E-Bikes: Impact on Physical Activity and Health

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Statement of Problem

• < 50% Americans get enough physical activity
• 66% American adults are overweight/obese
• 32% American children are overweight/obese
• CVD is the leading cause of death
Outline

• Benefits of Active Transportation
• Benefits of E-Bikes, Specifically
• Research Directions for E-Bikes
1. Benefits of Active Transportation

**Active Earth**

- Health
- Environment
- Economy
Active Transportation

Walking (3 mph) = 250 Calories/hour

Bicycling (10-12 mph) = 475 Calories/hour

Ainsworth et al. *Compendium of Physical Activities*, 2011
5-Mile Commute, Round-trip

**DRIVE**
- 25 Calories burned
- 4000 g CO₂ produced
- $5.00
- 20 min

**BIKE**
- 300 Calories burned
- 120 g CO₂ produced
- $0.50
- 40 min
Public Transit Users

- 3312 Transit users on the 2001 NHTS
- Transit users spend a median of 19 min/day walking to and from transit

Bessler and Dannenberg, AJPM 2005
E-Bikes: a new form of alternative transportation
Active Transportation and Health

Active Transportation

Health

Obesity, Diabetes Protection

CVD Protection

Social Equality

Mental Well-Being
Active Transportation & Obesity


Obesity Prevalence Based on Self-Report (%)

Walk + Bike + Transit Trips (% of Total)

USA, Australia, Canada, Ireland, France, Denmark, Finland, Germany, Sweden, Spain, Netherlands, Switzerland

Obesity Prevalence (%)
Active Commuting & Obesity
(ACS and BRFSS data)

Correlations and Regression Equations

<table>
<thead>
<tr>
<th></th>
<th>State</th>
<th>City</th>
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<tbody>
<tr>
<td>Pearson correlation</td>
<td>-0.45**</td>
<td>-0.55**</td>
</tr>
<tr>
<td>Regression equation</td>
<td>0.13–0.09 log(BW)</td>
<td>0.15–0.07 log(BW)</td>
</tr>
<tr>
<td>t test of BW coefficient</td>
<td>4.78**</td>
<td>4.41**</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.31</td>
<td>0.28</td>
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<tr>
<td>Overall F</td>
<td>22.89**</td>
<td>19.44**</td>
</tr>
<tr>
<td>No.</td>
<td>50</td>
<td>47</td>
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Pucher et al. AJPH, 2010
Active Transportation & Body Weight

• 30 studies on active transportation and body weight (from Europe, N. America, Australia, New Zealand, & other nations)

• Conclusion: based on cross-sectional studies, active transportation is associated with a lower body weight

Motorized Transportation and Obesity

• 4741 Chinese adults (20-55 yrs)
• Chinese men who acquired a motor vehicle between 1989 and 1997 gained 1.8 kg more weight

Bell & Popkin. The Road to Obesity or the Path to Prevention. Motorized Transportation and Obesity in China, *Obes Res*, 2002
Active Transportation and CVD Risk

- Shanghai Women’s Health Study (1997-2004)
- Average follow-up 5.7 yr (n= 67,143)
- Exercise and cycling for transportation indep. and inversely related to mortality (p<0.05)

But, Air Pollution is a Concern

- Air pollution contributed to 1.2 million premature deaths in 2010, in China
- Ultra-fine particulate (UFP) matter is the 4th leading cause of death in China
- Data obtained from “2010 Global Burden of Disease”, published in The Lancet

Health Effects Institute Perspectives Report, 2013, reported in NY Times, April 3, 2013
Riding in Cars and CVD Risk

Bike Commuters are the Happiest

Oliver Smith, Commute well-being among bicycle, car, and transit commuters in Portland, OR, Portland State University 2013
Commute Well-Being

Fig. 2. The commute well-being measure and its components
Cronbach’s alpha = 0.87

Social Equality-
The High Cost of Car Ownership

Consumer Reports 2012- “Over 5 years, the median cost of owning a small car like the mini-Cooper is $5,800 per year.”
Are Cars the New Tobacco?

