INTEGRATING HEALTH INTO SCENARIO PLANNING

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University of British Columbia
The Global Warming Gamble

Policy Levers to Reduce Transportation-related CO2 emissions

- Fuel Mix
- Vehicle Efficiency
- Demand
Outline

• Need for evidence based tools to evaluate health impacts of land development and transportation investments
  – HIA’s to date are largely qualitative
• Leveraging large scale data collection efforts funded by NIH and other entities over past decade
• Scenario planning provides an opportunity to incorporate health impacts
  – Varying scales of analysis
• Two UD4H approaches to health modeling in California
  – CommunityViz – California and Toronto
  – Vision California (Urban Footprint)
Scenario planning overview

- Scenario planning is a tool for analyzing and comparing the impacts of various land use and transportation alternatives.
- Typical impacts considered include financial costs, transportation accessibility, housing availability, etc.
- Results are used to inform decision-making about infrastructure investments, master planning, development proposals, etc.
Integrating health

- Growing body of evidence documenting built environment influences on active and sedentary time from travel, recreational behavior, and diet
- Health-related outcomes and costs need to be considered when making transportation & land use decisions
- Integrating health metrics into scenario planning results in a quantitative Health Impact Assessment tool
CONCEPTUAL MODEL

Note: 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.
Translating evidence into policy

- California tools build upon previous UD4H projects:
  - Strategies for Metropolitan Atlanta’s Regional Transportation and Air Quality (SMARTRAQ)
  - Land Use, Transportation, and Air Quality (LUTAQ) study in Puget Sound region, WA
  - Neighborhood Quality of Life Studies (National Institutes of Health)
- Canadian Scenario Planning Tool
  - Toronto Application
The Hidden Health Costs of Transportation

Kavage, Frank, and Kolian 2010
American Public Health Association
Tool Development

- Select test areas
- Gather/enter input data (demographics & built environment)
- Review and compare outcomes across scenarios
- Modify tool as needed

- Develop tool
- Add elasticities
- Develop user interface

- Determine association of outcomes with built environment & demographics
- Create elasticities, which describe the magnitude and direction of change outcomes

- Review, clean, organize data
- Create measures, and map results
- Check variation across region
- Investigate extreme values

- Outcomes
- Demographics
- Parcels, land use
- Transportation system

Data Needs - identify and acquire

Built environment measures - create

Analysis

Tool Development

Application
Health modeling in San Diego

- A program of the County of San Diego Health and Human Services Agency
  - Funded by 2009 Communities Putting Prevention to Work (CPPW) grant and 2011 Centers for Disease Control Community Transformation Grant
- Goal was to integrate health considerations into regional land use and transportation decision making using CommunityViz scenario planning tool
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

Ministry of Education
- Schools

Public Health
- Food locations

Transit Agencies
- Transit stops and mode

Other
- Farmers’ markets, crime

Census
- Demographic covariates
Built Environment Measures

- Residential density
- Land use mix
- Non-residential floor-to-area ratio (FAR)
- Access to schools, parks, retail food outlets
- Street connectivity
- Transit level of service
- Sidewalk, bike lane, and trail coverage
- Proximity to high-volume streets
- Steep slopes
Utilitarian Walkability

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

Regional walkability distribution, by block group

Google “SANDAG Healthy Communities Atlas”
Health/activity data

- Physical activity (utilitarian & leisure)
- Body mass index, overweight/obese status
- Walking to/from school
- Type II diabetes
- High blood pressure, cardiovascular disease
- Asthma
- General health status
- Risk of pedestrian or cyclist collisions with automobiles
Directly Linking Health Surveys With Urban Form

• Difficult to get data at the address level
  – First two projects to effectively make linkage at the small area level

• One of the first efforts to be able to directly link health outcomes (e.g. diabetes and cardiovascular) with built environment measures

• Results provide a basis to predict changes in health outcomes based on changed in built environment features
Health Outcomes in CViz Tool

California Health Interview Survey data

- Amount of physical activity, leisure walking / walking to school (all age groups)
- BMI, obese / overweight likelihood (all age groups)
- Likelihood of high blood pressure, diabetes (adults)
- Likelihood of asthma (all age groups)
- General health (adults)
- Likelihood of visiting a park (adults, teens)
- Walking to school (child, teens)
- Fast food consumption (child)

