UC ANR Nutrition Policy Institute
Brown Bag Seminar Series

Role of Transportation and Land Use in Obesity

Daniel A. Rodríguez, MS, PhD
Professor of City & Regional Planning
UC Berkeley Department of Environmental Design

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Transportation, land use, and obesity

Empirical evidence and emerging opportunities

Daniel A. Rodriguez, Ph.D.
Chancellor's Professor, City & Regional Planning
Institute for Transportation Studies

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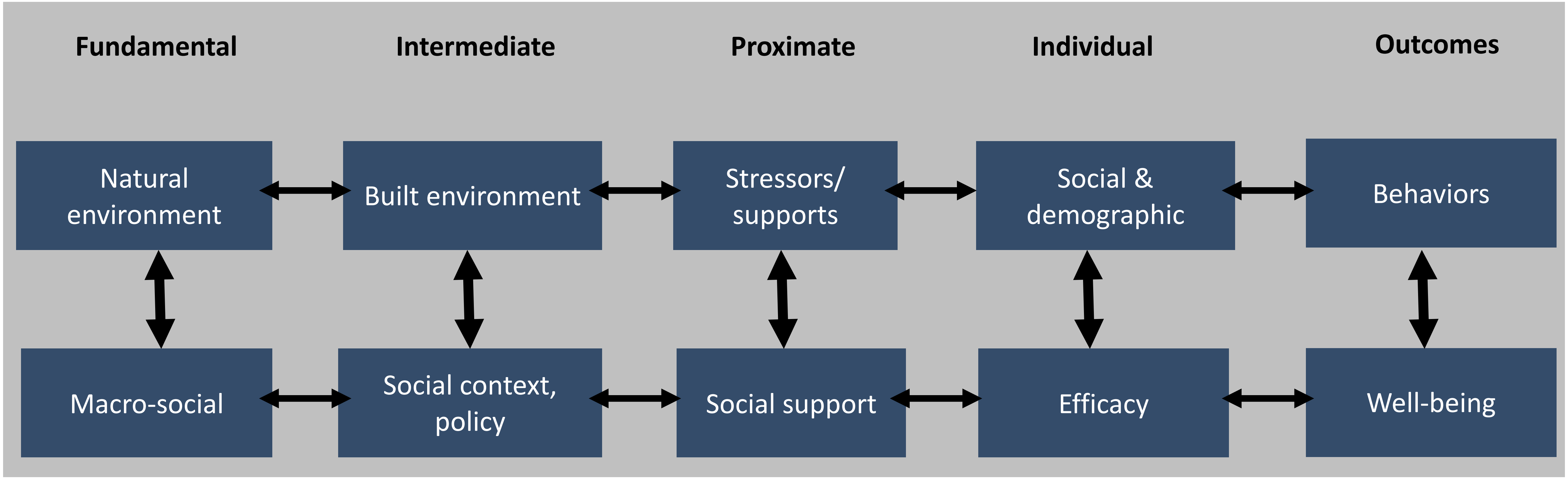
Outline

- 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

Social determinants of behavior



Adapted from Northridge et al, 2003 and Stokols, 1992

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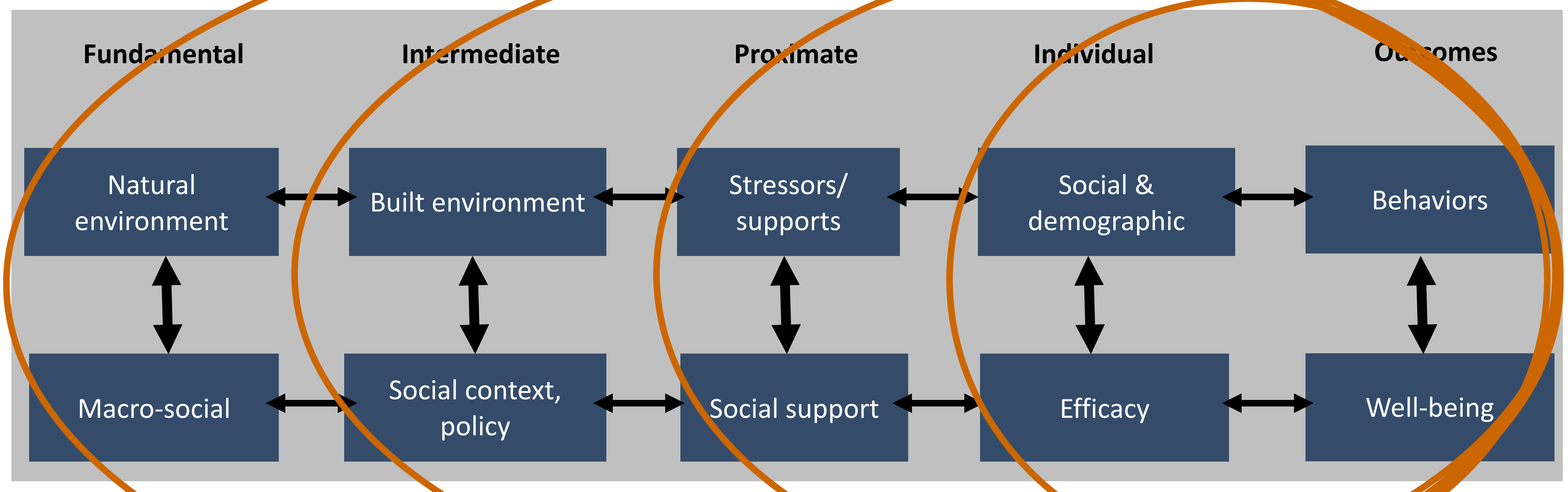
Social determinants of behavior



Adapted from Northridge et al, 20[illegible] 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

Knuiman, M. W., H. E. Christian, M. L. Divitini, S. A. Foster, F. C. Bull, H. M. Badland, and B. Giles-Corti. 2014. "A Longitudinal Analysis of the Influence of the Neighborhood Built Environment on Walking for Transportation." *American Journal of Epidemiology* no. 180 (5):453-461. doi: 10.1093/aje/kwu171.

