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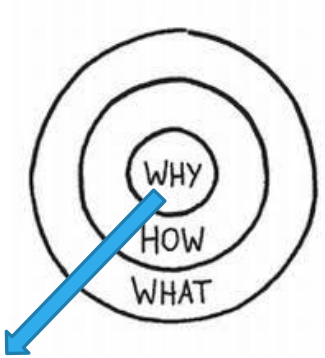

The effect of prosthetic alignment on prosthetic and total leg stiffness

while running with simulated running-specific prostheses

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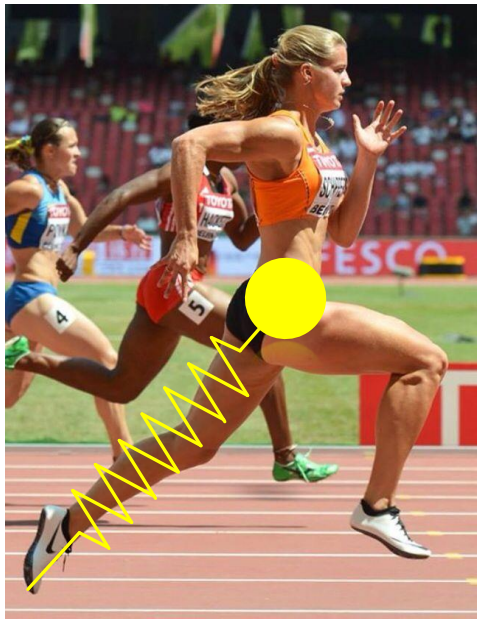
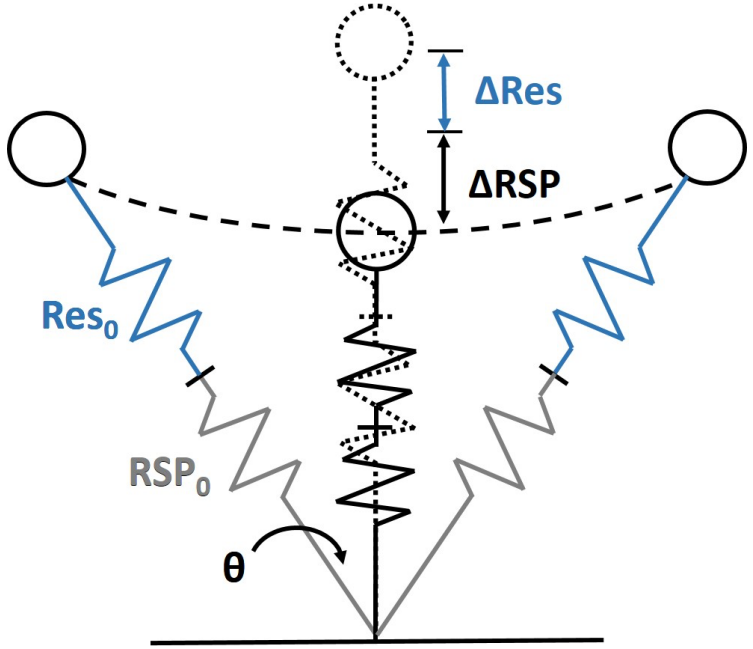
RSP designed to replicate spring-like behavior of leg





Spring mass model

Important aspects to improve running performance:

- Step frequency
- Contact time

↕

- Total leg stiffness (**RSP** + residual)
- Angle of attack

RSP stiffness might not only depend on properties of the blade,

but also on the **alignment of the blade relative to the socket**.

Changing direction of loading by changing angle of alignment

Research Question

What is the effect of angle of alignment on RSP stiffness during running on a treadmill ?

and

how does this affect the total leg stiffness and gait pattern ?