- Private cars cause harm to public health
- Physical inactivity, obesity, death, injury from crashes, cardiorespiratory disease from air pollution, community severance, & global climate change
- The car lobby fights efforts to restrict car use, using tactics similar to the tobacco lobby

2. BENEFITS OF E-BIKES
General Benefits of e-Bikes

• Caloric expenditure (similar to pedal bikes)
• Weight management
• Reduced CVD mortality
• Less air pollution
• Less expensive than a car
Vehicle Weight

- Honda Accord, 3297 lb
- E-bike, 50 lb
Specific Benefits of E-bikes

• Reduced physical exertion
• Pedaling assist on hills
• Extends the range of trip distances
Energy demand of walkers and riders of electric-assist bicycles and traditional bicycles
B. C. Langford, C. Cherry, E.C. Fitzhugh, D.R. Bassett

Background:
• Little knowledge about the role of e-bikes as active transportation.
• Electric assist bicycles (e-bikes) have emerged as a sustainable, alternative form of transportation.

Purpose:
• To evaluate the physical activity of bicycling, e-bike riding, and walking, in the context of a bicycle and e-bike sharing system.
Study Participants:

- 19 volunteers (initially)
- Must be users of cycleUshare

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<tr>
<td>Female</td>
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<td>20-25</td>
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<td>26-30</td>
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<td>41-50</td>
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<td>&gt;50</td>
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<td>Minorit</td>
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<table>
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<tr>
<th>Other:</th>
<th>N</th>
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<tbody>
<tr>
<td>Own/have access to a bike</td>
<td>9</td>
</tr>
<tr>
<td>Own a car</td>
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<table>
<thead>
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<th>BMI</th>
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<tr>
<td>Male</td>
<td>26.11</td>
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<tr>
<td>Female</td>
<td>22.44</td>
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Study Design – Field Tests:

Equipment for testing:
• 2 E-bikes and 2 R-bikes matching those used in e-bike share.
• Quarq power meter
• Garmin HR monitor

Exercise:
• Participants completed identical trips on e-bike, r-bike and walking.
• 2.75 mile loop including variety of terrain and facilities.
## Results:

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<th>Travel Mode&lt;sup&gt;a,b&lt;/sup&gt;</th>
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<tbody>
<tr>
<td></td>
<td>Walking</td>
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<tr>
<td><strong>Average Power (watts)</strong></td>
<td>N/A</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td><strong>Heart Rate (bpm)</strong></td>
<td>115.19</td>
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<td></td>
<td>(17.58)</td>
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<tr>
<td><strong>VO2 (ml/kg/min)</strong></td>
<td>14.72</td>
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<tr>
<td></td>
<td>(5.76)</td>
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<tr>
<td><strong>REE (Kcal/min)</strong></td>
<td>5.73</td>
</tr>
<tr>
<td></td>
<td>(2.67)</td>
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<tr>
<td><strong>Average Speed (kph)</strong></td>
<td>4.92</td>
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<td></td>
<td>(1.51)</td>
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<sup>a</sup> Standard deviations shown in parenthesis.

<sup>b</sup> Comparisons of means are significant at 99% confidence level across all categories.
Paul Frymier, PhD
Emile and Teresa Catignani
3. FUTURE RESEARCH DIRECTIONS
Future Research Directions

• Cross-sectional studies to determine if e-bike users are healthier than others
• Longitudinal studies to determine if new e-bike users become healthier over time
• Safety of e-bike use
• Studies to determine if rural users would adopt e-bikes
Regular Physical Activity and Obesity Prevention

- Regular physical activity reduces weight gain, based on longitudinal studies.
- Over decades, these small reductions in excess weight gain accumulate into net savings that are quite significant.

Commuting, Per Year

**DRIVE**
- 6,250 Calories burned
- 1000 kg CO$_2$ produced
- $2,250
- 83 hr driving

**BIKE**
- 75,000 Calories burned
- 30 kg CO$_2$ produced
- $112
- 167 hr cycling
Access to Healthy Foods and Jobs

EatRightRacine.org

www.oregonlive.org