Street connectivity and sidewalks

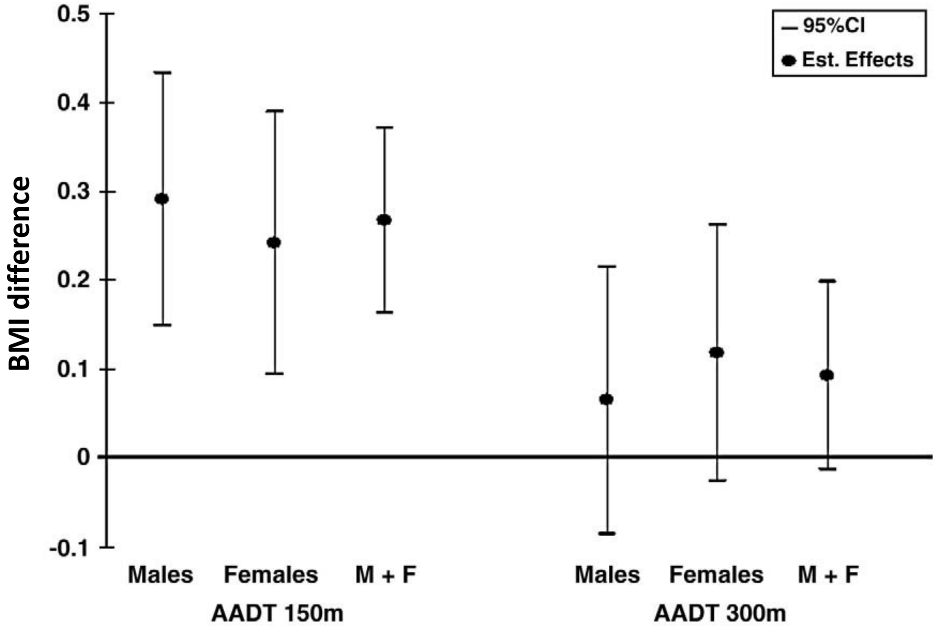
- Higher connectivity: shorter distances; safety from traffic
- RESIDE project, Perth (AU) Knuiman et al 2014
  - n=1813 participants into 73 new developments, 2003-2012
  - Street connectivity associated with higher walking
  - Yet
    - "In low-density cities such as in Australia, installing sidewalks 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

Image source: Boeing, 2017

Veerman, J. L., B. Zapata-Diomedi, L. Gunn, G. R. McCormack, L. J. Cobiac, A. M. M. Herrera, B. Giles-Corti, and A. Shiell. 2016. "Cost-effectiveness of investing in sidewalks as a means of increasing physical activity: a RESIDE modelling study." *Bmj Open* no. 6 (9). doi: 10.1136/bmjopen-2016-011617.

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

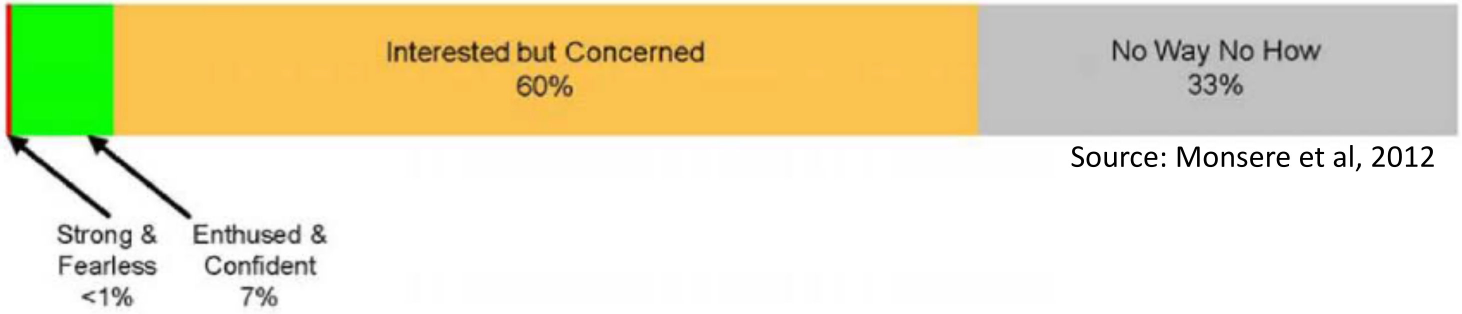


Confounders: Ethnicity/Race, Gender, Cohort variables, in addition, adjusted for Parental Education, Personal Weekly Smoking, Second Hand Smoke (Current + Past), Ever Asthma, Buffer Population, Gamma Index, Proportion of Below Poverty People within Census Block, NDVI, Foreign Born, Town Level Violent Crime Rate, and Having No Food Stores within 500m Road Network Buffer with Random Community Effects

Image source: Jerrett et al, 2010

Jerrett, M., R. McConnel, C. C. R. Chang, J. Wolch, K. Reynolds, F. Lurmann, F. Gilliland, and K. Berhane. 2010. "Automobile traffic around the home and attained body mass index: A longitudinal cohort study of children aged 10-18 years." *Preventive Medicine* no. 50:S50-S58. doi: 10.1016/j.ypmed.2009.09.026.

Cycling infrastructure



Source: Monsere et al, 2012

- 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

Mytton, O. T., J. Panter, and D. Ogilvie. 2016. "Longitudinal associations of active commuting with body mass index." *Preventive Medicine* no. 90:1-7. doi: 10.1016/j.ypmed.2016.06.014.

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

Brown, B. B., D. Tharp, C. P. Tribby, K. R. Smith, H. J. Miller, and C. M. Werner. 2016. "Changes in bicycling over time associated with a new bike lane: Relations with kilocalories energy expenditure and body mass index." *Journal of Transport & Health* no. 3 (3):357-365. doi: 10.1016/j.jth.2016.04.001.