Two conditions

1. Step frequency **imposed** condition

   - Assess the effect of alignment angle independently from possible changes in leg angle of attack

2. Step frequency **free** condition

   - Include potential adaptations of the athletes to this manipulation in terms of changing leg angle of attack and gait pattern

protocol

8 trials:

- 4 angles: 0 – 5 – 10 – 15
- 2 conditions: free and imposed

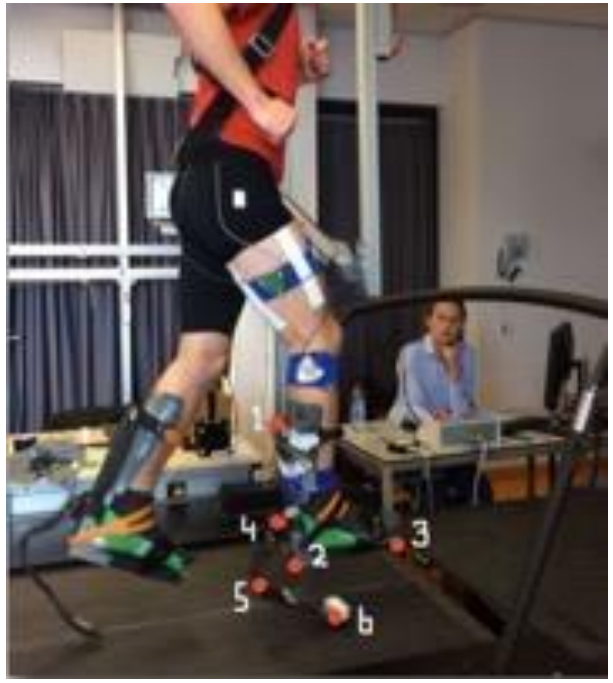
Data acquisition

Optotrak and embedded force plates

Data analysis

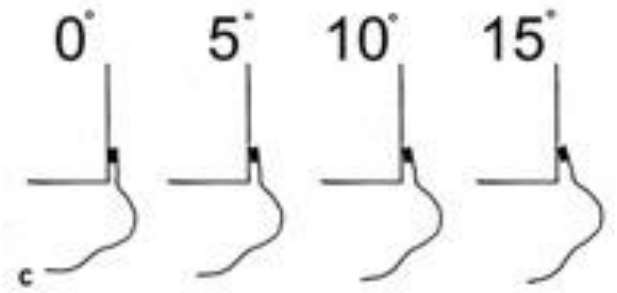
Outcome measures:

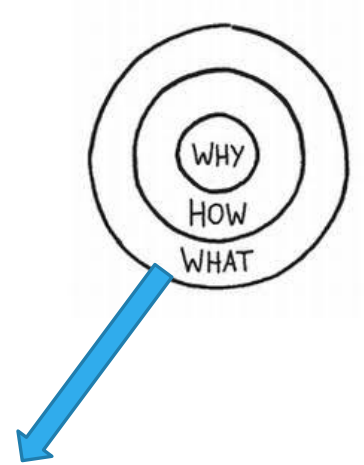
- K_{RSP} K_{TOT} K_{RES}
- Angle of attack
- K_{knee}
- Knee angle at initial contact



