Metabolic Efficiency and Mechanics of Walking On Sloped Terrain

Galavotti et al.: Metabolic Efficiency and Mechanics of Walking On Sloped Terrain
Layla Galavotti[1], Nicholas Ayala[1], Justin Water PhD[2] & Kristen R. R. Savell PhD[1]
[1]Department of Biology, [2]Department of Physical Therapy & Human Movement Science, Sacred Heart University

INTRODUCTION

Walking is the primary means of movement for *Homo sapiens*. People walk on different surfaces, from completely flat to steeply sloped. While many studies have examined the energetic cost and biomechanics of walking on flat surfaces, little research has been conducted on the cost and mechanics of walking up sloped terrain

BACKGROUND

- Humans often adopt a "forefoot walking" strategy (**Figure 1**) when climbing steep slopes and stairs.
  - This may influence the metabolic cost of walking by changing the muscular behavior.
- On flat terrain, people with long lower limbs are more energy efficient than those with shorter lower limbs because they can cover more distance per stride.
  - However, humans evolved walking across varied surfaces (including sloped, mountainous terrain) – this may have provided evolutionary pressures that influenced modern human skeletal structure.
  - Shorter lower limbs may provide an energetic advantage over long-legged individuals when traversing sloped terrain.

HYPOTHESES

1. A forefoot strike pattern will be more mechanically efficient then flat-footed walking on sloped terrain.
2. Subjects with shorter lower extremity lengths will demonstrate greater efficiency in sloped walking than those with longer lower limbs.

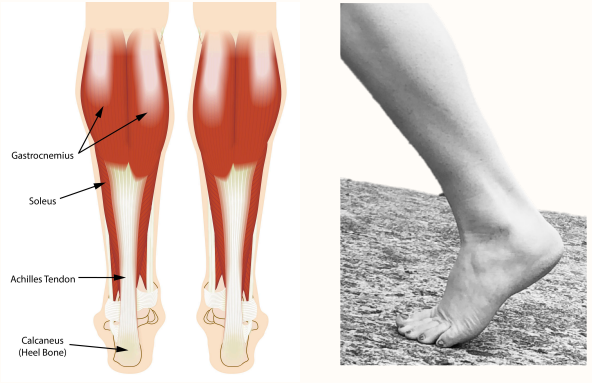

Figure 1. Muscles associated with plantar flexion (left), "forefoot" position (right).

Figure 2. Approximation of motion capture receptor placement on the lower limb of a subject (Mayo Clinic)

MATERIALS & METHODS

Sample ~15 participants ages 18-55, in good health

Data Collected Before or During Trials

- Anthropometric measurements
- Motion capture models to create simulations (**Figure 2**)
  - 21 bony landmarks recorded by 10 cameras
- Electromyography (EMG)
  - Used to measure the electrical activity muscles
- Metabolic data (oro-nasal mask)
  - Records oxygen consumption
  - Measures energy usage during activity

Trial Methods

- Preferred walking speed will be determined at highest comfortable slope.
- Starting at 0%, slope will be increased by 5% until the subject assumes a "forefoot" walking posture. This is their **set point**.
- Subject will walk for 5 minutes flat-footed, and 5 minutes in a "forefoot" posture at each of **three different speeds:**
  1. Set point - 5%
  2. Set point
  3. Set point + 5%

AIMS

By exploring sloped walking in modern humans, we will not only shed light on the energetic costs and mechanics of this movement, but may be able to speak to the evolutionary pressures that shaped modern human body proportions.