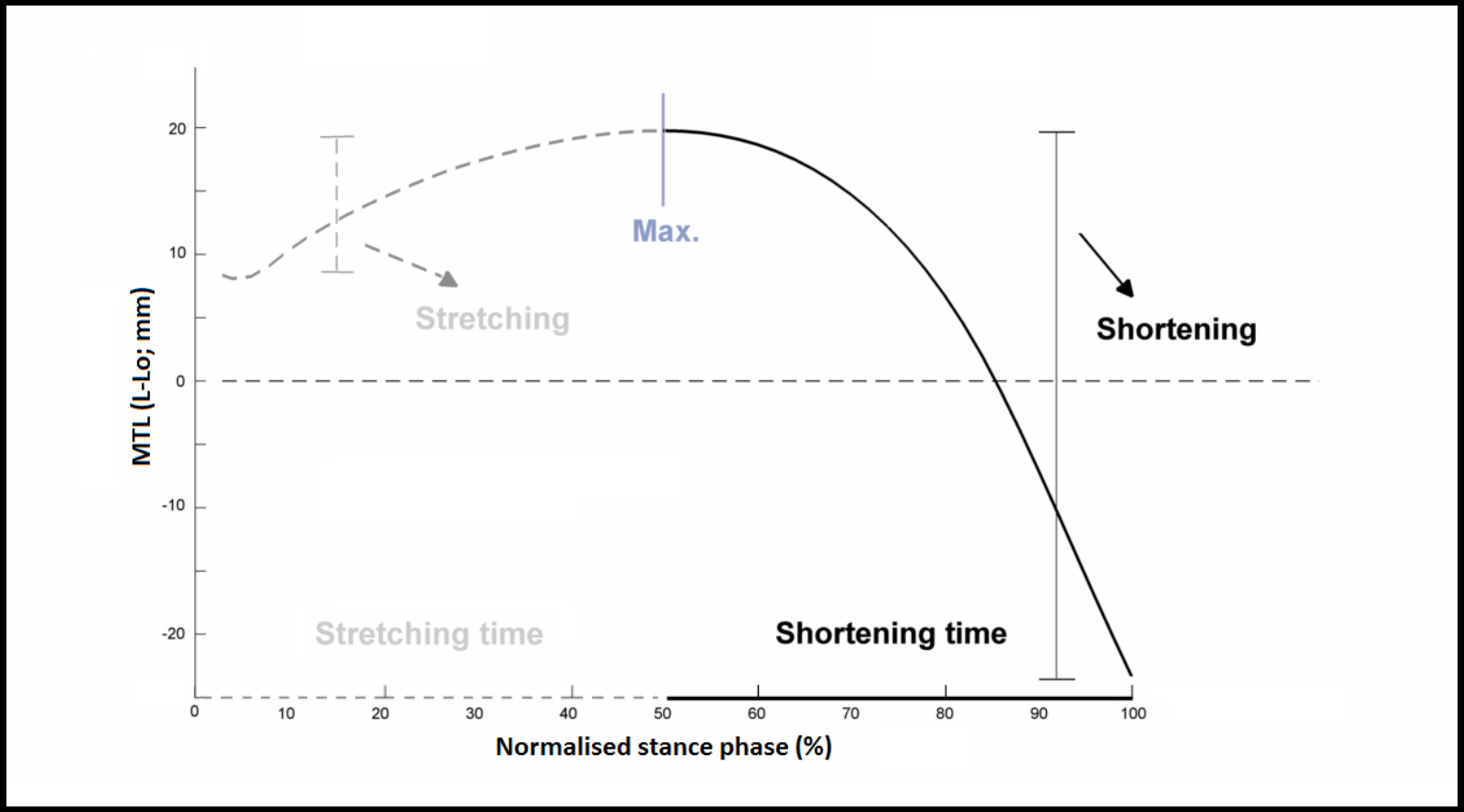
MT deformation characteristics

- MT stretching
- MT stretching time
- Maximal MT stretching velocity

- MT shortening
- MT shortening time
- Maximal MT shortening velocity

KU LEUVEN

MT deformation characteristics



KU LEUVEN