Prosthetic simulators

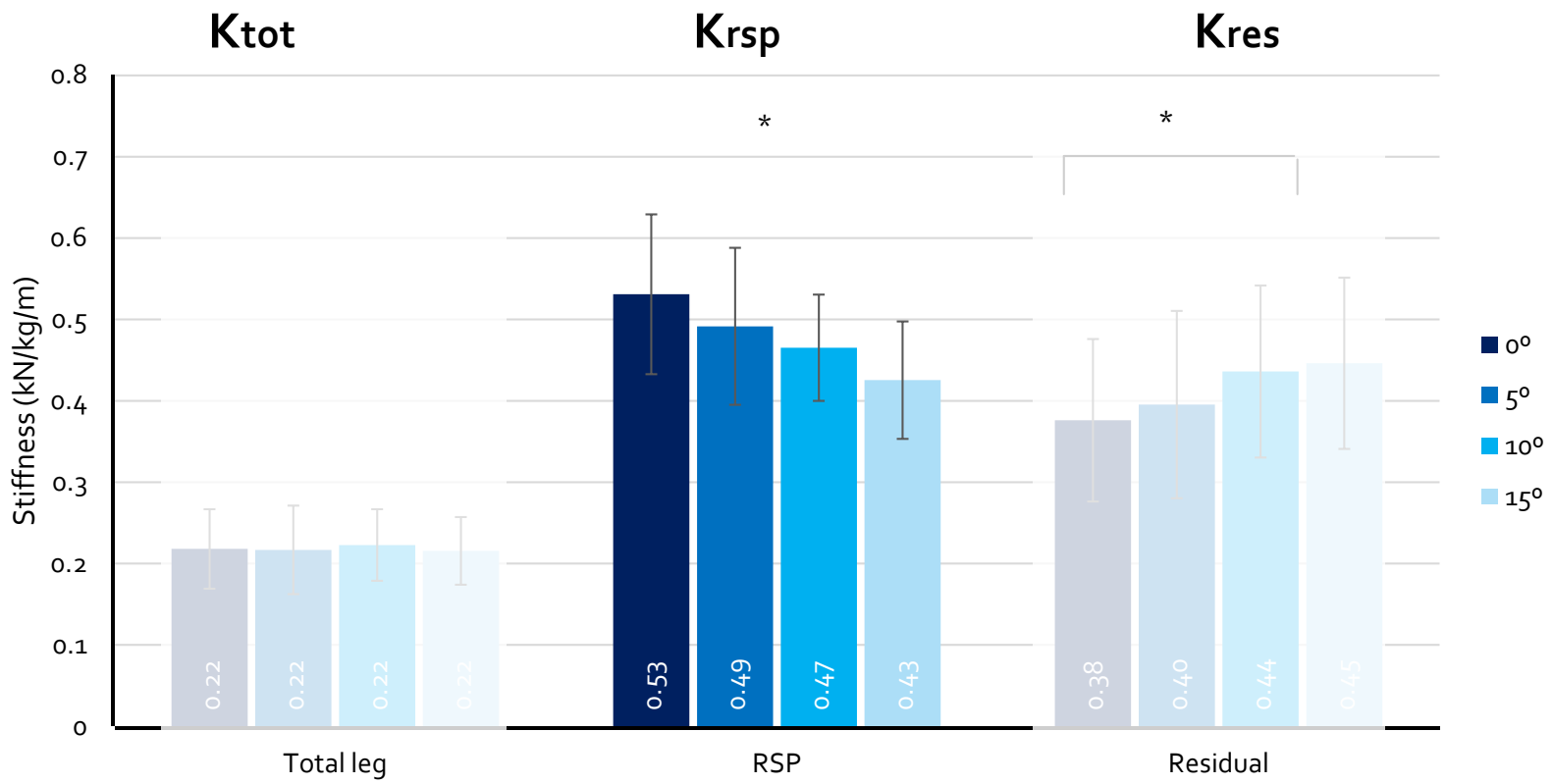
Alignment angles

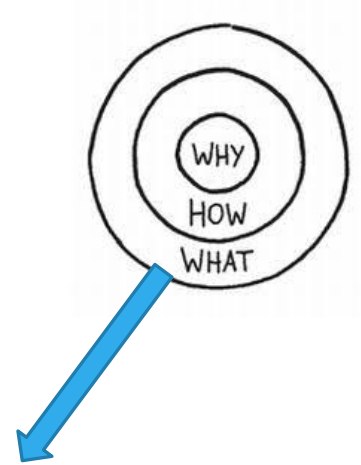




RSP stiffness