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

Freeland, A. L., S. N. Banerjee, A. L. Dannenberg, and A. M. Wendel. 2013. "Walking Associated With Public Transit: Moving Toward Increased Physical Activity in the United States." *American Journal of Public Health* no. 103 (3):536-542. doi: 10.2105/ajph.2012.300912.

Mass transit

- Pre- and post-construction studie
  - Charlotte Lynx, MacDonald et al 2010
    - Lower BMI, lower obesity for new LRT user

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

	Estimate	*p*-value
	***B* (95% CI)**	
BMI (change T2–T1)	−1.18 (−2.22, −0.13)	0.015
	OR (95% CI)	
Obesity (change T2–T1)	0.19 (0.04, 0.92)	0.039
Met walking physical activity (change T2–T1)	1.36 (0.39, 4.73)	0.48
Met vigorous physical activity (change T2–T1)	3.32 (0.81, 13.63)	0.094

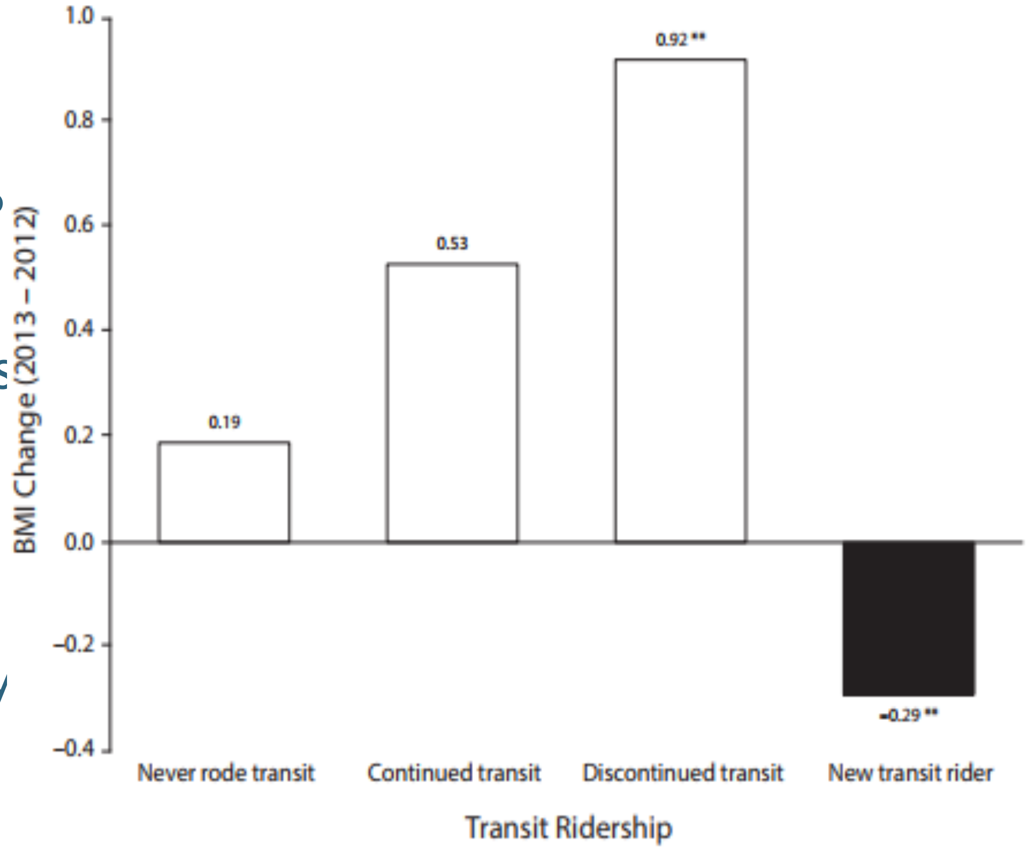
Note: Baseline plans to use LRT (=1) and race (black=1) were controlled for.
B, linear coefficient; LRT, light rail transit

Source: MacDonald et al, 2010

MacDonald, J. M., R. J. Stokes, D. A. Cohen, A. Kofner, and G. K. Ridgeway. 2010. "The Effect of Light Rail Transit on Body Mass Index and Physical Activity." *American Journal of Preventive Medicine* no. 39 (2):105-112. doi: 10.1016/j.amepre.2010.03.016.

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 activ



Note. The control group was never rode transit.
**$P < .01$.

