ENERGY DEMAND OF WALKERS AND RIDERS OF ELECTRIC-ASSIST BICYCLES AND TRADITIONAL BICYCLES

Casey Langford, Chris Cherry, Gene Fitzhugh, David Bassett

University of Tennessee, Knoxville

Moving Active Transportation to Higher Ground:

Opportunities for Accelerating the Assessment of Health Impacts

Washington, DC

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THE UNIVERSITY of TENNESSEE KNOXVILLE

Big Orange. Big Ideas.

Southeastern Transportation Center

E-Bikes and Physical Activity

E-Bike Sharing at UT

Presidential Court

Ag Campus

User Participation

Two Criteria:

1. Registered user of **cycleUshare**
2. Pass a physical activity readiness questionnaire (**PAR-Q**)

Study Design:

- Laboratory Testing
- Field Testing (Walk, Bike, E-Bike)
- Post-Activity Surveys

Sex	**N**
Male	11
Female	8
Age	**N**
<20	3
20-25	8
26-30	4
31-40	2
41-50	0
>50	2
Ethnicity	**N**
White	14
Minority	5
Other:	**N**
Own/have access to a bike	9
Own a car	17
BMI	
Male	26.10
Female	22.44

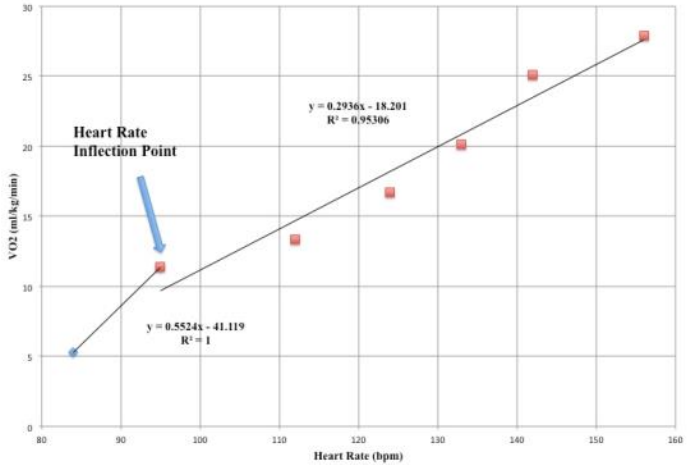
Initial Testing

Laboratory test:

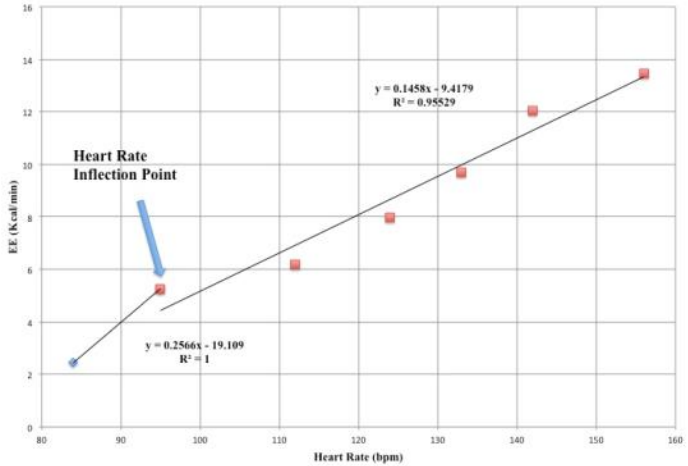
- Baseline measurements

- Stationary bike test
  - Incremental resistance until reaching 85% age predicted heart rate
  - HR, VO2, and EE measured at each phase

Heart Rate Versus VO_2 (Typical Participant)



Heart Rate Versus EE (Typical Participant)