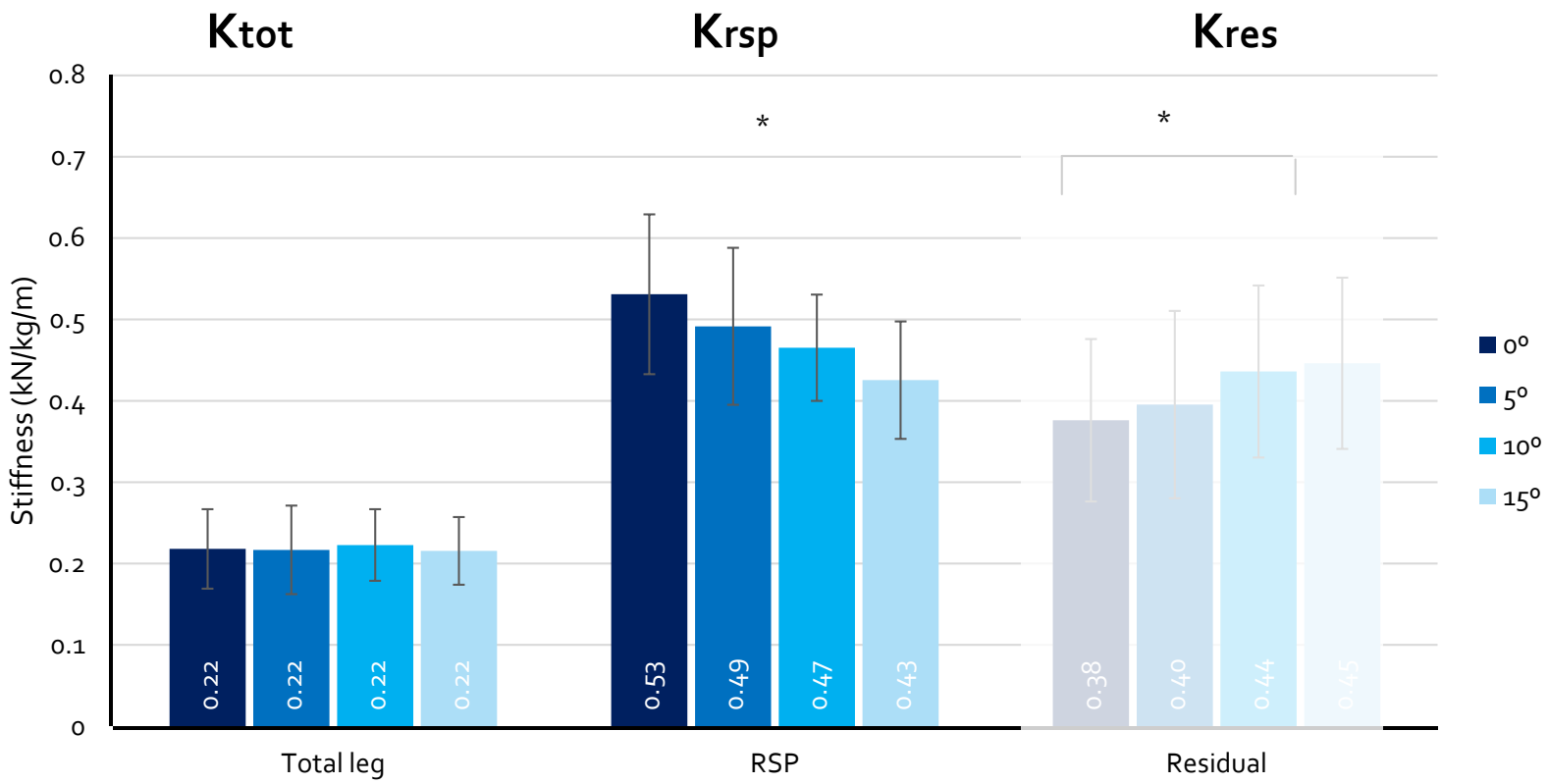
We hypothesized that prosthetic stiffness would decrease as a function of alignment angle