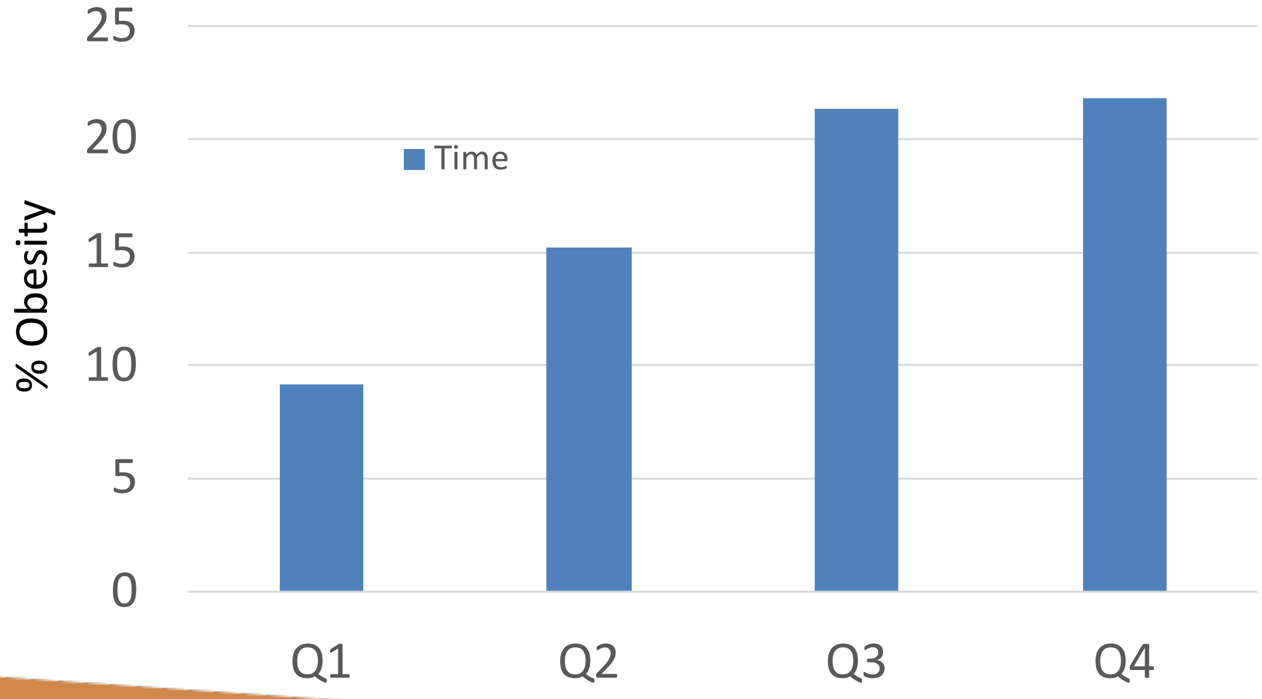
Source: Brown et al, 2015

Brown, B. B., C. M. Werner, C. P. Tribby, H. J. Miller, and K. R. Smith. 2015. "Transit Use, Physical Activity, and Body Mass Index Changes: Objective Measures Associated With Complete Street Light-Rail Construction." *American Journal of Public Health* no. 105 (7):1468-1474. doi: 10.2105/ajph.2015.302561.

Cars

- California ecological analysis, at county level

Time spent commuting and miles traveled associated with higher obesity

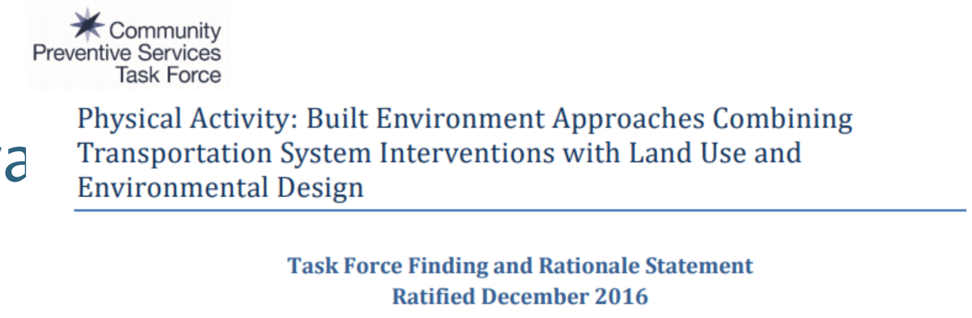


Source: Lopez-Zetina et al 2006

Lopez-Zetina, J., H. Lee, and R. Friis. 2006. "The link between obesity and the built environment. Evidence from an ecological analysis of obesity and vehicle miles of travel in California." *Health & Place* no. 12 (4):656-664. doi: 10.1016/j.healthplace.2005.09.001.

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, sidewa


Community Preventive Services Task Force

Physical Activity: Built Environment Approaches Combining Transportation System Interventions with Land Use and Environmental Design

Task Force Finding and Rationale Statement
Ratified December 2016

Mackenbach, J. D., H. Rutter, S. Compernolle, K. Glonti, J. M. Oppert, H. Charreire, I. De Bourdeaudhuij, J. Brug, G. Nijpels, and J. Lakerveld. 2014. "Obesogenic environments: a systematic review of the association between the physical environment and adult weight status, the SPOTLIGHT project." *Bmc Public Health* no. 14. doi: 10.1186/1471-2458-14-233.

Bringing transportation and land development together: The "package"

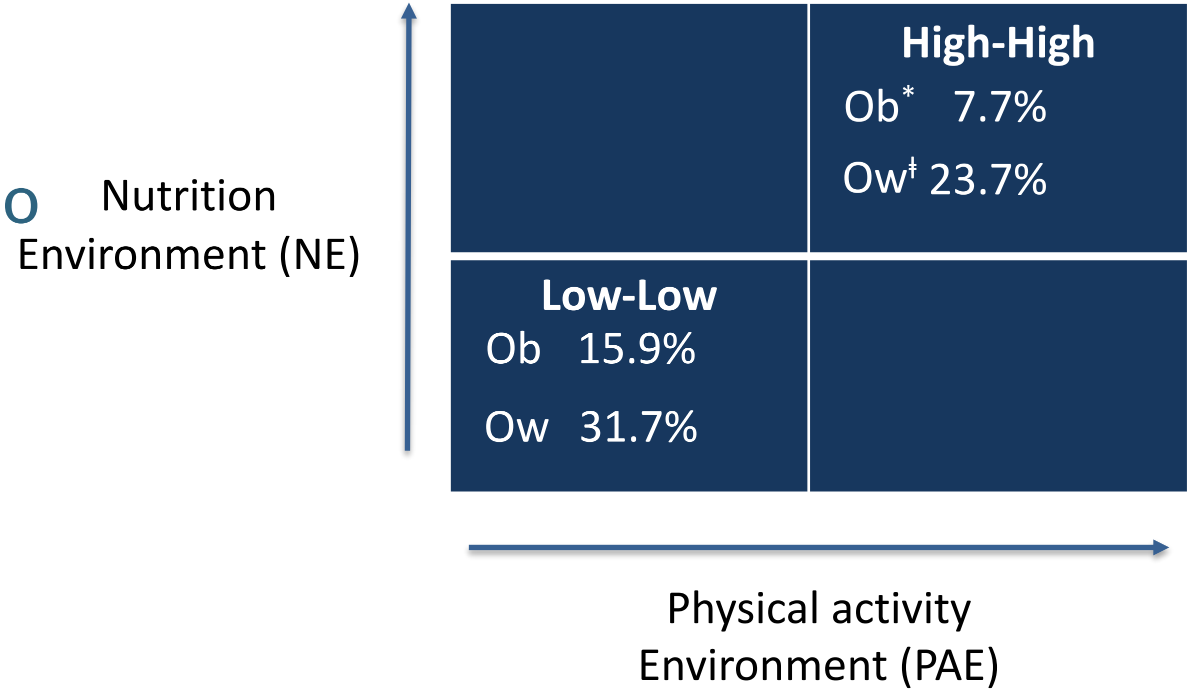
- Walkability
  - Density, land use mix, connectivity, safety, overall location
  - As a score or index (walkscore®, walkability index, etc.)