Travel Related Injury SWTRS data

- Pedestrian and bicycle collision rate

SANDAG travel survey data

- Likelihood of making a walk trip (adults, youth under 16)
- Daily minutes of walking (adults, youth under 16)
- Likelihood of making a car trip
- Daily minutes of driving/ riding in a car
Key findings

• Features most commonly associated with better health: park accessibility, intersection density, residential density, floor-to-area ratio, transit accessibility, sidewalk coverage, grocery store accessibility, school accessibility

• Feature most commonly associated with poor health: traffic volume density

• Mixed land use index was often related to more utilitarian walking and less car travel but less leisure physical activity
Palomar Gateway Case Study

- 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 tested health impacts of potential Specific Plan alternatives
## 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>
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<tr>
<td>Total Population</td>
<td>884</td>
<td>3841</td>
<td>people</td>
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<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>31%</td>
<td>36%</td>
<td>in past 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>
Toronto Walkability Index

Utilitarian walkability by 1km buffered postal code

- Low
- Medium-low
- Medium-high
- High
- Public green area
- Highway
- Major road

© 2012 City of Toronto.
Data sources: City of Toronto Geospatial Competency Centre; MPAC
(see full report for source files, licenses, and restrictions)
West Don Lands (Toronto) Example

Pilot study site for software tool application:
- Substantial planning already done
- 80 acres
- Significant changes in built environment
  - dense/mixed use development
  - 6000-6500 housing units
  - 1 million sq ft of office/retail
  - 2 new streetcar stops
  - new park space
- Redevelopment is part of revitalizing Toronto's waterfront
- Site of athlete’s village for Pan American Games (2015)
### Steps 1-2. Prepare and Add Data

**Data preparation**

1. **Data type**
   - Postal code boundaries with built environment measures
2. **Used to Measure**
   - Residential density
   - Land use mix
   - Retail floor area ratio
   - Office floor area ratio
   - Walkability index

<table>
<thead>
<tr>
<th>Data type</th>
<th>Used to Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postal code boundaries</td>
<td>Residential density</td>
</tr>
<tr>
<td>with built environment</td>
<td>Land use mix</td>
</tr>
<tr>
<td>measures</td>
<td>Retail floor area ratio</td>
</tr>
<tr>
<td></td>
<td>Office floor area ratio</td>
</tr>
<tr>
<td></td>
<td>Walkability index</td>
</tr>
<tr>
<td>Bicycle facilities</td>
<td>Metres of bicycle facilities</td>
</tr>
<tr>
<td>Trail network</td>
<td>Metres of trails</td>
</tr>
<tr>
<td></td>
<td>Metres of bicycle facilities and trails</td>
</tr>
<tr>
<td>Food retail locations</td>
<td>Supermarket density</td>
</tr>
<tr>
<td></td>
<td>Convenience store density</td>
</tr>
<tr>
<td></td>
<td>Farmer market density</td>
</tr>
<tr>
<td></td>
<td>Restaurant density</td>
</tr>
<tr>
<td></td>
<td>Take-out restaurant density</td>
</tr>
<tr>
<td>Parks</td>
<td>Park area</td>
</tr>
<tr>
<td>Road network</td>
<td>Metres of all walkable roads</td>
</tr>
<tr>
<td></td>
<td>Number of intersections</td>
</tr>
<tr>
<td></td>
<td>Intersection density</td>
</tr>
<tr>
<td></td>
<td>Crow-fly distance to nearest major arterial</td>
</tr>
<tr>
<td>School locations</td>
<td>Network distance to nearest school</td>
</tr>
<tr>
<td></td>
<td>School density</td>
</tr>
<tr>
<td>Sidewalk network</td>
<td>Sidewalk coverage</td>
</tr>
<tr>
<td>Transit stops</td>
<td>Network distance to nearest transit stop</td>
</tr>
<tr>
<td></td>
<td>Transit stop density</td>
</tr>
</tbody>
</table>