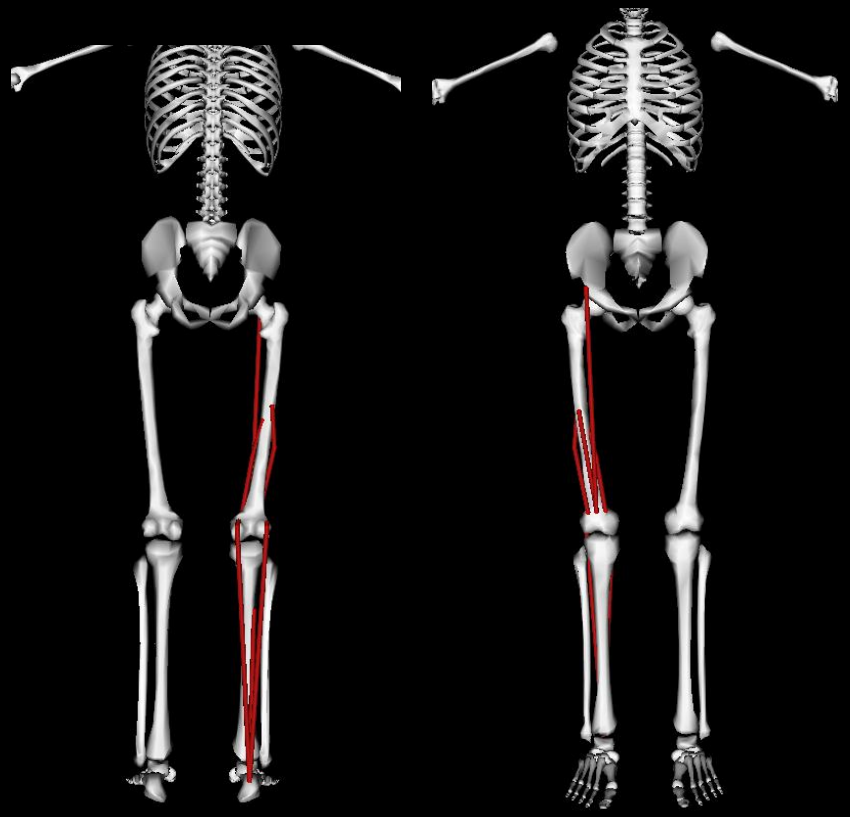
Muscles analysed

Plantar flexors

- **m. Soleus**
- **m. Gastrocnemius**
  - **- medialis**
  - **- lateralis**

Knee extensors

- **m. Rectus Femoris**
- **m. Vastus**
  - **- medialis**
  - **- intermedius**
  - **- lateralis**