- 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

De Bourdeaudhuij, I., D. Van Dyck, D. Salvo, R. Davey, R. S. Reis, G. Schofield, O. L. Sarmiento, J. Mitas, L. B. Christiansen, D. MacFarlane, T. Sugiyama, I. Aguinaga-Ontoso, N. Owen, T. L. Conway, J. F. Sallis, and E. Cerin. 2015. "International study of perceived neighbourhood environmental attributes and Body Mass Index: IPEN Adult study in 12 countries." *International Journal of Behavioral Nutrition and Physical Activity* no. 12. doi: 10.1186/s12966-015-0228-y.

Bringing transportation and land development together: The "package"

- NIK study
  - n=730 families
  - Seattle and San Diego



Adjusting for parent weight status, race/ethnicity, income, household size, etc.
*p=0.02
ǂ p=0.08

Saelens, B. E., J. F. Sallis, L. D. Frank, S. C. Couch, C. Zhou, T. Colburn, K. L. Cain, J. Chapman, and K. Glanz. 2012. "Obesogenic Neighborhood Environments, Child and Parent Obesity The Neighborhood Impact on Kids Study." *American Journal of Preventive Medicine* no. 42 (5):E57-E64. doi: 10.1016/j.amepre.2012.02.008.

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

Density
Land use
Destinations
Street Pattern
Mass transit

- Development intensity
- Connected retail centers
- Public transportation

Hirsch, J. A., K. A. Moore, T. Barrientos-Gutierrez, S. J. Brines, M. A. Zagorski, D. A. Rodriguez, and A. V. D. Roux. 2014. "Built Environment Change and Change in BMI and Waist Circumference: Multi-Ethnic Study of Atherosclerosis." *Obesity* no. 22 (11):2450-2457. doi: 10.1002/oby.20873.

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)

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

After adjusting for time-varying age, income, season, working status, health compared with others, arthritis, cancer diagnosis, and for BMI transport and leisure walking

Hirsch, J. A., A. V. D. Roux, K. A. Moore, K. R. Evenson, and D. A. Rodriguez. 2014. "Change in Walking and Body Mass Index Following Residential Relocation: The Multi-Ethnic Study of Atherosclerosis." *American Journal of Public Health* no. 104 (3):E49-E56. doi: 10.2105/ajph.2013.301773.

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
Street connectivity

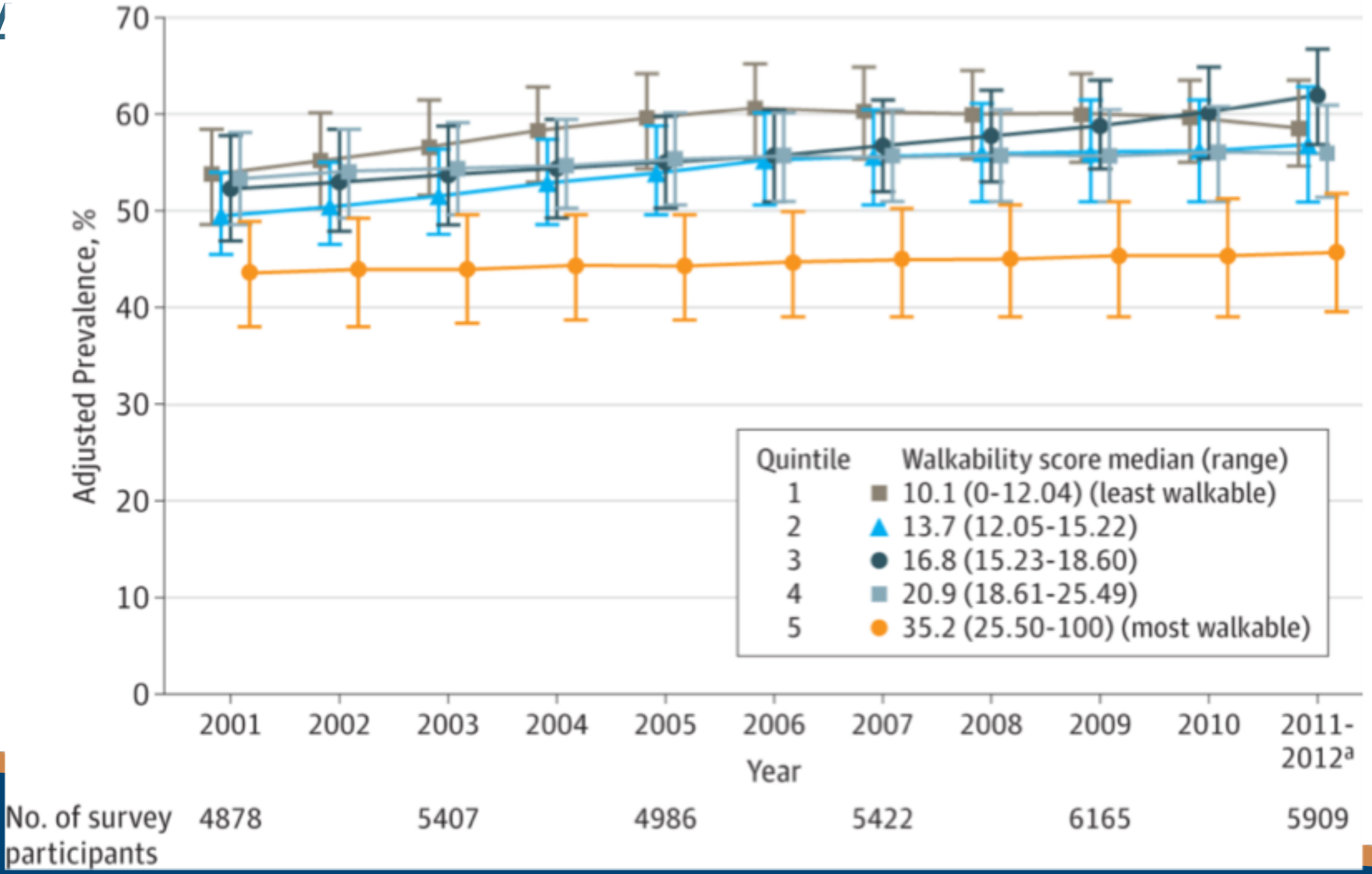
$\left.\begin{array}{l}\text{Density}\\ \text{Destinations}\\ \text{Street connectivity}\end{array}\right\}$ Walkability, in quintiles

