Uphill walking has a greater metabolic cost than walking on level ground. Humans will alter their gait by reducing their walking speed, cadence, and step length to reduce energy expenditure as the incline becomes more strenuous.[1,5,13] These reductions are a result of the demand from potential energy and a sense of caution for possible slippage at toe-off.[5] The leading leg for uphill walking will perform positive work as it assists the trailing leg to raise the COM with each step. Both legs generate more power at double support in order to exert greater propulsive forces.[13] Tests in a laboratory environment, where speed is kept constant in both level and uphill walking found an increase in knee power generation, and greater muscle activity primarily in the knee, hip and ankle extensor muscles as slope grade increased.[6,20] Oxygen consumption is also found to have a direct proportionality to hill gradient, which has led metabolic cost data to portray a linear trend with slope grade.[12] (Figure #) Past studies have mainly focused on the metabolic cost increase when either walking on inclined planes, or with a backpack load. There is significantly lesser data available on how such a load affects human gait and energy expenditure during uphill walking.

Prior research on backpack loads have focused on how gait and metabolic cost are altered during level walking.[] A linear relationship exists between the added load and the increase in metabolic cost.[] There is evidence that suggests that modifying the center of mass of subjects carrying a backpack load can also affect energy expenditure.[] However, despite both uphill walking and center of mass affecting gait, their interaction together has not been studied extensively. With our research, we plan to study the dynamics of this novel environment in greater detail.

In a similar vein, the impact of heel wedges has been studied extensively in level walking[] and much of the research has been focused on the effects of high heeled shoes[]. Joint moments show a graded response as heel height increases.[] Meanwhile, experiments with heel wedges have shown that they do not hinder foot kinematics significantly[]. They have also shown potential in redistributing loads among the triceps surae.[] In uphill walking, heel wedges which negate the slope of the treadmill have shown to reduce the metabolic cost.[] The optimal treadmill grade minimized the COM work rate and propulsive ground reaction forces. Thus, heel wedges can potentially improve comfort and save energy. However, the effect of such wedges on joint kinematics while walking with a load remains largely unstudied. The results obtained from studying these effects can be used to optimise footwear based on metabolic rate or joint moments.

Following the literature review, it is evident that there are very few studies focusing on the novel environment of uphill walking with a backpack load. We believe that the data gathered from our research can be used for developing strategies to reduce metabolic cost or improve comfort while walking uphill, provide insight into efficient backpack positioning, and potentially have use for designing walkways on campuses with suitable inclines for backpack carrying students.