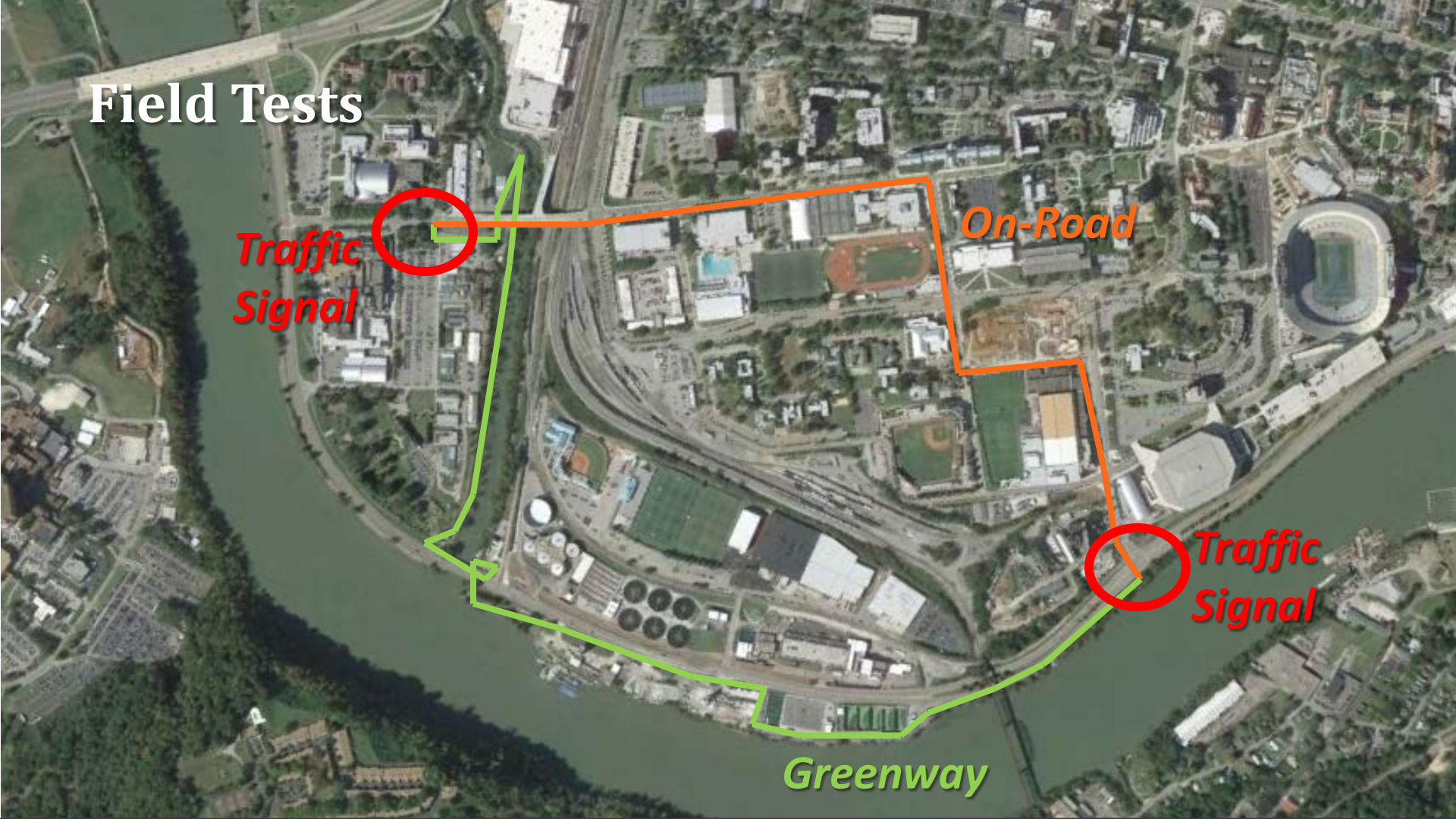
Field Tests

Exercise:

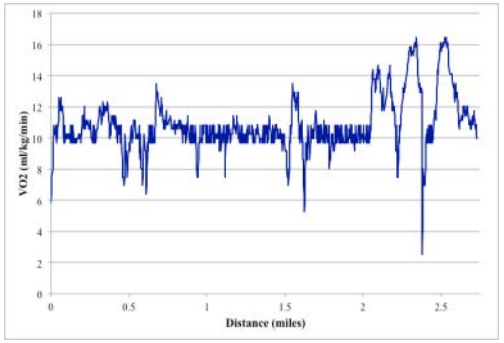
- Participants completed identical trips on e-bike, r-bike and walking.
- 2.75 mile loop including variety of terrain and facilities.
- Completed post-activity survey for each trip.

