UC ANR Nutrition Policy Institute
Brown Bag Seminar Series

Role of Transportation and Land Use in Obesity

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February 1, 2018

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Transportation, land use, and obesity
Empirical evidence and emerging opportunities

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February 1, 2018
Outline

• Personal interests and approach
• What do we know?
  – Transportation elements
    • Street connectivity and walking
    • Traffic
    • Infrastructure
  – Land development elements
    • Land use, density
  – The package of the above
• Emerging opportunities
Background

• City planning and health
• Affiliations and experience
<table>
<thead>
<tr>
<th>Fundamental</th>
<th>Intermediate</th>
<th>Proximate</th>
<th>Individual</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural environment</td>
<td>Built environment</td>
<td>Stressors/ supports</td>
<td>Social &amp; demographic</td>
<td>Behaviors</td>
</tr>
<tr>
<td>Macro-social</td>
<td>Social context, policy</td>
<td>Social support</td>
<td>Efficacy</td>
<td>Well-being</td>
</tr>
</tbody>
</table>

Adapted from Northridge et al, 2003 and Stokols, 1992
Social determinants of behavior

Adapted from Northridge et al, 2003 and Stokols, 1992
Street connectivity and sidewalks

- Higher connectivity: shorter distances; safety from traffic
- RESIDE project, Perth (AU) Knuiman et al 2014
  - n=1813 participants into 73 new developments, 2003–2012
  - Street connectivity associated with higher walking

Image source: Boeing, 2017

Street connectivity and sidewalks

• Higher connectivity: shorter distances; safety from traffic

• RESIDE project, Perth (AU) Knuiman et al 2014
  – n=1813 participants into 73 new developments, 2003–2012
  – Street connectivity associated with higher walking
  – Yet
    • “In low-density cities such as in Australia, installing sidewalks in established neighborhoods as a single intervention is unlikely to cost-effectively improve health” Veerman et al 2016
  – In dense areas, with mixed uses, key
Traffic

- High traffic around home associated with higher obesity in children Jerrett et al 2010
  - N=3318 So Cal children, 9–10 yrs. old at baseline (1993–96); followed until they were 18 yrs. old
  - Figure shows predicted BMI difference between 90th and 10th percentile in traffic
    - 0.27 higher BMI → 5% higher BMI by age 18
    - Small effect, but breadth of impact relevant

Image source: Jerrett et al, 2010

Cycling infrastructure

- **Commuting and Health in Cambridge Study** Mytton et al 2016
  - 2009–2012; n=809 adults
  - Maintenance of active commuting over one year had 1.14 lower BMI at the end of that year
    - Adjusting for socio-demographics; walking; well-being; other physical activity

Source: Monsere et al, 2012

Cycling infrastructure

• New bicycle lanes in Salt Lake City, Brown et al, 2016
  – Tracked bicycling activity over two years using accelerometers and GPS loggers
    • Pre–post construction, n=536 adults (MAPS study)
  – Greater use of a urban bicycle lane related to lower BMI and more calories burned

Source: Transportation for America, 2017
Mass transit

- In US, transit walkers added a median of 21 minutes daily while walking to and from transit Freeland et al 2013
  - Roughly 99 calories per day

Mass transit

• Pre- and post-construction studies:
  – Charlotte Lynx, MacDonald et al 2010
  • Lower BMI, lower obesity for new LRT users

Table 3. Effects of using LRT on changes in BMI and physical activity

<table>
<thead>
<tr>
<th>Estimate</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (change T2–T1)</td>
<td>$-1.18$ ($-2.22$, $-0.13$)</td>
</tr>
<tr>
<td>OR (95% CI)</td>
<td></td>
</tr>
<tr>
<td>Obesity (change T2–T1)</td>
<td>0.19 ($0.04$, $0.92$)</td>
</tr>
<tr>
<td>Met walking physical activity (change T2–T1)</td>
<td>1.36 ($0.39$, $4.73$)</td>
</tr>
<tr>
<td>Met vigorous physical activity (change T2–T1)</td>
<td>3.32 ($0.81$, $13.63$)</td>
</tr>
</tbody>
</table>

Note: Baseline plans to use LRT (=1) and race (black=1) were controlled for.
B, linear coefficient; LRT, light rail transit