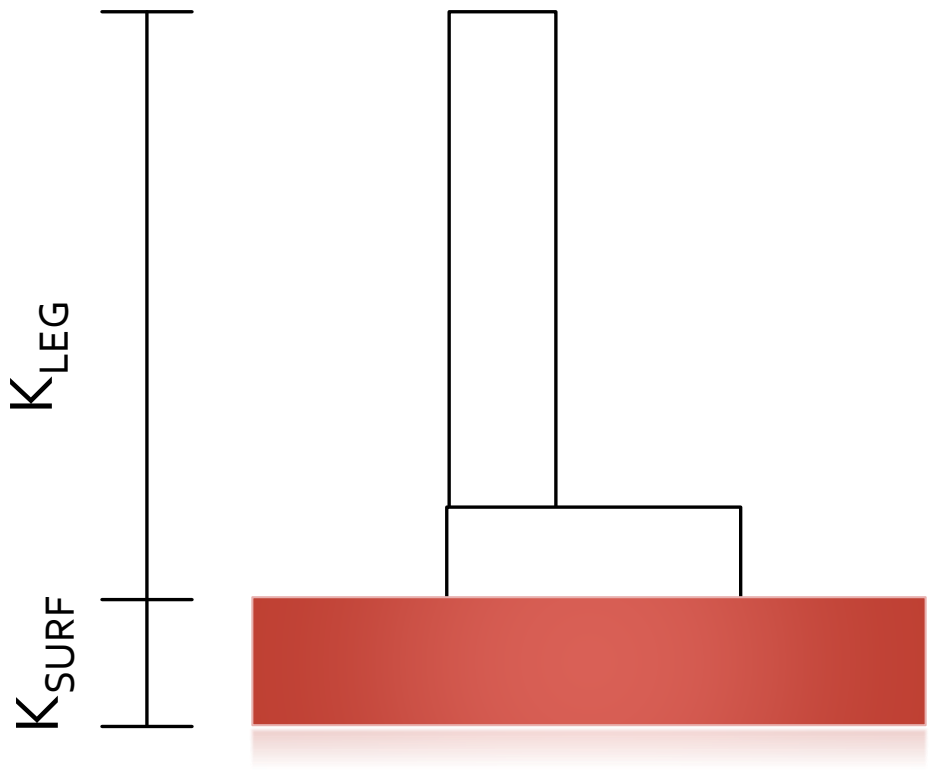


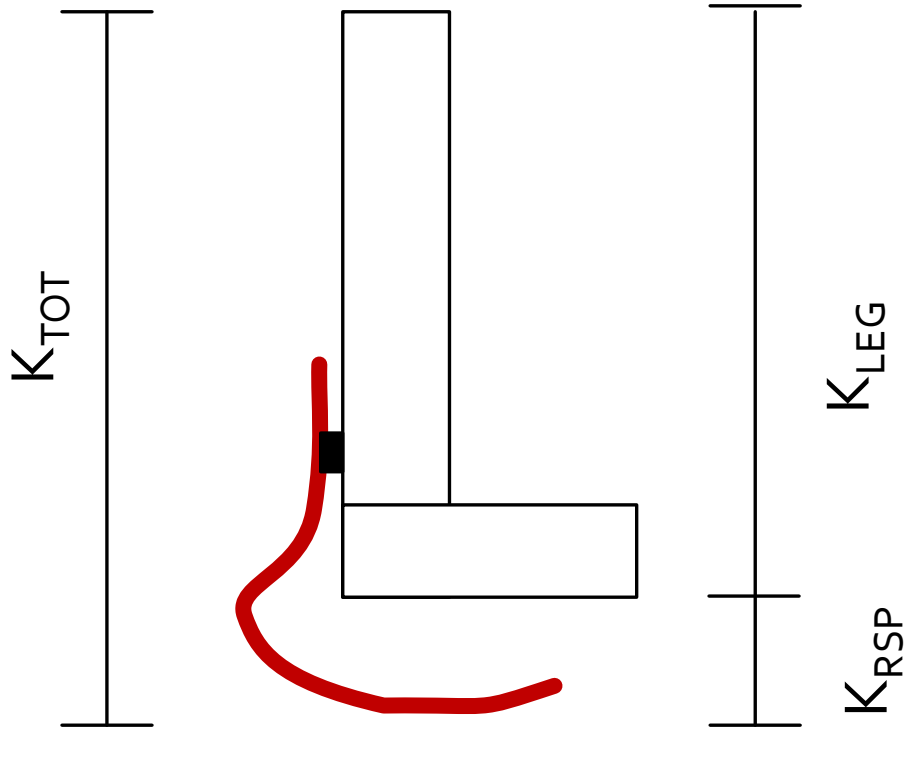


Total leg stiffness

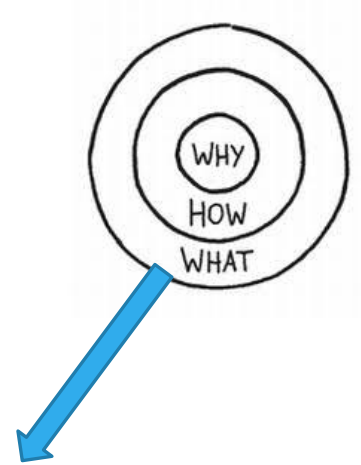
Compensate for substantial decrease in RSP stiffness