Creatore, M. I., R. H. Glazier, R. Moineddin, G. S. Fazli, A. Johns, P. Gozdyra, F. I. Matheson, V. Kaufman-Shriqui, L. C. Rosella, D. G. Manuel, and G. L. Booth. 2016. "Association of Neighborhood Walkability With Change in Overweight, Obesity, and Diabetes." *Journal of the American Medical Association* no. 315 (20):2211-2220. doi: 10.1001/jama.2016.5898.

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



Error bars indicate 95% CIs around prevalence

Source: Creatore et al 2016

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)

	Home	Home n/hood	Away
Sedentary	36	5.9	24.7
Low	13.5	2.2	8.5
Mod-Vig	1.8	3.8	3.7
Total	51.3	11.9	36.9

Source: TRAC Study, Hurvitz et al 2014

  - Of all MVPA time in bouts, 47% in home neighborhood Rodriguez, Brown, and Troped (2008)

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)

		Median % MVPA bouts in home neighborhood	p[a]
Age	18-35	43.3	0.07
	36-59	49.3	
	60-85	62.7	
Race/ Ethnicity	Non-Hispanic White	49.3	0.1
	Non-Hispanic Black	38.4	
	Hispanic	49.9	
	Other	46.0	
Education	≤High School	52.4	0.2
	Some College	48.3	
	College Degree	46.3	

[a] 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

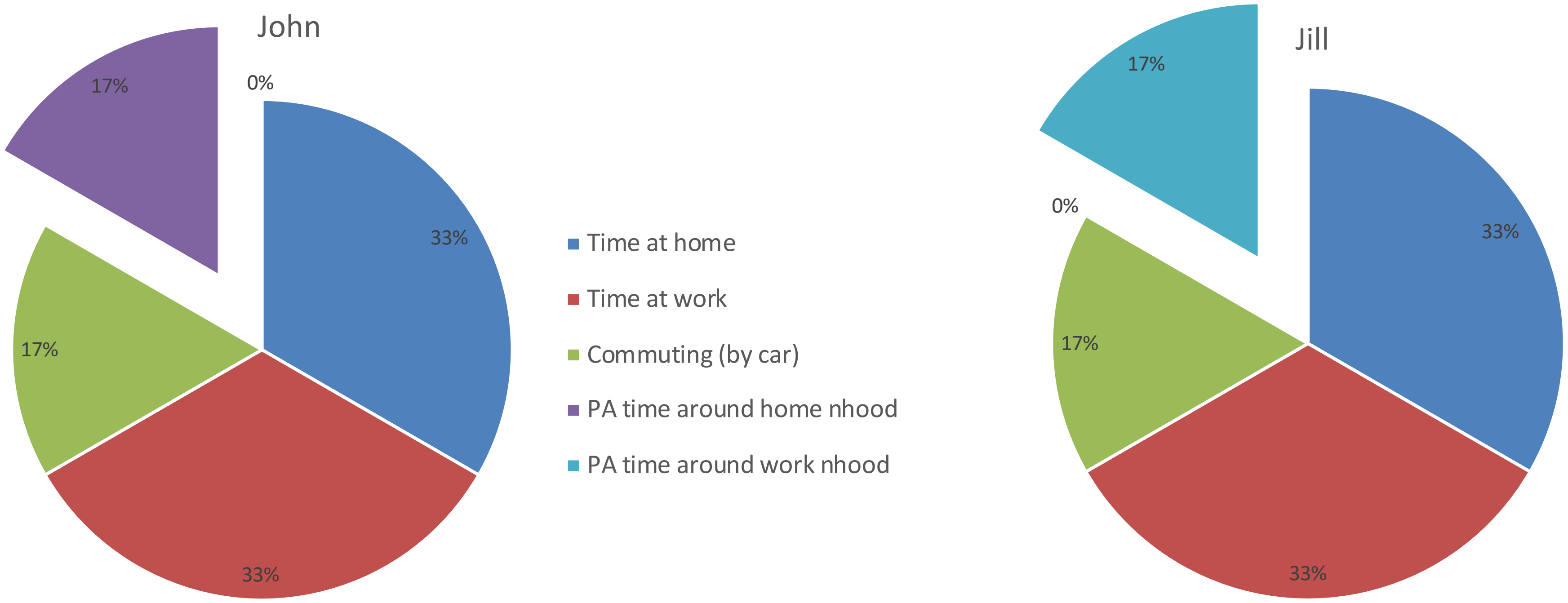
➔ The case for understanding built environment exposures through GPS/locational awareness

Promise or peril?

"Examining where physical activity takes place, and its correlates will help clarify relationships"

Promise or peril?