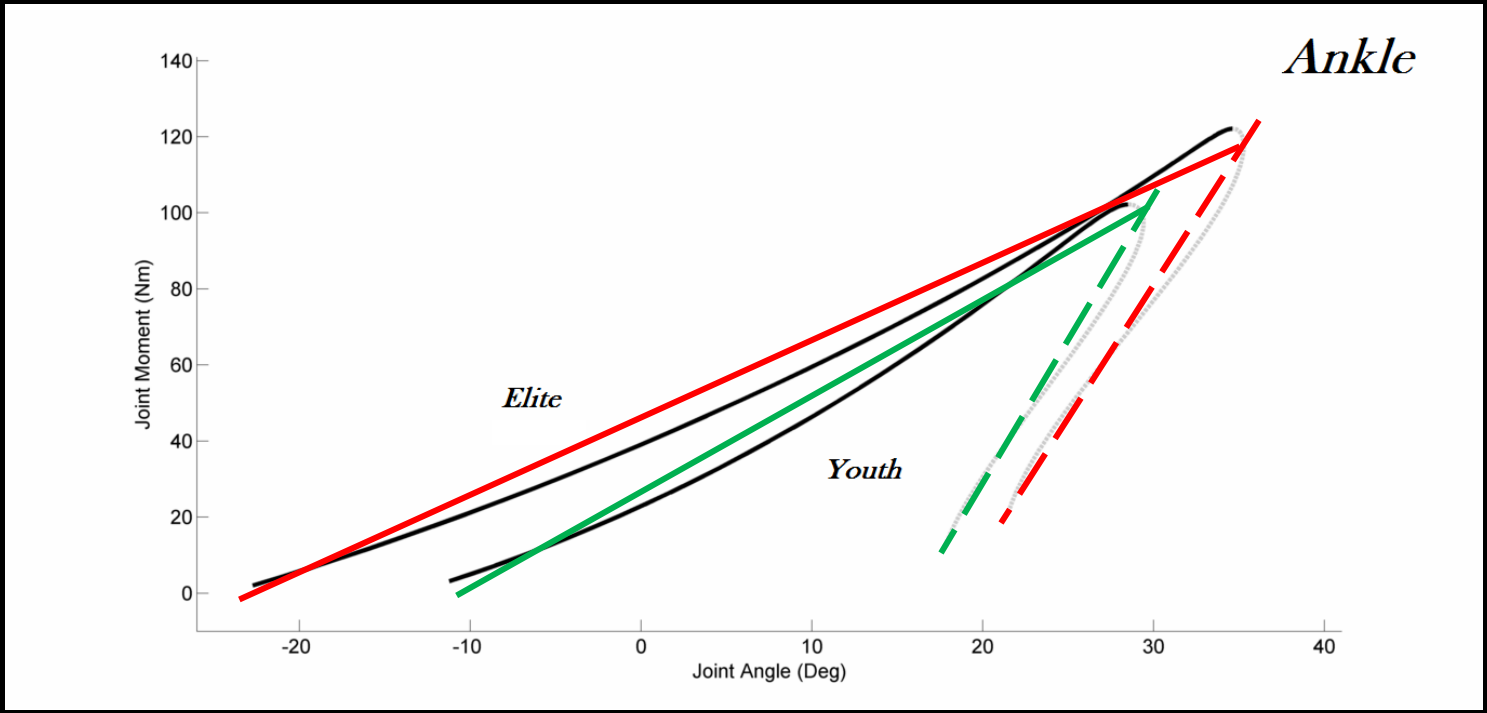


KU LEUVEN

Results

Joint Stiffness

Elite Youth



KU LEUVEN

Results

Joint Stiffness

