Walking Uphill Efficiently with a Load

Specific Goals

The topic for our research proposal is understanding the mechanics around walking uphill with a load, and how we can adjust certain parameters to potentially reduce the metabolic cost. This involves first looking at the change in metabolic cost as the slope and load changes. Further, we will investigate how the location of the effective center of mass, and various heel wedges could help minimize the cost for walking uphill.

By understanding how these parameters can affect costs, we hope to develop an informative approach on how people can make a hill climb less strenuous when carrying a load.

- How the metabolic cost changes with load and slope

  Understanding how metabolic cost changes with load and slope/grade. Past studies have shown that energy expenditure for uphill walking is much higher in comparison to level walking[1,5,6,12]. Energy expenditure is also shown to increase in both level walking and uphill walking has also shown to increase when a load is added, with a past study commenting that energy expenditure becomes "far more sensitive as the condition for walking becomes more strenuous." [1] With this, we hypothesize that metabolic costs for walking uphill with a load increases as the slope grade of the hill and/or the load being carried increases.

- How the location of the COM can affect metabolic cost

  The dynamics of human gait is sometimes studied as an inverted pendulum, where the body's center of mass must pass a tipping point to create a forward motion.? When adding a load, such as a backpack, the human's center of mass changes. Specifically, if the load is carried as a backpack, the center of mass is moved towards the rear on the sagittal plane. To compensate for this, humans must lean forward in order to walk forward[4]. Studies have shown that there is a linear relationship between an added load and metabolic cost, but this research will discover if there is more to it than just the added load[14]. We hypothesize that the further the center of mass is moved from the human's center of mass, the higher the metabolic cost will be.

- How heel wedges can affect metabolic cost

  The influence of heel height on kinematics and gait during level walking has been studied extensively[11,15-18]. However, while walking uphill, a heel wedge which negates the slope reduces metabolic cost[10,12,13]. While walking with a load, such a heel wedge can be used to both reduce effort? and increase comfort?. The metabolic cost and limb mechanics data obtained from exposing subjects to broad heel incline angles can be used for informing new ways to affect metabolic cost while walking uphill. We hypothesise that a heel wedge which brings an uphill slope closer to level walking will reduce metabolic cost while walking with a backpack load.

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