**Loading data**

**Define the analysis area**

**Build the future (change) scenario(s)**

**Report existing/future conditions**

**Review results and adjust scenarios as necessary**
Comparing Scenarios – West Don Lands Example

West Don Lands Place Types
- Undeveloped postal code
- Mill Street neighbourhood
- Front Street neighbourhood
- Don River Park neighbourhood
- Don River Park neighbourhood (park)
- River Square neighbourhood

Built environment features
- Transit stop
- School
- Road
- Bicycle facility
- Trail
Outcome Changes – West Don Lands

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Study Area*</th>
<th>Impacted Area**</th>
<th>City**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base</td>
<td>Future</td>
<td>Base</td>
</tr>
<tr>
<td>average <strong>active trips</strong>/person/day</td>
<td>0.2</td>
<td><strong>0.4</strong></td>
<td>0.4</td>
</tr>
<tr>
<td>average <strong>transit trips</strong>/person/day</td>
<td>0.6</td>
<td><strong>0.7</strong></td>
<td>0.7</td>
</tr>
<tr>
<td>average <strong>automobile trips</strong>/person/day</td>
<td>1.0</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>average <strong>trip kilometers</strong>/person/day</td>
<td>18.2</td>
<td>15.9</td>
<td>14.6</td>
</tr>
<tr>
<td>average <strong>CO2</strong> generated (kg/HH/day)</td>
<td>3.4</td>
<td>2.5</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>walking for exercise</strong> monthly freq.</td>
<td>14.4</td>
<td><strong>14.6</strong></td>
<td>12.0</td>
</tr>
<tr>
<td><strong>walk to work/school</strong> monthly freq.</td>
<td>7.8</td>
<td>9.8</td>
<td>10.8</td>
</tr>
<tr>
<td><strong>bicycle for exercise</strong> monthly freq.</td>
<td>1.1</td>
<td><strong>1.4</strong></td>
<td>1.2</td>
</tr>
<tr>
<td><strong>bicycle to work/school</strong> monthly freq.</td>
<td>0.8</td>
<td><strong>1.1</strong></td>
<td>1.0</td>
</tr>
<tr>
<td><strong>daily energy expenditure</strong> (kcal/kg/day)</td>
<td>2.7</td>
<td><strong>3.2</strong></td>
<td>2.8</td>
</tr>
<tr>
<td><strong>body mass index</strong></td>
<td>24.3</td>
<td>24.2</td>
<td>24.0</td>
</tr>
<tr>
<td><strong>high blood pressure</strong> (likelihood)</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

*Average of postal code values
** Population weighted average of postal code values
Vision California > Urban Footprint

- **Purpose:** to develop scenario planning tools to be used by California regions to evaluate development and infrastructure impacts on the environment, health, land use, etc.

- **Funded by the California High Speed Rail Authority in Partnership with the Strategic Growth Council**

- **Health models implemented in Calthorpe’s Urban Footprint tool**
### CALIFORNIA’S URBAN FOOTPRINT MODEL

<table>
<thead>
<tr>
<th>Data source</th>
<th>Sample</th>
<th>Built environment inputs</th>
<th>Spatial unit for built environment analysis</th>
<th>Demographic/ socioeconomic inputs</th>
<th>Health outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>King County Neighborhood Quality of Life Study (NQLS)</strong></td>
<td>1,228 adults</td>
<td>Walkability (composed of land use mix, street connectivity, net residential density, and floor-to-area ratio)</td>
<td>1-kilometer buffer of respondent’s home</td>
<td>Gender, age, education, ethnicity, number of children under 18, household income, vehicle ownership</td>
<td>BMI, objectively measured levels of physical activity, depressive symptoms, social cohesion</td>
</tr>
<tr>
<td><strong>SMARTRAQ Atlanta Regional Commission Household Travel Survey</strong></td>
<td>16,873 participants 5 years or older</td>
<td>Walkability (composed of land use mix, street connectivity, net residential density)</td>
<td>1-kilometer buffer of respondent’s home</td>
<td>Gender, age, education, ethnicity, number of children under 18, household income, vehicle ownership</td>
<td>BMI, transportation-related physical activity, time spent in automobiles, social cohesion</td>
</tr>
</tbody>
</table>
Two modeling approaches