Source: MacDonald et al, 2010
Mass transit

• Pre– and post–construction studies
  – Charlotte Lynx, MacDonald et al 2010
    • Lower BMI, lower obesity for new LRT users
  – Salt Lake City, Brown et al 2015
    • New users
      – Lower BMI
      – More moderate or vigorous physical activity
    • Former (bus) users
      – Gained weight
      – Were more sedentary, engaged in less activity

Source: Brown et al, 2015

Cars

- California ecological analysis, at county level

Time spent commuting and miles traveled associated with higher obesity

Source: Lopez-Zetina et al, 2006

Land development

• Mixing of land uses
  – Recent review of 92 studies
    • “Land use mix and urban sprawl were more consistently associated with overweight or obesity than other physical environmental factors” Mackenbach et al 2014

• Density
  – An antithesis to “sprawl”
  – Cost effectiveness of destinations, sidewalks
Bringing transportation and land development together: The “package”

• Walkability
  – Density, land use mix, connectivity, safety, overall location
  – As a score or index (walkscore®, walkability index, etc.)

• IPEN 17 city, 12–country study, n=14,222
  – Walkability index negatively related to odds of being overweight/ obese and to BMI De Bourdeaudhuij et al 2015
Bringing transportation and land development together: The “package”

• NIK study
  – n=730 families
  – Seattle and San Diego

<table>
<thead>
<tr>
<th>Nutrition Environment (NE)</th>
<th>Physical activity Environment (PAE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-High Ob* 7.7%</td>
<td>Ob 15.9%</td>
</tr>
<tr>
<td>23.7%</td>
<td>Ow 31.7%</td>
</tr>
<tr>
<td>Low-Low Ob 7.7%</td>
<td>Ow† 31.7%</td>
</tr>
</tbody>
</table>

Adjusting for parent weight status, race/ethnicity, income, household size, etc.

*p=0.02
†p=0.08

Bringing transportation and land development together: The “package”

- MESA study Hirsch et al 2014
  - Baltimore, Chicago, Forsyth County, Los Angeles, New York, St. Paul
  - n= 5506 adults, 45–84 without CVD at baseline
  - BMI and WC assessed at baseline (2000–2) and four subsequent visits (2010–12)
  - Development intensity associated with less pronounced increase BMI, decrease in WC

Adjusting for age, gender, race/ethnicity, education, income, employment, marital status, car ownership, health status, cancer, alcohol, smoking, and time in transport

<table>
<thead>
<tr>
<th>Density</th>
<th>Land use</th>
<th>Destinations</th>
<th>Street Pattern</th>
<th>Mass transit</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Development intensity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Connected retail centers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Public transportation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bringing transportation and land development together: The “package”

- **MESA again** Hirsch et al 2014b
  - n=subset of 701 participants that moved (2004–2012), with walkscore® (range 0–100)

<table>
<thead>
<tr>
<th>Variable; given a 10 pt walkscore change</th>
<th>Change or OR (9% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean change in mins</td>
<td>16.04 (5.12, 26.96)</td>
<td>.004</td>
</tr>
<tr>
<td>OR of meeting everybody walks</td>
<td>1.11 (1.02, 1.21)</td>
<td>.01</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean change in BMI</td>
<td>-0.06 (-0.12, -0.01)</td>
<td>.02</td>
</tr>
<tr>
<td>OR of becoming a higher BMI category</td>
<td>1.00 (0.97, 1.02)</td>
<td>.79</td>
</tr>
</tbody>
</table>

After adjusting for time-varying age, income, season, working status, health compared with others, arthritis, cancer diagnosis, and for BMI transport and leisure walking.
Bringing transportation and land development together: The “package”

• **Southern Ontario CA** Creatore et al 2016
  
  – Outcomes
    • Annual prevalence of OW and Obesity from community health survey participants 2001–2012
    • Incidence of diabetes
  
  – Exposures
    
    
    | Density | Destinations | Walkability, in quintiles |
    |---------|--------------|--------------------------|
    | Street connectivity |              |                          |

Bringing transportation and land development together: The “package”

- Southern Ontario CA

Adjusted Prevalence of Overweight and Obesity Among Adults Aged 30 to 64 Years and Living in Urban Areas, by Walkability Quintile, 2001-2012
Predominant research designs
Predominant research designs
Selected concerns

• Internal validity
  – Selectivity and confounding
  – SUTVA

• Rarely measure exposure in different contexts
  – Misattribution of exposures and behaviors
    • Including physical activity and nutrition
What we know

- People don’t spend as much time in their home neighborhood as we think they do
  - When they do, it’s physically active time