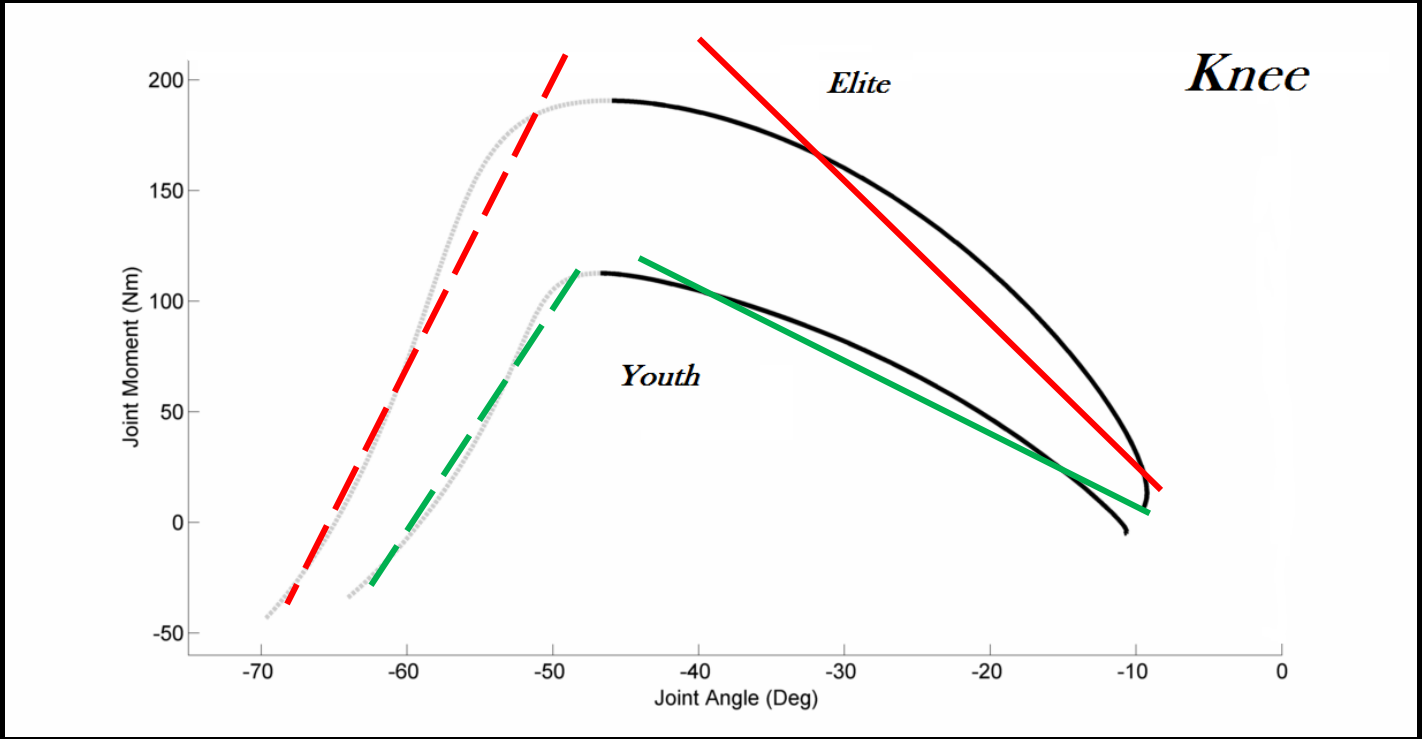
	Elite		Youth
Ankle	6.6 ± 2.0 Nm/deg	=	7.4 ± 3.1 Nm/deg
	2.3 ± 0.6 Nm/deg	=	2.8 ± 1.2 Nm/deg