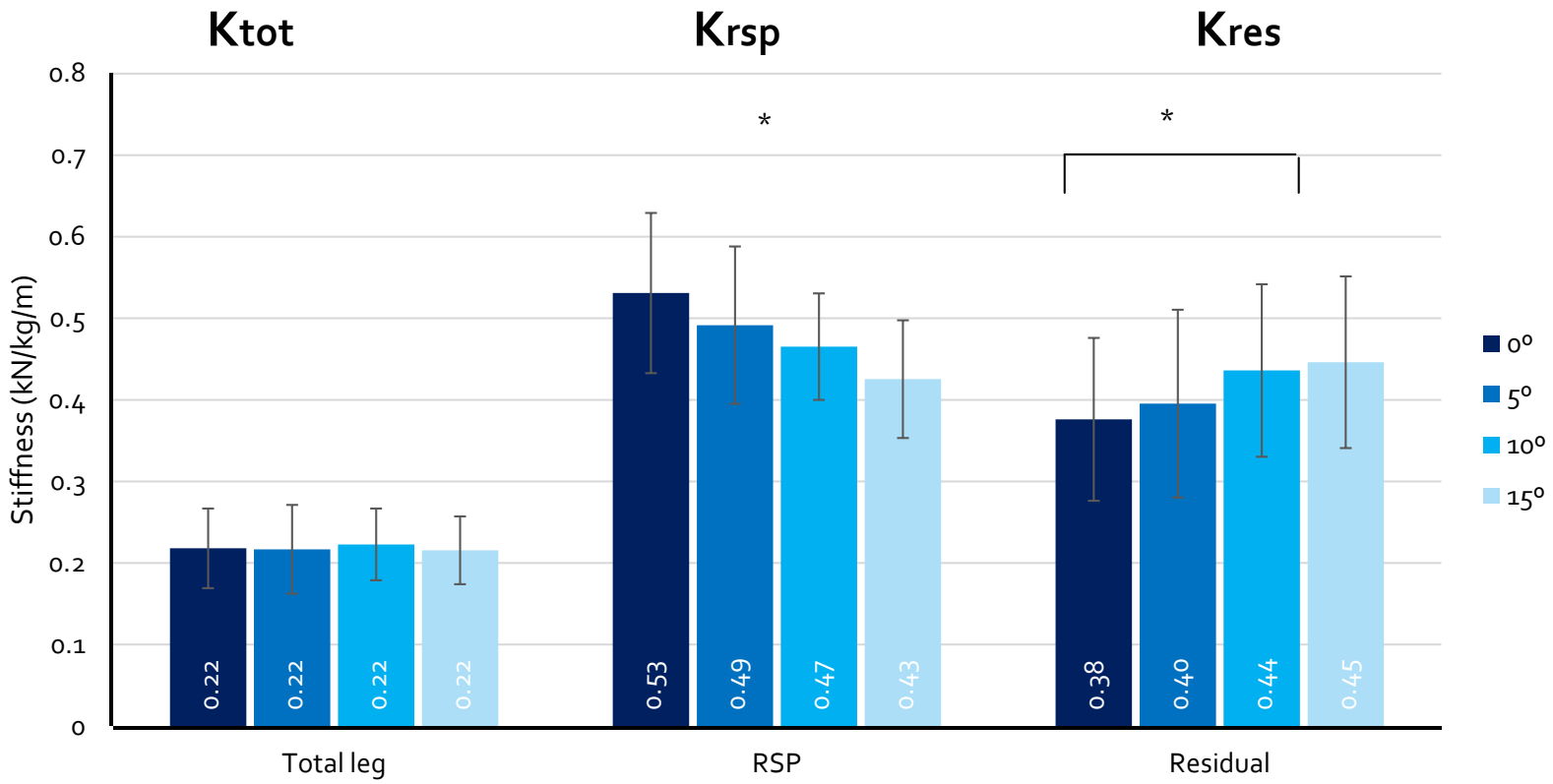


$$K_{LEG} = K_{RES}$$

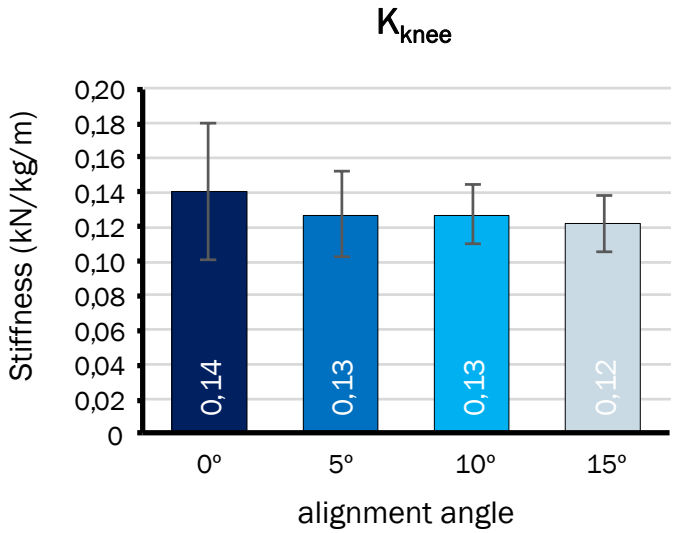


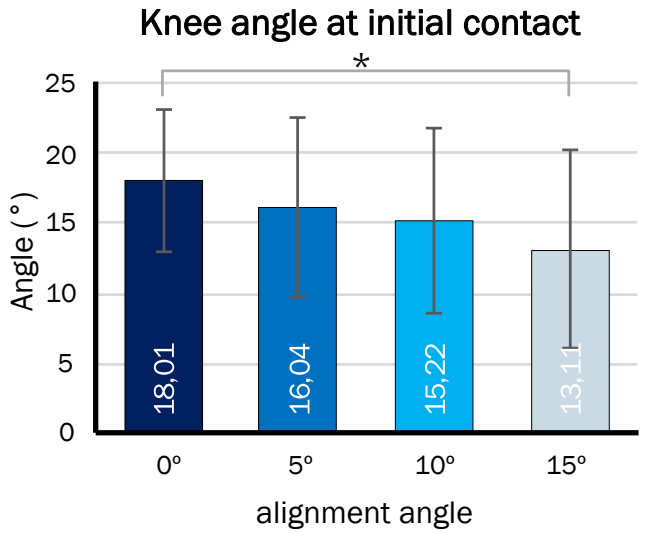
Residual leg stiffness