  % of physical activity duration by location and PA levels for valid records, 2008–2009, King County, WA (n=611, 1 week)

<table>
<thead>
<tr>
<th></th>
<th>Home</th>
<th>Home n/hood</th>
<th>Away</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>36</td>
<td>5.9</td>
<td>24.7</td>
</tr>
<tr>
<td>Low</td>
<td>13.5</td>
<td>2.2</td>
<td>8.5</td>
</tr>
<tr>
<td>Mod-Vig</td>
<td>1.8</td>
<td>3.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>51.3</td>
<td>11.9</td>
<td>36.9</td>
</tr>
</tbody>
</table>

- Of all MVPA time in bouts, 47% in home neighborhood

Source: TRAC Study, Hurvitz et al 2014

What we know

- Patterning by age, race/ethnicity, education

### Median Percent of Moderate to Vigorous Physical Activity (MVPA) Bout Minutes Located within Home Buffers by Sociodemographic Characteristics SOPARC Sub-Study Participants, 2009-2011 (N=217)

<table>
<thead>
<tr>
<th></th>
<th>Median % MVPA bouts in home neighborhood</th>
<th>p&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-35</td>
<td>43.3</td>
<td>0.07</td>
</tr>
<tr>
<td>36-59</td>
<td>49.3</td>
<td></td>
</tr>
<tr>
<td>60-85</td>
<td>62.7</td>
<td></td>
</tr>
<tr>
<td><strong>Race/ Ethnicity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic White</td>
<td>49.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>38.4</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>49.9</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>46.0</td>
<td></td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤High School</td>
<td>52.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Some College</td>
<td>48.3</td>
<td></td>
</tr>
<tr>
<td>College Degree</td>
<td>46.3</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Kruskal Wallis p-values

Source: Holliday, 2016
What we know

• Similar evidence emerging for adolescents, children

  – NIK study: although less than 1% time in home neighborhood, 42% of it in MVPA (35% at follow up) Kneeshaw-Price et. al., 2013; Perry, 2016

  – Substudy of ICAN (NZ): 46% of bouts were within home neighborhoods Maddison et. al., 2010

  – SPEEDY (England): 62% of all PA outdoors in home neighborhood Jones et. al., 2009

  – TAAG2 substudy (US): 26% of all MV time in home neighborhood
Implications

• Misattributing location of PA behaviors by at least 50% of PA time
• Misattributing exposures to home neighborhood environments by significant amounts
• With the prevailing designs described, we’re biasing results of studies towards the null
  – Lots of noise and exposures elsewhere
  – The effect is likely to vary by subgroup

⇒ The case for understanding built environment exposures through GPS/locational awareness
Promise or peril?

“Examining where physical activity takes place, and its correlates will help clarify relationships”
Promise or peril?

“Examining where physical activity takes place, and its correlates will help clarify relationships…”
Promise #1

- Examining people exposed to different BEs and choices that result

Home neighborhood and PA

Work neighborhood and PA
Promise #2
Promise #2

• Improved internal validity
• Ability to convey tradeoffs between environmental attributes
  – “...a pedestrian is willing to walk 2.9 min longer if the path is through Boston Common, but 3.5 min shorter if it is through Beacon Hill, all else being equal” (Guo, 2009)

  – Unsignalized arterial crossing, 73 m shorter walk (Broach and Dill 2015)

  – 1% increase in sidewalk presence on path to bus stop, 8 min longer walk (Rodriguez and Joo, 2003)
Participants

• Add-on to Trial of Activity for Adolescent Girls
  – Minneapolis, San Diego
  – Girls in control condition in 8th grade

• 532 girls eligible; 303 recruited
  – 152 in Minneapolis, 151 in San Diego

• Data collected at two time points for each girl
  – 10 & 11th grade, 11th & 12th grade
Analytic approach

- Identify walking trips and paths
- Identify alternative paths
- Characterize the path environment
- Develop variables
- Conduct analysis

Source: nolli.uoregon.edu/map/
Two alternative routes, with the attribute values held at observed mean/mode values for site.
Destinations in Minneapolis

Two alternative routes, with the attribute values held at observed mean/mode values for site
Promise # 3

- Competing risks in cities: Towards salutogenic environments in vibrant activity nodes

- To date: through modeling and simulation
- Emerging possibility: through observational studies – portable sensors of air quality and physical activity

Source: de Nazelle and Rodriguez, 2009
Thank you!

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