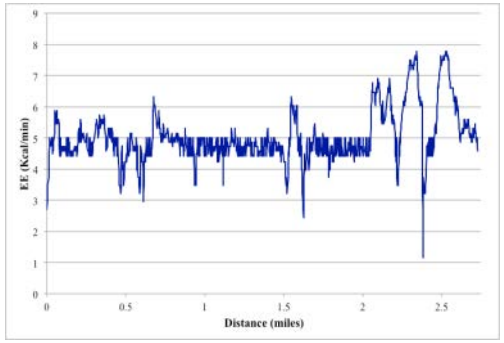
Equipment:

- 2 E-bikes and 2 R-bikes
- Addition of Quarq SRAM S2275 MTB power meter (power supplied by user at 1s intervals).
- Garmin HR monitors (also record at 1s).
- Garmin Edge 500 GPS

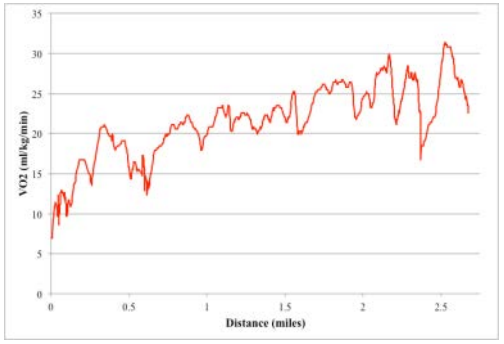

Field Tests
Traffic Signal
On-Road
Traffic Signal
Greenway

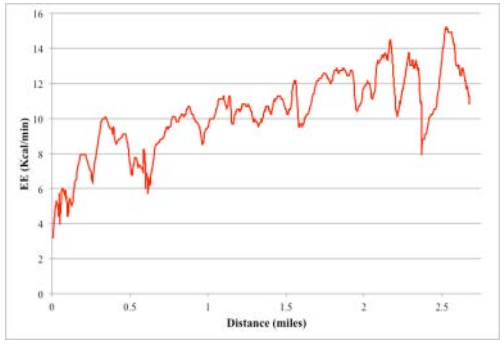
Walking Trip

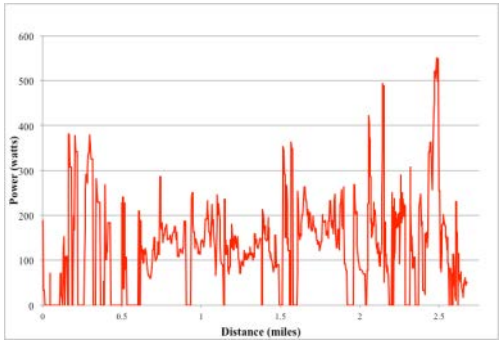




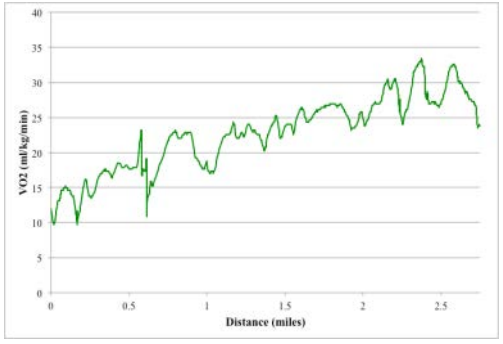
Regular Bicycle Trip

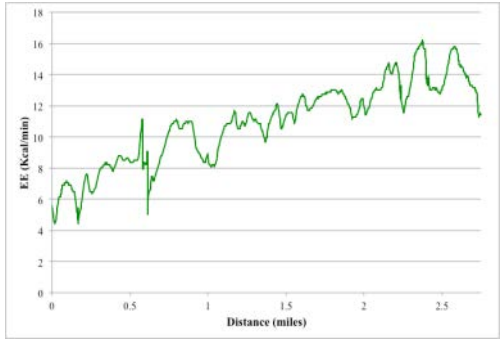


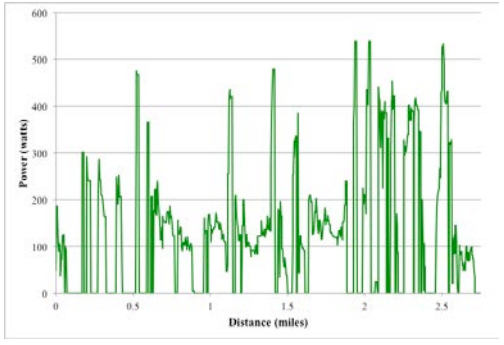




