



US DEPARTMENT OF DEFENSE

# BLAST INJURY RESEARCH PROGRAM COORDINATING OFFICE

## Computational Modeling and Simulations

### Bioenergetics of Amputee Gait

Decades of research indicates that a below-knee amputation negatively affects walking mechanics and the metabolic cost of walking. Researchers with the Extremity Trauma and Amputation Center of Excellence at Brooke Army Medical Center (BAMC; Fort Sam Houston, TX), in partnership with collaborators at the University of Maryland (College Park, MD), hypothesized that maintaining muscle strength after limb loss may mitigate the high metabolic cost of walking typically seen in the larger general limb loss population.

The research team used musculoskeletal modeling and optimal control simulations to perform a longitudinal study (25 virtual “subjects”) of the metabolic cost of walking pre- and post-below-knee limb loss (*Esposito and Miller, 2018*). Simulations of walking were first performed pre-limb loss on a model with two intact biological legs, then post-limb loss on a model with a passive prosthetic foot. Metabolic costs were compared pre- vs. post-limb loss, with systematic modifications to the muscle strength and prosthesis type (passive, powered) in the post-limb loss model. The metabolic cost in models with a passive prosthesis did not increase above the pre-limb loss cost if pre-limb loss muscle strength was maintained, particularly in the residual limb. A powered prosthesis compensated for up to 20 percent loss of strength.

The present simulation results support recent experimental data suggesting an increase in the metabolic cost of walking is not an inevitable consequence of unilateral below-knee limb loss: an increase in metabolic cost may be driven more by loss of strength in the remaining muscles rather than loss of the limb.

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#### REFERENCES:

ER Esposito and RH Miller (2018), “Maintenance of muscle strength retains a normal metabolic cost in simulated walking after transtibial limb loss,” *\_PLoS ONE\_* 13(1): e0191310