Compensation for lower RSP stiffness

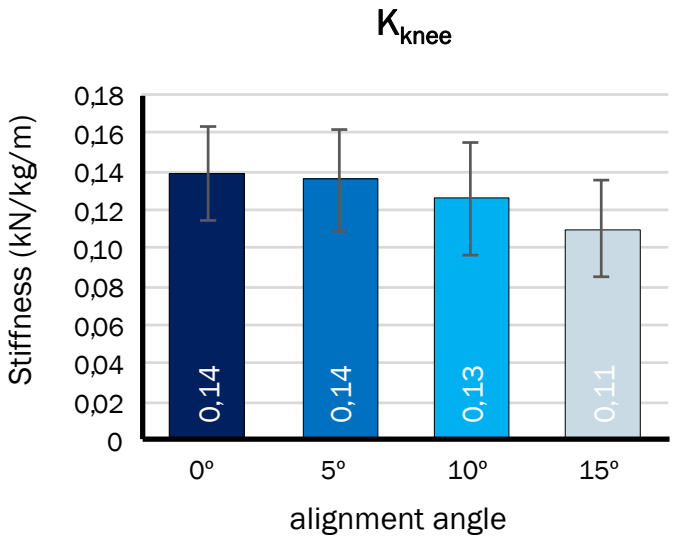


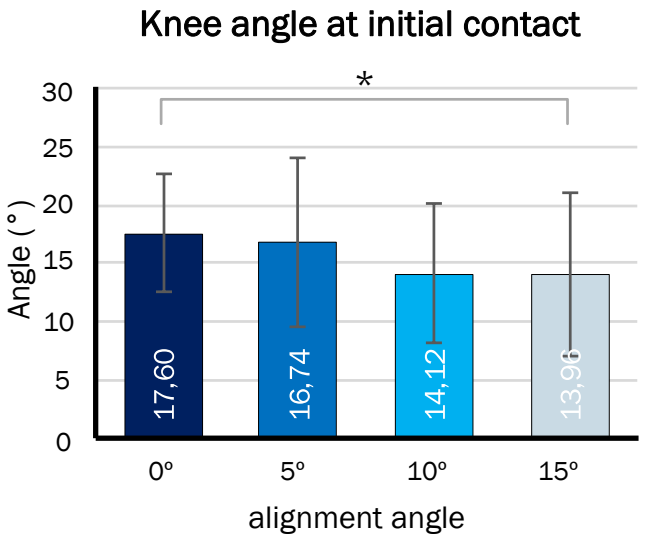
K_{knee} and knee angle at initial contact





