APPLYING EVIDENCE ON HEALTH AND BUILT ENVIRONMENT RELATIONSHIPS: HEALTH IMPACT ASSESSMENT TOOLS

Dr. Lawrence Frank, President, Urban Design 4 Health, Inc. Professor, University of British Columbia
“The Hidden Health Costs of Transportation” - Frank et al 2010
American Public Health Association
Diet and nutrition, age, gender, income, genetics, and other factors also impact weight and chronic disease and to the extent possible are controlled in analyses. Vehicle age and climate impacts emissions and air quality, and respiratory function is also impacted by a variety of factors.
Health and Built Environment Evidence to Date

1) Built environments play a role in shaping health outcomes and disparities
   a) behaviors and b) exposures
2) Environments relate with health outcomes independent of preferences or self selection
   - relationship is likely at least partially causal
3) Built environment X Health relationships vary considerably across age, income, and gender
4) Meeting physical activity guidelines and reduce risk of obesity are associated with transit use and more bikable and walkable environments
   a) reduces odds of chronic disease onset for several morbidities
   b) logically reduces demands on health care system and associated costs
4) It is both possible and timely to monetize these costs
Why Should we care?

- **Health Care Costs**
  - Changes in health care system service delivery
  - Affordable care act & Health District Planning

- **GHG Impacts and Co-Benefits**
  - Energy Security

- **Aging population need easy access to facilities**
  - Reduced response time
  - Increased efficiency of case management

- **Meeting the growing unmet demand for walkable environments**
California will see its 65-plus population more than double from 3.5 million in 2000 (10.6 percent of the state's population) to 8.2 million in 2030 (17.8 percent).

- Where will the 65-plus population live?
- Access to services, Less reliance on driving for safety reasons, Maintaining Independence

Lack of Affordable Housing in Walkable Places

- Cost of service delivery with Aging in central / walkable versus peripheral / unwalkable unbikeable places
Proximity

Connectivity

Disconnected

Connected

Crow-Fly Buffer
Network Buffer
Sample Household

Single Family Residential
Multi Family Residential
Commercial
Office
Industrial
Institutional
Greenspace/Recreational
Parking
Unknown

2 KM

1 KM
Built Environment Data Sources

BUILT ENVIRONMENT MEASURES
(Independent variables)

GIS Data Layers
- Roads, trails, bicycle facilities, sidewalks

Assessors’ / Parcel data
- Residential density, land use mix, retail FAR

Public Health
- Food locations

Transit Agencies
- Transit stops and mode

Census
- Demographic covariates

Other
- Farmers’ markets, crime

Health Facility Planners
### Comparing Two Communities

<table>
<thead>
<tr>
<th>Metric</th>
<th>Uptown Moody Park</th>
<th>Queensborough</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Residential Density (dwelling units/acre)</td>
<td>40.29</td>
<td>7.73</td>
</tr>
<tr>
<td>Mixed Use Index (range 0 – 1)</td>
<td>0.58</td>
<td>0.09</td>
</tr>
<tr>
<td>Intersection Density (per square km)</td>
<td>70.12</td>
<td>27.91</td>
</tr>
<tr>
<td>Retail Floor Area Ratio</td>
<td>0.64</td>
<td>0.30</td>
</tr>
<tr>
<td>Overall Walkability</td>
<td>4.26</td>
<td>-3.74</td>
</tr>
</tbody>
</table>
Transit Use and Physical Activity

Transit use was significantly associated with greater odds of meeting physical activity recommendations (OR=3.42; CI=2.40-4.87) by walking for transportation.

The odds of meeting 30 minute Physical Activity Recommendation is negative for additional trips as a car driver when compared to moderate walking (OR = .87; CI=0.76-0.99).

Source: LaChapelle and Frank JPAH, 2009
## Physical Activity Case Study: Estimated Costs Savings from Walkable Urban Design

<table>
<thead>
<tr>
<th>Land Use/Urban Design Characteristics</th>
<th>Change in Amount of Walking (Miles, over a two-day period)</th>
<th>Number of Persons Who Will Move from First to Second Tertile of Physical Activity</th>
<th>Annual Lives Saved</th>
<th>Present Discounted Value (In Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (median-75th percentile) High (median-95th percentile)</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Street connectivity (intersection density)</td>
<td>0.3816</td>
<td>1.1844</td>
<td>22.79</td>
<td>78.59</td>
</tr>
<tr>
<td>Retail employment density (retail 0.0652 jobs/square mile)</td>
<td>0.0652</td>
<td>0.9734</td>
<td>4.72</td>
<td>62.09</td>
</tr>
<tr>
<td>Total employment density (jobs/ 1.0648 square mile)</td>
<td>0.0019</td>
<td>1.0648</td>
<td>1.57</td>
<td>66.02</td>
</tr>
<tr>
<td>Population density (persons/ square mile)</td>
<td>0.2581</td>
<td>0.549</td>
<td>15.72</td>
<td>28.29</td>
</tr>
<tr>
<td>Distance to central business district (miles)</td>
<td>-0.8108</td>
<td>-2.5054</td>
<td>45.58</td>
<td>209.05</td>
</tr>
</tbody>
</table>
The Global Warming Gamble