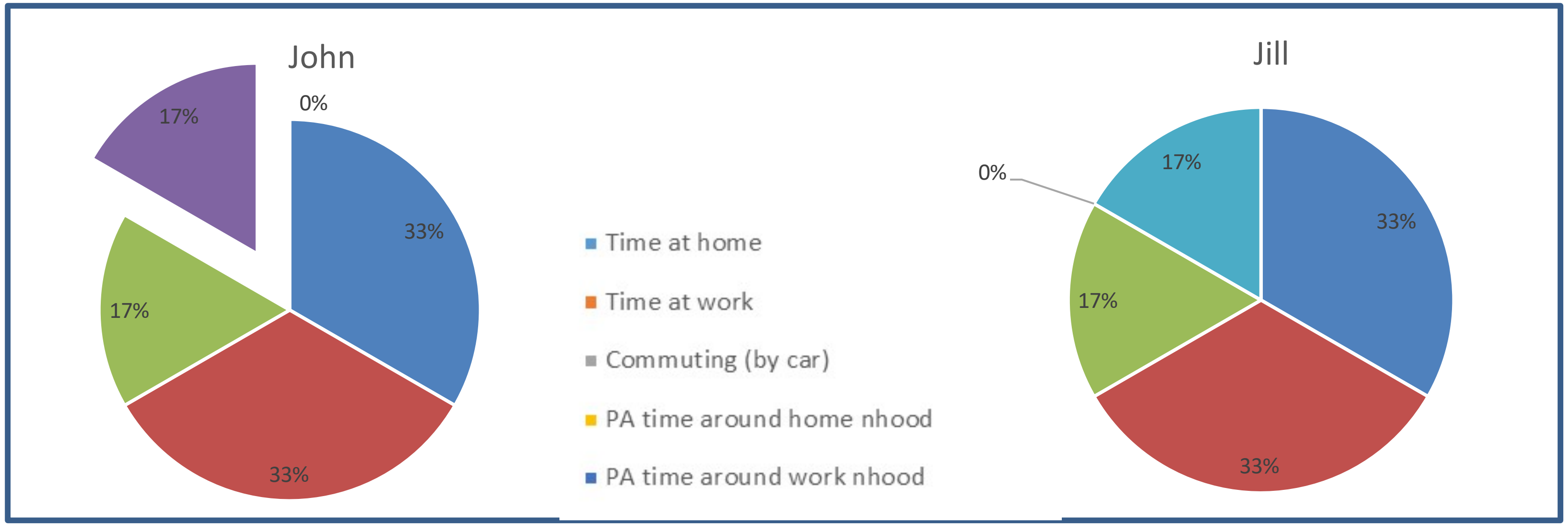
"Examining where physical activity takes place, and its correlates will help clarify relationships…"