KU LEUVEN

Results

Joint Stiffness

Elite Youth



KU LEUVEN

Results

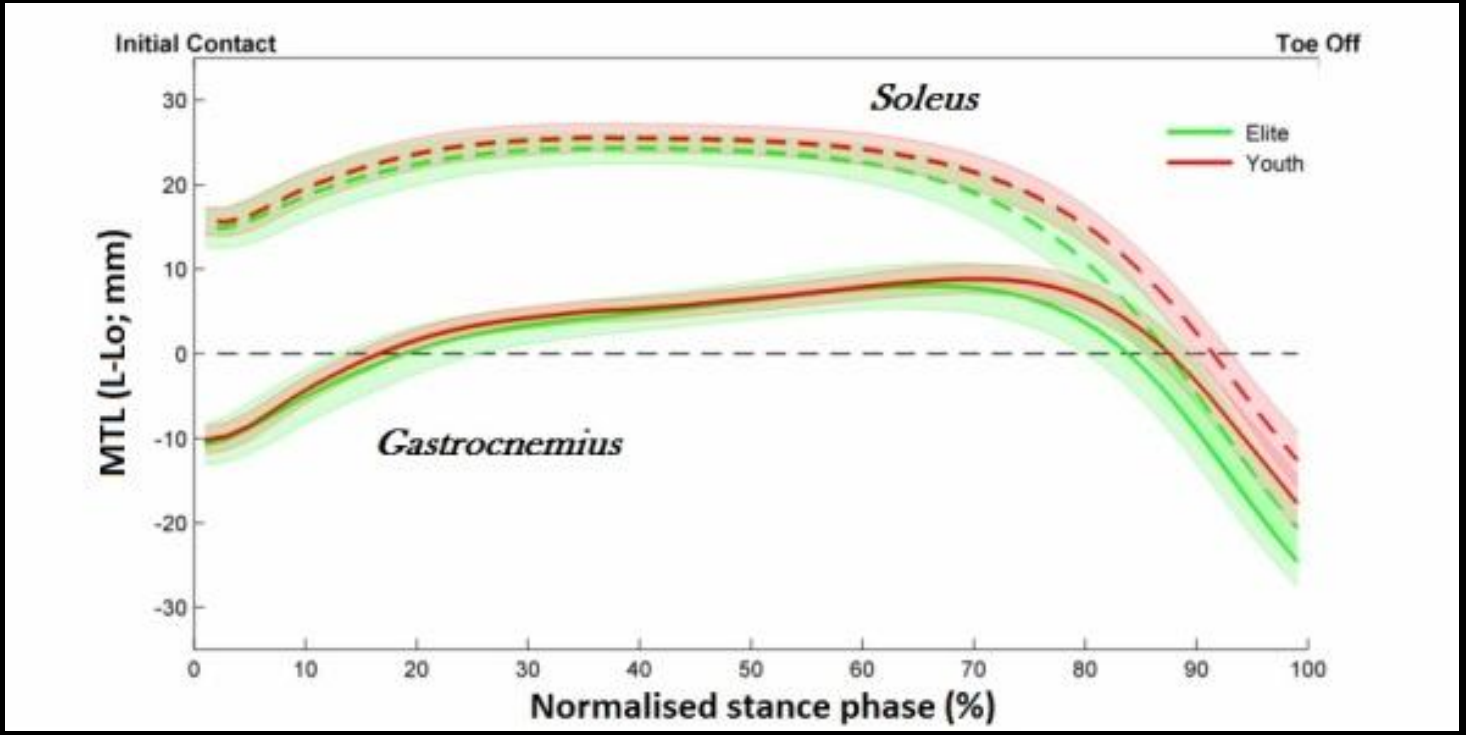
Joint Stiffness

		Elite		Youth
Ankle		6.6 ± 2.0 Nm/deg	=	7.4 ± 3.1 Nm/deg
		2.3 ± 0.6 Nm/deg	=	2.8 ± 1.2 Nm/deg
Knee		12.5 ± 5.6 Nm/deg	=	9.9 ± 4.5 Nm/deg
		5.2 ± 2.0 Nm/deg	>	3.7 ± 1.4 Nm/deg