Policy Levers to Reduce Transportation - Related CO2 emissions

Fuel Mix
Vehicle Efficiency
Demand
Final Map of CO2 emissions from transportation

Includes:
- Local urban form (land use mix, intersection density, retail FAR)
- Regional location (auto travel time, transit accessibility & travel time)
- Demographics
Driving 1/3 As Much in 2050

2050 Payoff Scenarios

<table>
<thead>
<tr>
<th>Major Progress</th>
<th>Technology Breakthrough</th>
</tr>
</thead>
<tbody>
<tr>
<td>47 MPG</td>
<td>61 MPG</td>
</tr>
<tr>
<td>-35% GHGs/gal</td>
<td>-65% GHGs/gal</td>
</tr>
<tr>
<td>8.4 daily VMT per capita</td>
<td>20.9 daily VMT per capita</td>
</tr>
</tbody>
</table>

Brookings Draft Report – King County
Enhancing Walk Score’s Ability to Predict Physical Activity and Active Transportation

Dr. Lawrence Frank, PhD
Professor in Population and Public Health and Urban Planning
University of British Columbia

Mr. Jared Ulmer, Senior Scientist
Urban Design 4 Health, Inc.
Implemented and tested airline versus network distance measurement for Walk Score:

- Network method resulted in stronger bivariate association (as compared to airline method) with daily minutes of moderate or vigorous physical activity**, body mass index*, obesity, overweight**, and daily time spent in an automobile**

** = p < 0.01, * = p < 0.05
## Recommended Walk Score components and weights

<table>
<thead>
<tr>
<th>Walk Score component</th>
<th>Adult</th>
<th>Senior</th>
<th>Teen</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banks</td>
<td>.04</td>
<td>.12</td>
<td>.09</td>
<td>-</td>
</tr>
<tr>
<td>Books</td>
<td>.18</td>
<td>.04</td>
<td>.10</td>
<td>-</td>
</tr>
<tr>
<td>Parks</td>
<td>.18</td>
<td>.24</td>
<td>.08</td>
<td>.16</td>
</tr>
<tr>
<td>Coffee</td>
<td>.26</td>
<td>.26</td>
<td>.23</td>
<td>-</td>
</tr>
<tr>
<td>Entertainment</td>
<td>.10</td>
<td>.11</td>
<td>.13</td>
<td>.12</td>
</tr>
<tr>
<td>Grocery</td>
<td>.04</td>
<td>.08</td>
<td>.08</td>
<td>-</td>
</tr>
<tr>
<td>Restaurants/bars</td>
<td>.04</td>
<td>.01</td>
<td>.04</td>
<td>-</td>
</tr>
<tr>
<td>Shopping</td>
<td>.05</td>
<td>.08</td>
<td>.08</td>
<td>.09</td>
</tr>
<tr>
<td>Link:node ratio</td>
<td>.10</td>
<td>.06</td>
<td>.17</td>
<td>-</td>
</tr>
<tr>
<td>Average block length</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.63</td>
</tr>
</tbody>
</table>

Note: weights sum to 1.00 for each age cohort
Vision California – Urban Footprint
Evidence based research on relationships (regression models)

- Urban Form Patterns
- Residential Density
- Land Use Mix
- Street Network Connectivity
- Retail Floor Area Ratio

- Outcomes
  - Physical activity
  - Obesity / Body Mass Index
  - Transportation patterns
  - Greenhouse gas -- CO2

Integrate findings into existing software
Calculated Outcome Changes

Neighbourhood Design Feature

Health Outcome

value X

value Y

value Z

Base Scenario A Scenario B
### King County Neighborhood Quality of Life Study (NQLS)

- **Sample**: 1,228 adults
- **Built environment inputs**: Walkability (composed of land use mix, street connectivity, net residential density, and floor-to-area ratio)
- **Spatial unit for built environment analysis**: 1-kilometer buffer of respondent’s home
- **Demographic/socioeconomic inputs**: Gender, age, education, ethnicity, number of children under 18, household income, vehicle ownership
- **Health outcomes**: BMI, objectively measured levels of physical activity, depressive symptoms, social cohesion

