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Energetic Cost of Carrying a Load

In physiology, the energetic cost of transportation is the amount of energy required to move a meter. It is measured as the number of calories required for a person to move the meter (Kcal/meter). In this case, the larger the subject or the more weight the subject carried, the greater the cost of transport would be. Alternatively, it could be measured as the cost per kilogram (Kcal/kgm). When measured this way, we hypothesize that larger subjects will have a lower or equal cost of transport and that the cost of transport will not change when subjects carry loads. In other words, we hypothesize that when individuals carry a load equal to 10% of their body weight, they will burn 10% more Kcal per meter. We expect that there will be variability in the results due to differences in the weight, muscle strength, leg length, and fitness levels of the subjects.

To determine the number of Kcal used, we measured each subject's oxygen consumption as they walked on the treadmill at speeds of 0.45, 0.67, 0.89, 1.18, 1.34, 1.56, and 1.79 meters per second while carrying no weight, 10, and 20kg of additional weight. Then we used the chemical equation for the aerobic metabolism of carbohydrates, proteins, and lipids to calculate the number of Kcal produced per liter of O_2 consumed. Each subject walked for 2 minutes at each of the velocities and we recorded the oxygen consumption for the last 30 seconds.

With the results in mind we have found that the most energetically favorable walking speed is about 1.18 meters/sec for all of our subjects, and that the energetically optimal walking speed is not affected by carrying added mass. According to the results, carrying extra weight is equivalent to carrying your own weight in terms of energy usage. One of the more critical findings was that in some cases, when subjects carried weights at high speed, oxygen consumption could not be used to calculate energy expenditure due to subjects using anaerobic respiration when the rate at which they used energy exceeded their ability to produce it by aerobic respiration. This was observed when the percentage of CO_2 produced compared to the percent of O_2 was heightened.

Based on these findings this research can assist in the studies of obesity and athletics. If scientists are able to broaden their knowledge on what causes individuals to use more energy, then more efficient weight loss plans can be determined for various body types. A deeper understanding on when a person is consuming the most oxygen effectively can aid with how people decide to work out and participate in physical activities. Athletes and their trainers will be able to use this information to optimize workouts and performances because they would have the intel to be aware of when an athlete is getting enough oxygen using energy in an effective manner.

Introduction

- In physiology, the energetic cost of transportation is the amount of energy required to move a meter. It is measured as the number of calories required for a person to move the meter. Alternatively It could be measured as the cost per kilogram
  - Energy x $mass^{-1}$ x $distance^{-1}$
  - kcal/kg m
- We expect variability due to differences in the following assets of each subject
  - Weight
  - Muscle strength
  - Leg length
  - Fitness level
- Due to human variability each individual will have multiple results throughout their trials allowing observations to determine which factors strongly affect an individual's cost of walking.

Hypothesis: We hypothesize that larger subjects will have a lower or equal cost of transport and that the cost of transport will not change when subjects carry loads. In other words, we hypothesize that when individuals carry a load equal to 10% of their body weight, they will burn 10% more Kcal per meter. We expect that there will be variability in the results due to differences in the weight, muscle strength, leg length, and fitness levels of the subjects.

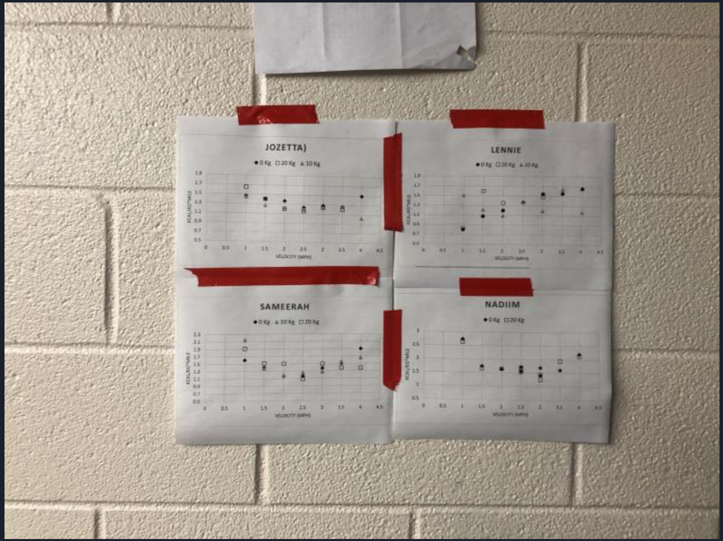
Methods

7 subjects between the ages of 19 and 43

- Each subject's initial weight is taking in kg
- Individuals are equipped with gas mask, reflective leg sleeve and chest strap heart monitor
    - Used in channels for data on LabScribe
- Subject's walked trials at seven speed increments with no weight, 10kg of added weight, and 20kg of added weight
- Each trial began with a 10secs still period in order to set the baseline for data results.
- Once trials were completed and the results calculated in iExcel, we were able to determine the cost of walking based off of oxygen consumption during trials.

Results

- When individuals carry a load equal to 10% of their body weight, they will burn 10% more Kcal per meter.



Conclusion

- Most energetically favorable walking speed is about 1.18 meters/sec for all of our subjects
- The energetically optimal walking speed is not affected by carrying added mass
- Carrying extra weight is equivalent to carrying your own weight in terms of energy usage.

One of the more critical findings was that in some cases, when subjects carried weights at high speed, oxygen consumption could not be used to calculate energy expenditure due to subjects using anaerobic respiration when the rate at which they used energy exceeded their ability to produce it by aerobic respiration. This was observed when the percentage of CO_2 produced compared to the percent of O_2 was heightened.

Based on these findings this research can assist in the studies of obesity and athletics. If scientists are able to broaden their knowledge on what causes individuals to use more energy, then more efficient weight loss plans can be determined for various body types. A deeper understanding on when a person is consuming the most oxygen effectively can aid with how people decide to work out and participate in physical activities. Athletes and their trainers will be able to use this information to optimize workouts and performances because they would have