KU LEUVEN

Results

MTL



KU LEUVEN

Results

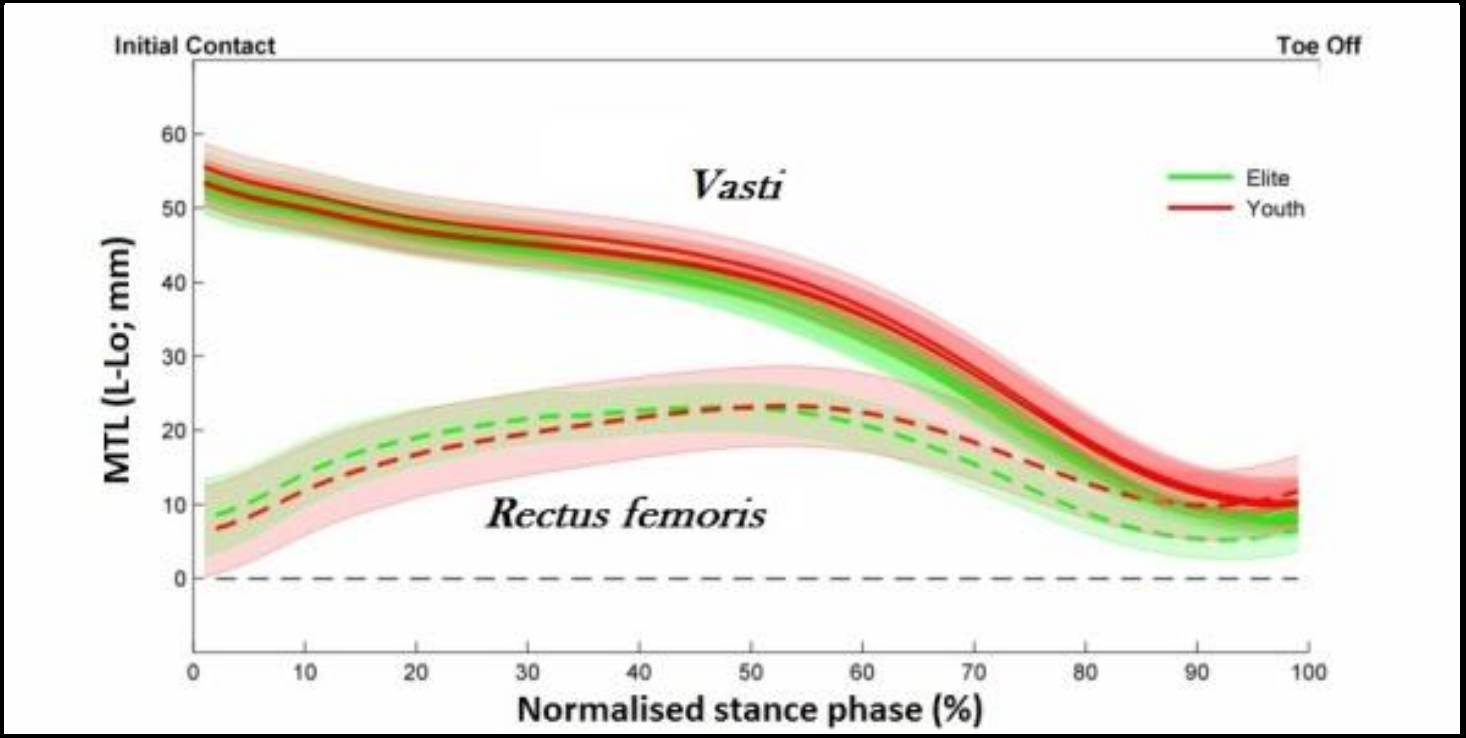
MTL

	Elite		Youth
Plantar Flexors	Shortening	>	
	Maximal shortening velocity	>	
	Stretching time (Gastrocnemii)	trend <	

KU LEUVEN

Results

MTL



KU LEUVEN

Results

MTL

		Elite		Youth
Plantar Flexors	Shortening		>	
	Maximal shortening velocity		>	
	Stretching time (Gastrocnemii)		trend <	
Knee Extensors	Shortening (Rectus Femoris)		>	
	Shortening time (Rectus Femoris)		>	
	Maximal shortening velocity (Rectus Femoris)		>	
	Stretching time (Rectus Femoris)		<	

KU LEUVEN


Elite sprinters have higher stiffness on the descending limb in the knee joint due to a increased moment generation
Elite sprinters have more shortening in all bi-articular power generating muscles
Youth sprinters seem to spend more time in stretching the muscle-tendon complex
Youth athletes need to train in improving their control in the combined change in joint angles
KU LEUVEN

Thank you for your attention

@AelesJ

Jeroen.aeles@kuleuven.be

By Jeroen Aeles

Co-Authors
Prof. Dr. Benedicte Vanwanseele
Prof. Dr. Ilse Jonkers
Prof. Dr. Christophe Delecluse
Dr. Sofie Debaere

HMB
Human Motion Biomechanics

KU LEUVEN