Using Accelerometer Data to Estimate Surface Incline and Its Walking App Potential

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Introduction

Experimental Design

- $n = 9$ (4 normal weight, 4 overweight, 1 obese)
- 8 experimental phases (2 speeds X 4 inclines)
- Speed: 2 mph and 3 mph
- Surface incline: 0%, 10%, 20%, and 30 %
- Accelerometer data was collected only during the exercise sessions.

Physical Attribute	$\mu \pm \sigma$	Range
Age (yr)	26.77 $\pm$ 3.59	23 - 34
Body Mass Index (kg.m ⁻²)	25.95 $\pm$ 3.30	22.1 - 32.7

Data Analysis

Significance Test

Surface Incline	0%	10%	20%
0%	-	-	-
10%	0.0080	-	-
20%	0.0023	0.004	-
30%	0.0001	0.0000	0.0006

Paired t-test results (P values) for the 2 mph walking sessions; $n=9$ for all tests.

Surface Incline	0%	10%	20%
0%	-	-	-
10%	0.0311	-	-
20%	0.0003	0.0000	-
30%	0.0008	0.0001	0.0130

Paired t-test results (P values) for the 3 mph walking sessions; $n=9$ for all tests except for the 0%-10% pair for which $n=6$.

Linear Modelling

Once surface incline is estimated from the model, its value is factored in Equation (1).

$$VO_2 = 3.5 + 0.1(\text{speed}) + 1.8(\text{speed})(\text{incline}) \dots (1)$$

The metabolic estimation VO_2 is mapped to caloric consumption via Equation (2).

$$E = (VO_2 - BMR) * 5 / (\text{Body_Mass}) \dots (2)$$

Summary

The statistical analysis proves that:

- Gravity Y linearly correlates to surface incline.
- Gravity Y values differ significantly between different surface inclines.

This approach opens new opportunities for improving the accuracy of walking apps.

Future Work

1. Different body positions

The Gravity Y readings from the arm location of Participant P1.

2. A full range of walking speeds (2 mph, 2.5 mph, 3 mph, and 3.5 mph) for both uphill and downhill walking.