### SMARTRAQ Atlanta Regional Commission Household Travel Survey

- **Sample**: 16,873 participants 5 years or older
- **Built environment inputs**: Walkability (composed of land use mix, street connectivity, net residential density)
- **Spatial unit for built environment analysis**: 1-kilometer buffer of respondent’s home
- **Demographic/socioeconomic inputs**: Gender, age, education, ethnicity, number of children under 18, household income, vehicle ownership
- **Health outcomes**: BMI, transportation-related physical activity, time spent in automobiles, social cohesion
SANDAG
Healthy Works
CPPW / ARRA
Grant
Many Innovations

First large scale study to spatially match a prevalence (health outcome dataset - Calif. Health Interview Survey) with detailed parcel level built environment measures

- Piloted in San Diego County N= appx 18000

One of 3 efforts to date that have imported elasticities linking local (walkability) and regional accessibility (transit LOS) with chronic disease outcomes directly into a decision support tool

- Type II Diabetes, Cardiovascular disease, respiratory ailments along with obesity, physical activity levels

Results forthcoming in several publications

Tool operational, validated, and ready for use
Utilitarian Walkability

Made up of: Residential density, retail Floor Area Ratio, intersection density, land use mix

Regional walkability distribution, by block group
Physical Activity Inhibitors: Composite Map Methodology

Made up of the following Base Maps:
- Traffic Volume Density
- Arterial Density
- Vacant Parcels
- Physical Disorder
- Violent Crime

- To calculate the composite score:
- Each Base Map measure was given a standardized value (z-score) for each block group.
- The final composite score per block group is the average of the Base Map z-scores.
- Block groups were separated into quintiles (5 groups with equal numbers of block groups in each) based on their composite score.
- Although only the western third of the region is shown in the map, the analysis is based on all 1,762 block groups in the San Diego region.
Transportation Infrastructure Support: Composite Map Methodology

Made up of the following Base Maps:
- Access to Transit
- Sidewalks
- Non-motorized Trails Access

To calculate the composite score:
- Each Base Map measure was given a standardized value (z-score) for each block group.
- The final composite score per block group is the average of the Base Map z-scores.
- Block groups were separated into quintiles (5 groups with equal numbers of block groups in each) based on their composite score.
- Although only the western third of the region is shown in the map, the analysis is based on all 1,762 block groups in the San Diego region.
Case study – Palomar Gateway

- Neighborhood-scale, using a parcel-level tool
- Located just east of I-5 in southern Chula Vista
- 100 acres of vacant, retail, and industrial land near Palomar St, with residential to the north and south
- Identified in the City’s 2005 General Plan as one of the top locations for infill and redevelopment
- Case study will test health impacts of potential Specific Plan alternatives
Case study 1 – Palomar Gateway
# Built environment changes

RESULTS ARE PRELIMINARY AND FOR ILLUSTRATIVE PURPOSES ONLY

<table>
<thead>
<tr>
<th>Name</th>
<th>Base Scenario</th>
<th>Change Scenario</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Family DU</td>
<td>192</td>
<td>80</td>
<td>housing units</td>
</tr>
<tr>
<td>Multi-Family DU</td>
<td>155</td>
<td>1626</td>
<td>housing units</td>
</tr>
<tr>
<td>Total Population</td>
<td>884</td>
<td>3841</td>
<td>people</td>
</tr>
<tr>
<td>Residential Area</td>
<td>44.3</td>
<td>68.5</td>
<td>acres</td>
</tr>
<tr>
<td>Net Residential Density</td>
<td>7.8</td>
<td>24.9</td>
<td>units/acre</td>
</tr>
<tr>
<td>Retail Floorspace</td>
<td>370073</td>
<td>395221</td>
<td>square feet</td>
</tr>
<tr>
<td>Retail Area</td>
<td>15.7</td>
<td>7.3</td>
<td>acres</td>
</tr>
<tr>
<td>Retail FAR</td>
<td>0.5</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Office Floorspace</td>
<td>0</td>
<td>41238</td>
<td>square feet</td>
</tr>
<tr>
<td>Office Area</td>
<td>0</td>
<td>1.2</td>
<td>acres</td>
</tr>
<tr>
<td>Office FAR</td>
<td>0</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Civic and Education Floorspace</td>
<td>0</td>
<td>20035</td>
<td>square feet</td>
</tr>
<tr>
<td>Recreation and Entertainment Floorspace</td>
<td>0</td>
<td>68393</td>
<td>square feet</td>
</tr>
<tr>
<td>Park Area</td>
<td>1.2</td>
<td>1.2</td>
<td>acres</td>
</tr>
<tr>
<td>Number of Schools</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Number of Transit Stops</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Number of Grocery Stores</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total Road Centerline Miles</td>
<td>4.2</td>
<td>4.2</td>
<td>miles</td>
</tr>
<tr>
<td>Total Sidewalk Miles</td>
<td>4.5</td>
<td>5.5</td>
<td>miles</td>
</tr>
<tr>
<td>Sidewalk Coverage</td>
<td>53%</td>
<td>66%</td>
<td></td>
</tr>
<tr>
<td>Total Bike Miles</td>
<td>0.5</td>
<td>1.2</td>
<td>miles</td>
</tr>
</tbody>
</table>
## Change in health outcomes