A. Adaptation of non-California regression models to multi-region California data
B. Adaptation of published associations to multi-region California data

Both approaches were used to predict health outcomes within 150-meter grid cells resulting from different planning scenarios.
Predicted Health Outcomes

- Daily adult moderate or vigorous physical activity – objective physical activity data
- Adult body mass index
- Likelihood of adult obesity or overweight
- Likelihood of adult obesity
- Daily adult time spent in cars
- Sense of community*
- Depressive symptoms*

*Not implemented in Urban Footprint
Literature-based health models developed

- Prevalent child asthma*
- Prevalent adult rhinitis*
- Health impacts of obesity/overweight
- Pedestrian/motor vehicle collisions
- Fiscal impacts of above health conditions

*Not implemented in Urban Footprint
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.
Background on use of Walk Score

• Health researchers have been regularly using Walk Score as a measure of the built environment for study participants

• Strengths:
  • Cheap & easy to acquire
  • Available using a consistent methodology for any location in the United States

• Weaknesses:
  • Has never been calibrated/validated against objectively measured physical activity data
  • Lack of transparency regarding changes in underlying data (threatens validity of longitudinal comparisons)
Purpose of this research

- Improve methods used to measure distances used in the Walk Score calculation (Phase I)
- Calibrate Walk Score Algorithm using National Institutes of Health data from the Neighborhood Quality of Life Studies (Phase II)
  - Four age cohorts: seniors 66+, adults 20-65, teens 12-16, children 6-11
  - Multi-region NIH funded data (NQLS & TEEN PI Sallis; SNQLS PI King; NIK PI Saelens): Seattle, Baltimore, San Diego
- Validate results using external data when possible (Phase II)
  - Strategies for Metropolitan Atlanta’s Regional Transportation and Air Quality (SMARTRAQ) data for seniors and adults
- Compare ability of Walk Score to Walkability Index to predict physical activity (Phase II)
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**

\[ ** = p < 0.01, * = p < 0.05 \]
Note: Child data were inconclusive, so a simple linear distance decay function was employed.
# 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
Implications and next steps

• Both tools are finished and ready for use for local or regional planning
  – Being applied in other regions of both nations

• Immediate next steps:
  – Urban Footprint:
    • develop new models using California-specific data
  – CommunityViz
    • Create generalizability methods, validate results, apply in other regions

• Calibrate tools using widely available data
  – Improved WalkScore
  – Census Block Group Data
The Beginning!
Approach A: Regression modeling

- Project timing made use of CHIS data infeasible
- Instead, UD4H data from other regions (Seattle & Atlanta) were used to fit new regression models
- Associations between the built environment and health outcomes using these same UD4H data have been published in peer-reviewed journals:
  - American Jrnl of Preventive Medicine (Frank, 2004)
  - American Jrnl of Preventive Medicine (Frank, 2004)
  - Journal of the American Planning Assn (Frank, 2006)
  - Social Science & Medicine (Saelens, 2009)
- Regression modeling methods were similar to those used for SANDAG
Approach B: Published research

- When UD4H data did not include key variables of interest (e.g. diabetes status), models were adapted from published research.

- Example references:
Pedestrian/vehicle collisions

- VMT per capita is estimated for each planning scenario
  - Tied to built environment features
- We then use VMT per capita to predict the number of pedestrian/vehicle collisions
- A 10% reduction in vehicle miles of travel (VMT) per capita is associated with a 10% reduction in pedestrian/vehicle collisions (Ferreira 2010)
Obesity-related health conditions

- Few models exist that associate obesity-related health conditions (e.g. cardiovascular disease, diabetes) with the built environment.
- But substantial literature exists linking physical activity levels or obesity status to these health conditions.
- Thus, we can model changes in the population distribution across obesity categories, then estimate the results impact on obesity-related health conditions.
Diabetes

• Being overweight (versus normal weight) increases the diabetes risk by over 3 times. (Guh, 2009)

• Being obese (versus normal weight) increases the diabetes risk by almost 9.5 times. (Guh, 2009)

• A planning scenario with reduced prevalence of overweight and obesity will also have a reduced prevalence of diabetes.