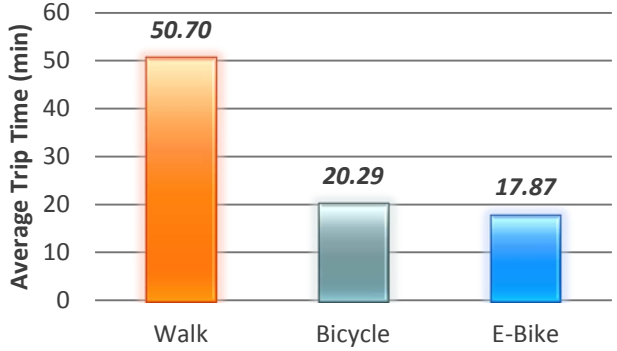
E-Bike Trip

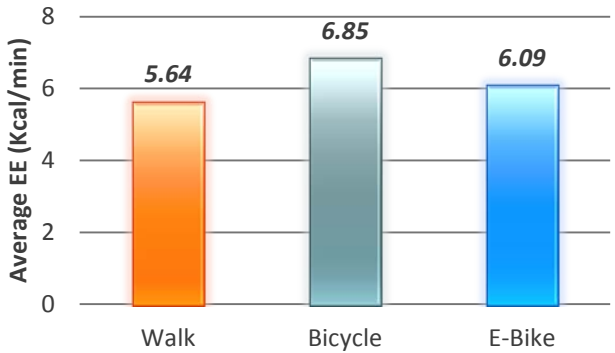


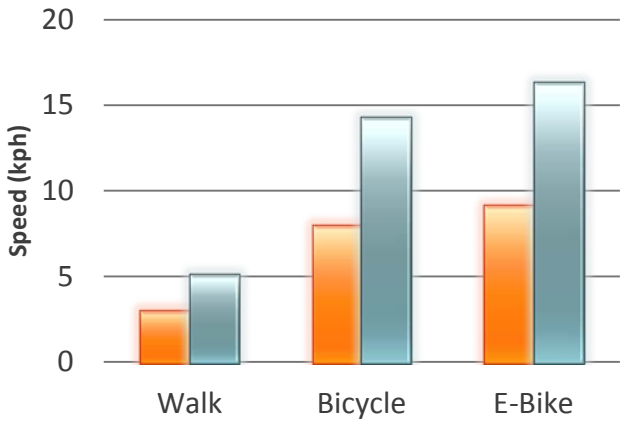


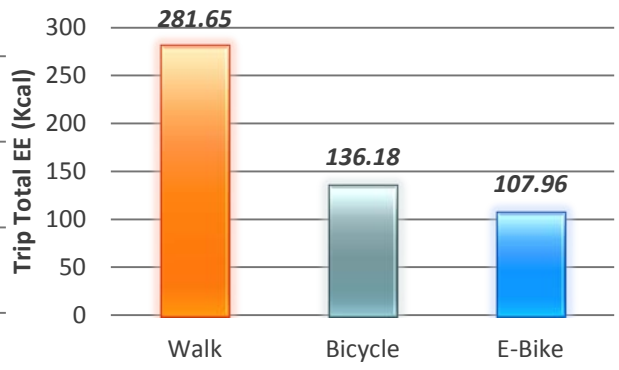


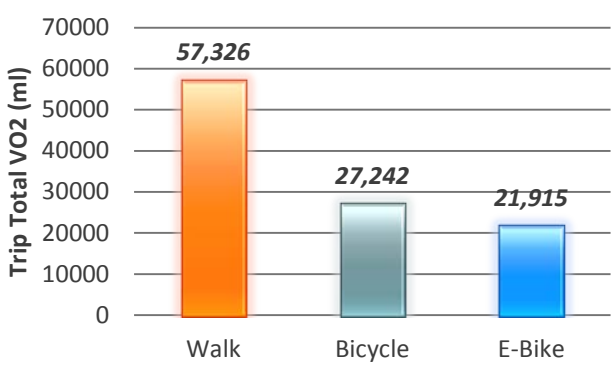
Modal Comparisons



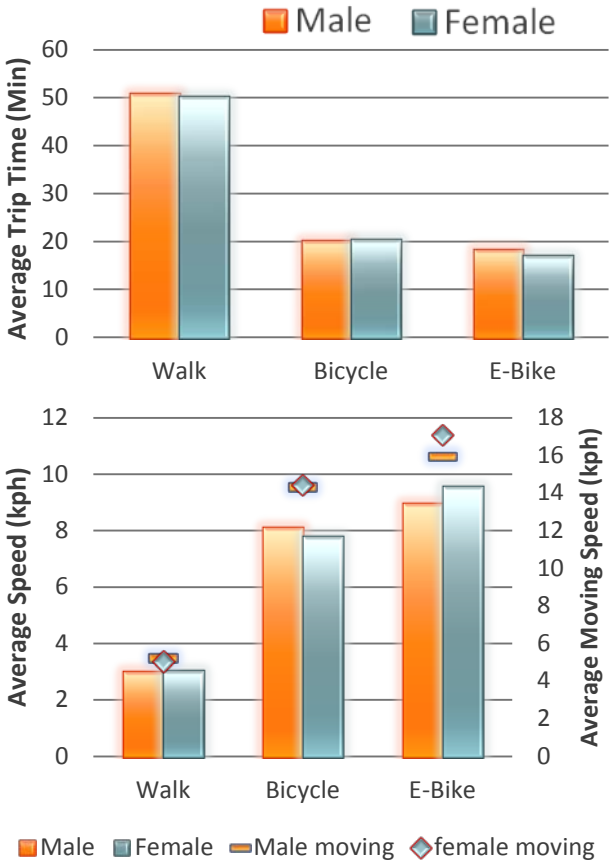


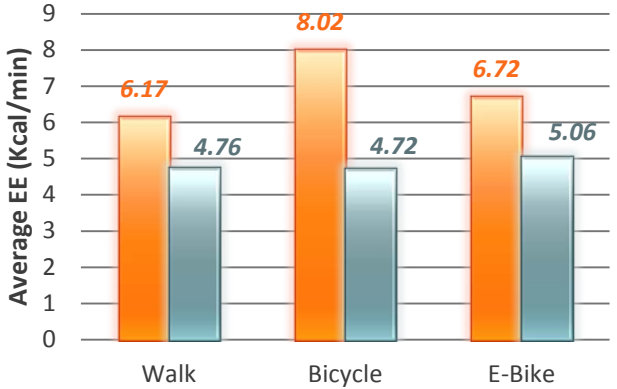


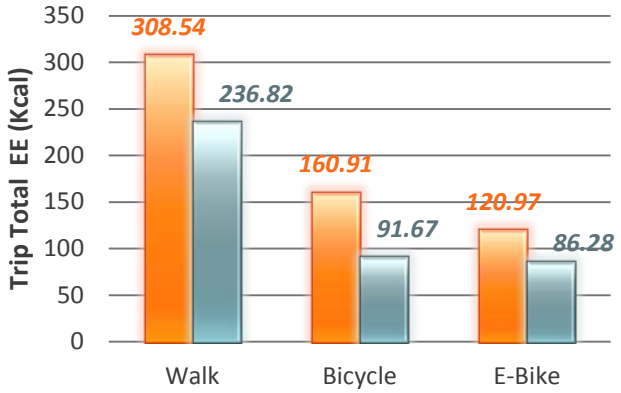




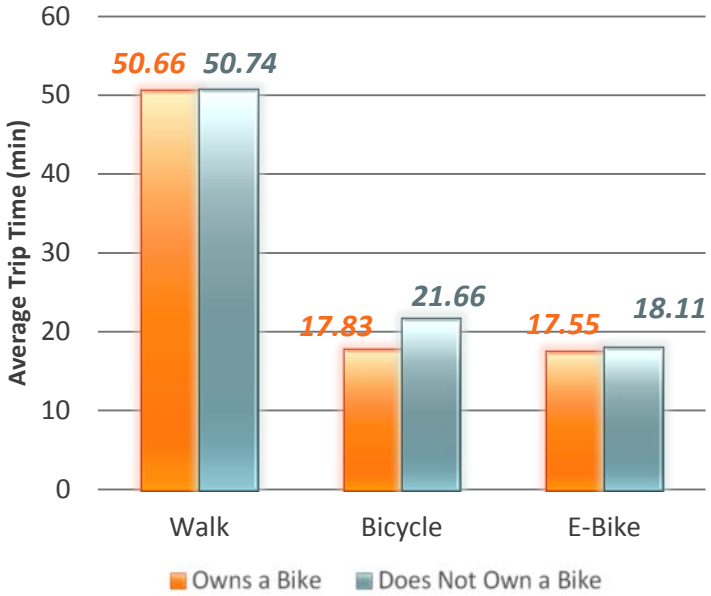
By Gender

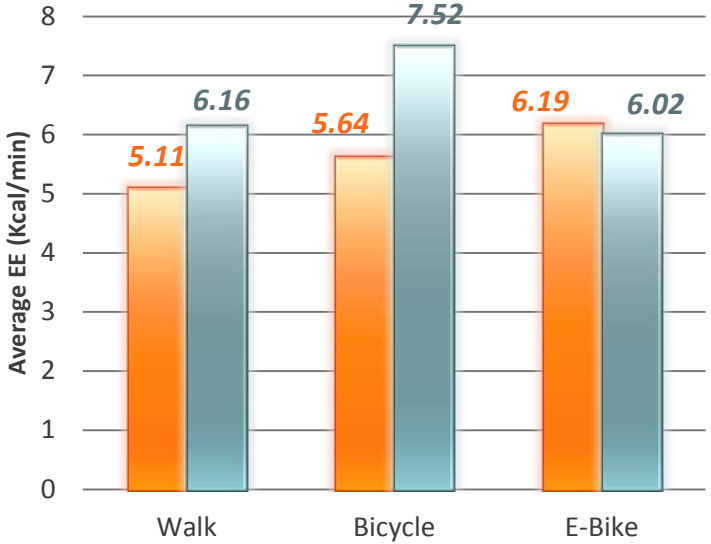

Male
Female
Average Trip Time (Min)
60
50
40
30
20
10
0
Walk
Bicycle
E-Bike
Average Speed (kph)
12
10
8
6
4
2
0
Average Moving Speed (kph)
18
16
14
12