<table>
<thead>
<tr>
<th>Name</th>
<th>Base Scenario</th>
<th>Change Scenario</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Transportation Walking</td>
<td>6.1</td>
<td>10.2</td>
<td>minutes per adult per day</td>
</tr>
<tr>
<td>Adult Leisure Walking</td>
<td>8.4</td>
<td>8.9</td>
<td>minutes per adult per day</td>
</tr>
<tr>
<td>Adult Leisure Moderate Physical Activity</td>
<td>17.3</td>
<td>18.4</td>
<td>minutes per adult per day</td>
</tr>
<tr>
<td>Adult Time in Private Automobiles</td>
<td>49.0</td>
<td>44.9</td>
<td>minutes per adult per day</td>
</tr>
<tr>
<td>Adult Body Mass Index</td>
<td>28.0</td>
<td>27.6</td>
<td></td>
</tr>
<tr>
<td>Adults Overweight or Obese</td>
<td>69%</td>
<td>67%</td>
<td></td>
</tr>
<tr>
<td>Adults Obese</td>
<td>33%</td>
<td>32%</td>
<td></td>
</tr>
<tr>
<td>Adults with Type 2 Diabetes</td>
<td>8.6%</td>
<td>7.8%</td>
<td></td>
</tr>
<tr>
<td>Adults with High Blood Pressure</td>
<td>31%</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>Adult Self-Rated General Health</td>
<td>3.2</td>
<td>3.3</td>
<td>scale of 1-5 (poor-excellent)</td>
</tr>
<tr>
<td>Adults Visiting a Park in the Last 30 Days</td>
<td>57%</td>
<td>59%</td>
<td>in past month</td>
</tr>
<tr>
<td>Teen/child transportation walking</td>
<td>4.4</td>
<td>5.2</td>
<td>minutes per child/teen per day</td>
</tr>
<tr>
<td>Teens walking to/from school</td>
<td>44%</td>
<td>47%</td>
<td></td>
</tr>
<tr>
<td>Teen moderate/vigorous physical activity</td>
<td>3.87</td>
<td>3.92</td>
<td>days with at least 60 minutes per teen per week</td>
</tr>
<tr>
<td>Teen body mass index</td>
<td>23.2</td>
<td>23.0</td>
<td></td>
</tr>
<tr>
<td>Teen park visitation</td>
<td>31%</td>
<td>36%</td>
<td>in past month</td>
</tr>
<tr>
<td>Children walking to/from school</td>
<td>19%</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>Child body mass index</td>
<td>20.9</td>
<td>20.7</td>
<td></td>
</tr>
<tr>
<td>Child park visitation</td>
<td>5.7</td>
<td>6.7</td>
<td>days per child per month</td>
</tr>
<tr>
<td>Pedestrian/bicycling risk factor</td>
<td>46.7</td>
<td>47.0</td>
<td>scale of 1-100 (low-high)</td>
</tr>
</tbody>
</table>
Case study 2 – South Bay BRT

- Regional-scale, using an MGRA-level tool
- Analysis will identify the health impacts of introducing BRT and transit-oriented development along the South Bay BRT corridor
Contact with Nature

• Healing power of nature suggests a key feature of health districts will need to be green space
  – Designated park space
  – Key corridors linking health facilities, shops and services, and homes

• Raises economic challenge over competition for space and who pays for cost of green space

• Enhanced walking environments and green space improvements will increases land value and impact affordability
Conclusions

- Evidence is quickly mounting on the health impacts of community design.
  - The ability to apply the evidence is also growing.
- There is a latent demand for walkable places.
  - More research is needed to understand the type of gaps between supply of and demand for residential environments.
- Designing communities that fully integrate health care is essential to meet health and environmental goals of the 21rst Century.
“If We Want More Evidence Based Practice We Need More Practice Based Evidence”

Dr. Larry Green