imposed step frequency





free step frequency

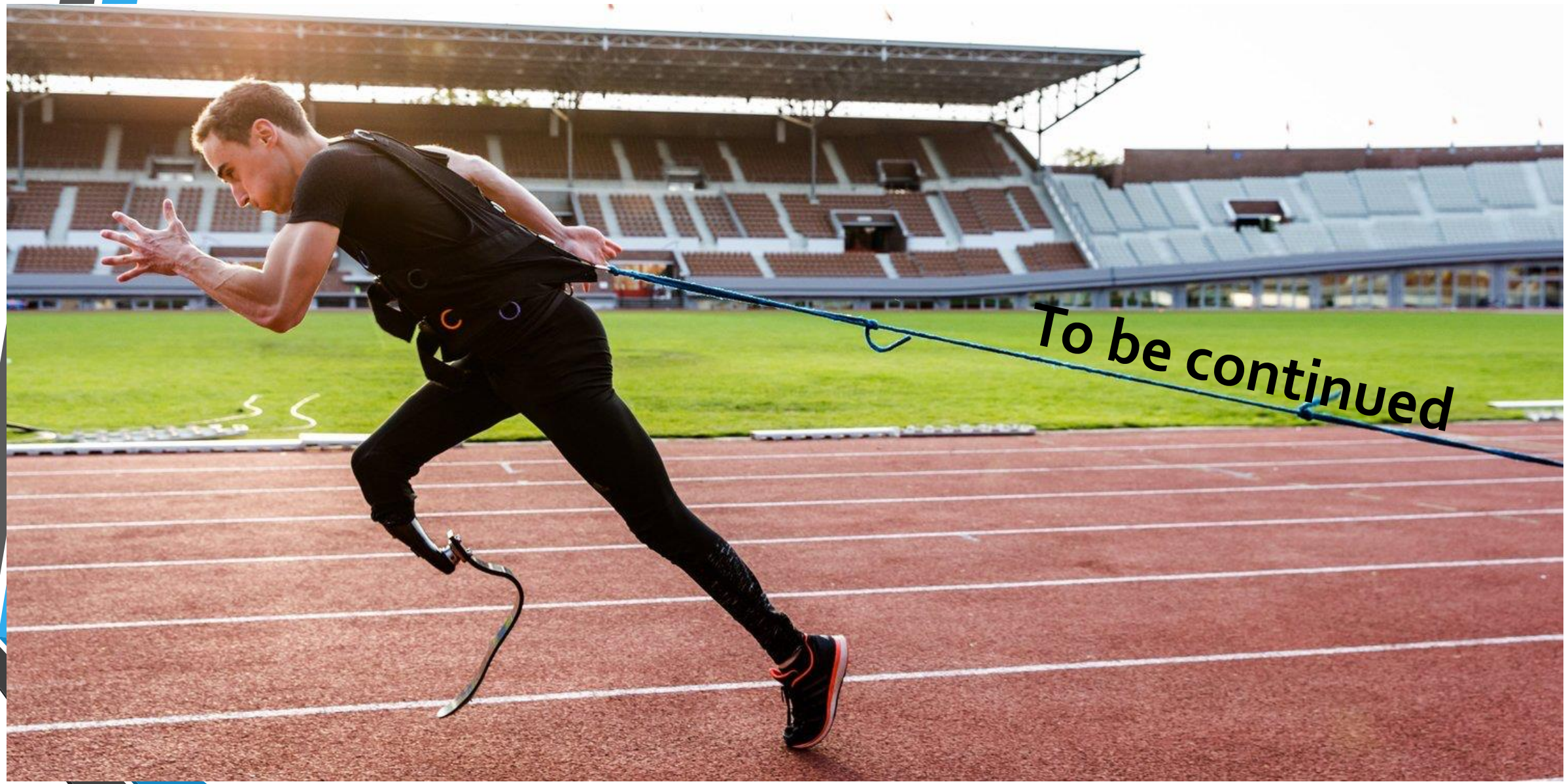
Conclusion

- Alignment decreases RSP stiffness.
- <u>Able-bodied athletes:</u>
  - Compensate for decrease in RSP stiffness - > increase in residual leg stiffness (Farley et al., 1998; Ferris et al., 1998)
- <u>Amputee athletes:</u>
  - Not capable of regulating residual leg stiffness (Oudenhoven et al. 2016)

Take home message

Optimal prosthetic stiffness selection:

1. Right RSP stiffness category
2. Alignment of the blade relative to the socket


To be continued

frontiers in Sports and Active Living

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The Effect of Prosthetic Alignment on Prosthetic and Total Leg Stiffness While Running With Simulated Running-Specific Prostheses

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