10
8
6
4
2
0
Walk
Bicycle
E-Bike
Male
Female
Male moving
female moving


Average EE (Kcal/min)
9
8
7
6
5
4
3
2
1
0
6.17
4.76
8.02
4.72
6.72
5.06
Walk
Bicycle
E-Bike


Trip Total EE (Kcal)
350
300
250
200
150
100
50
0
308.54
236.82
160.91
91.67
120.97
86.28
Walk
Bicycle
E-Bike

Bike Owners/Non-owners



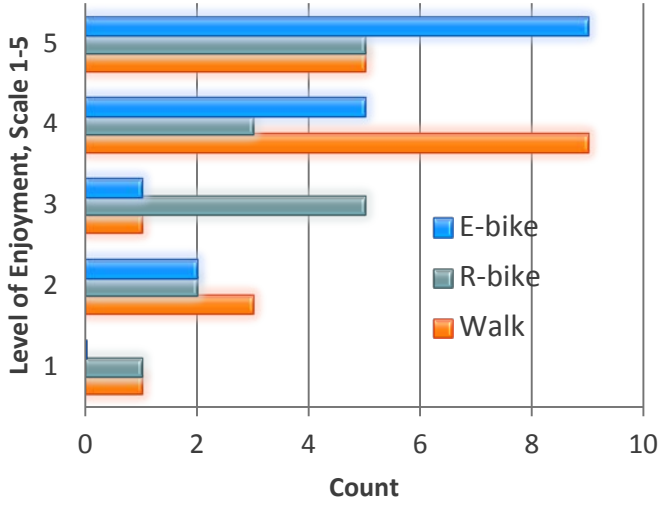


Perceived Exertion

Walking
Male: 9.1
Female: 9.9

E-Bike
Male: 9.6
Female: 9.6

Bicycle
Male: 13.3
Female: 13.7



6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

No exertion at all
Extremely light
Very light
Light
Somewhat hard
Hard
Very hard
Extremely hard
Maximal exertion

Conclusions

- E-bikes provide benefits over more sedentary travel modes.
- EE for e-bikes is closer to that for walking than for bicycling.
- Benefits can vary depending on the user.
- Low energy demand, high enjoyment and performance could lead to more trips by active transportation.
- Additional, naturalistic studies needed.

Thank you!

Casey Langford, PhD

Special Projects Coordinator

Center for Transportation Research

University of Tennessee, Knoxville

casey.langford@tn.gov | blangfo1@utk.edu

(615) 532-5824

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