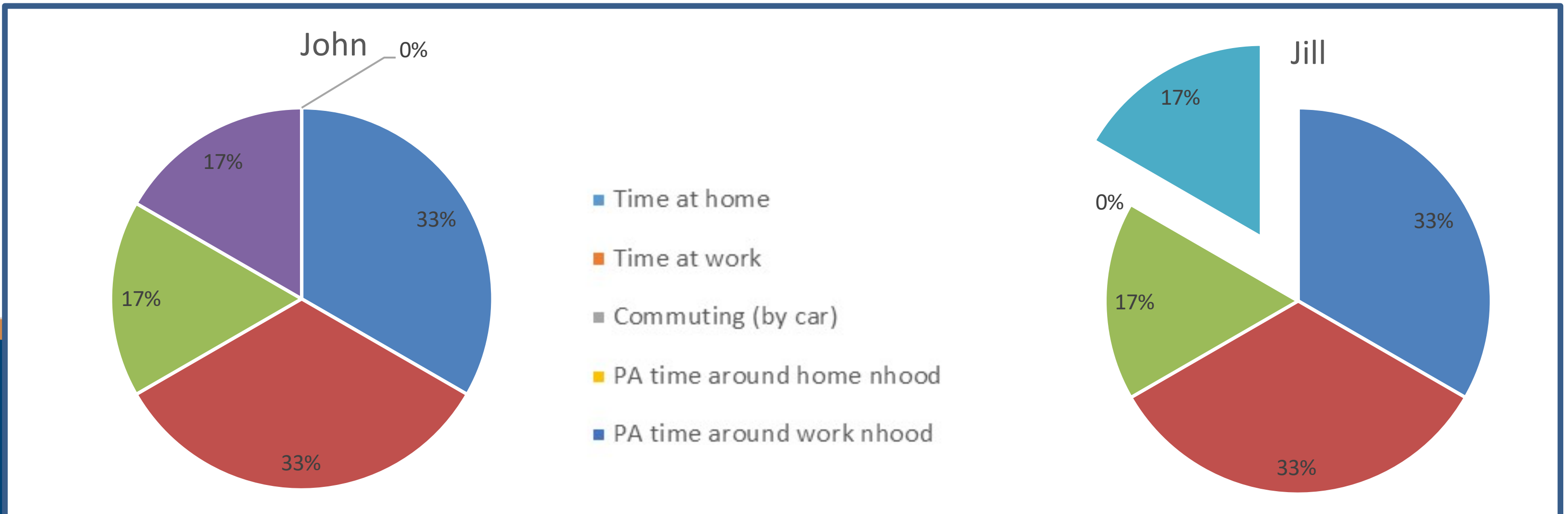
Promise #1

- Examining people exposed to different BEs and choices that result

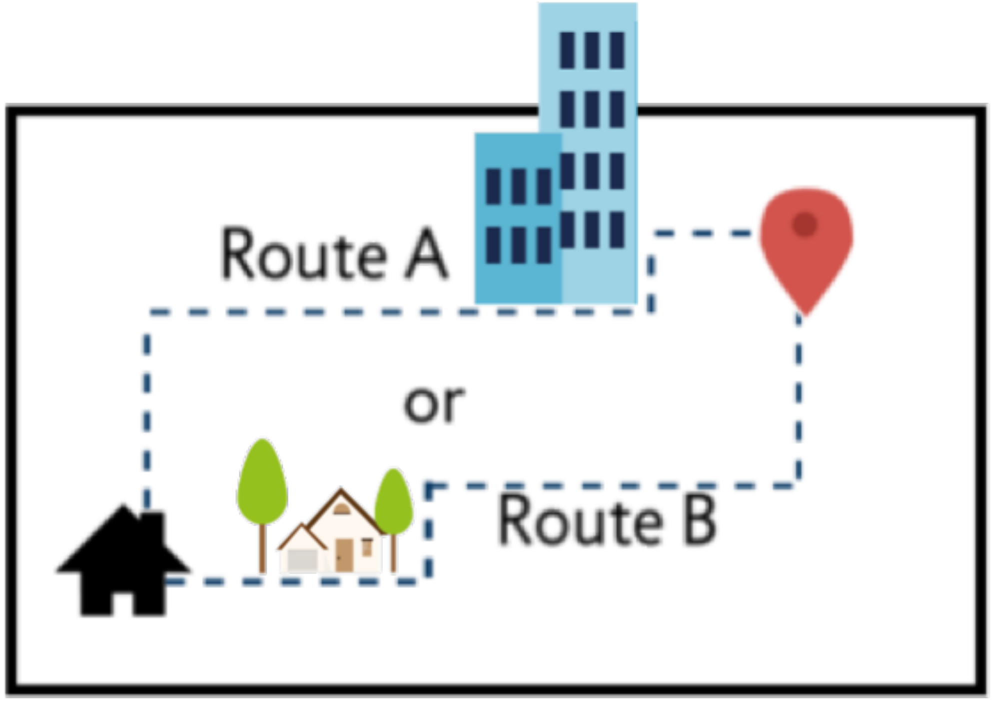
Home neighborhood and PA



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

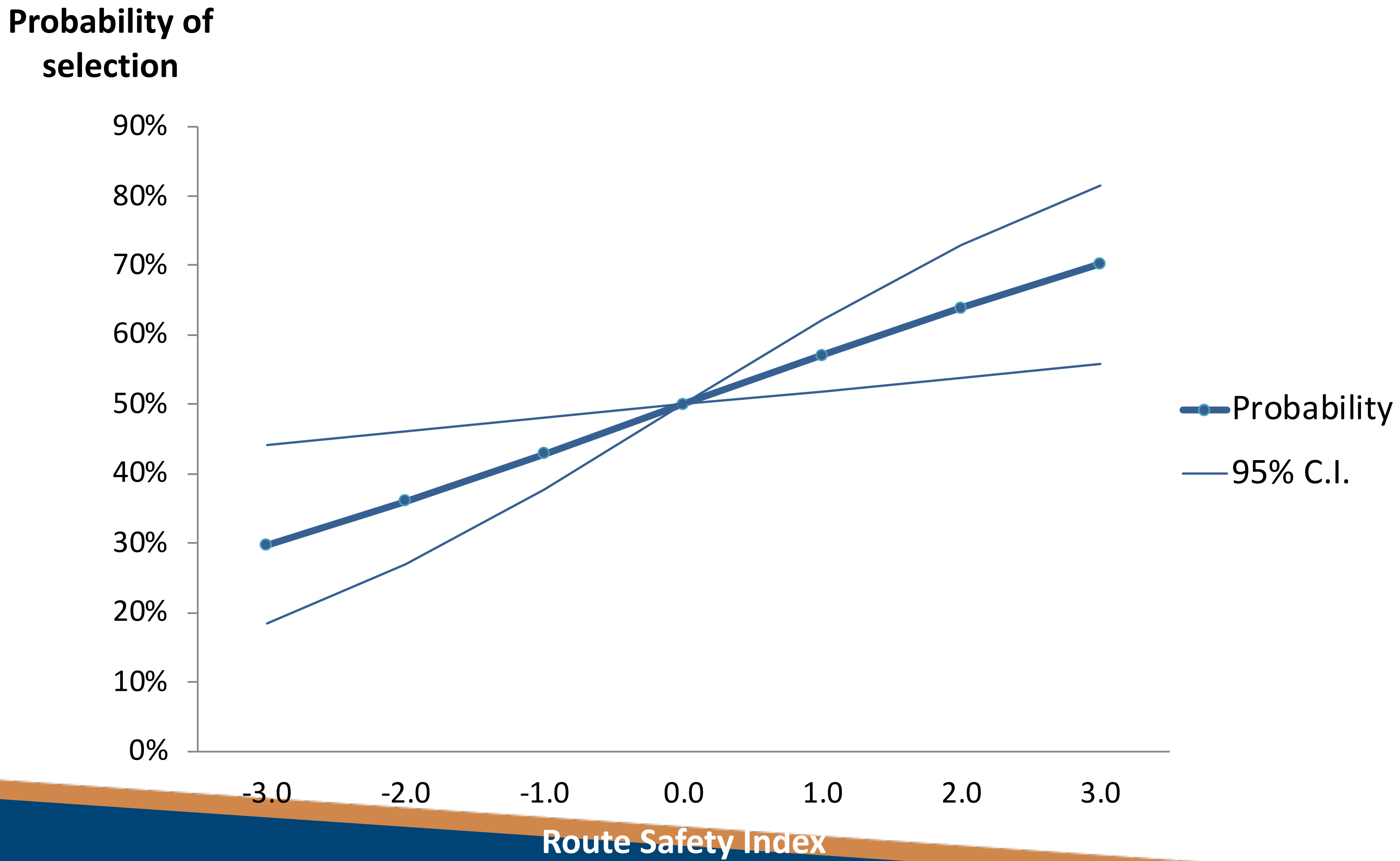
- Add-on to Trial of Activity for Adolescent Girls
  - Minneapolis, San Diego
  - Girls in control condition in 8th grade
- 532 girls eligible; 303 recruited
  - 152 in Minneapolis, 151 in San Diego
- Data collected at two time points for each girl
  - 10 & 11th grade11th & 12th grade

Analytic approach

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

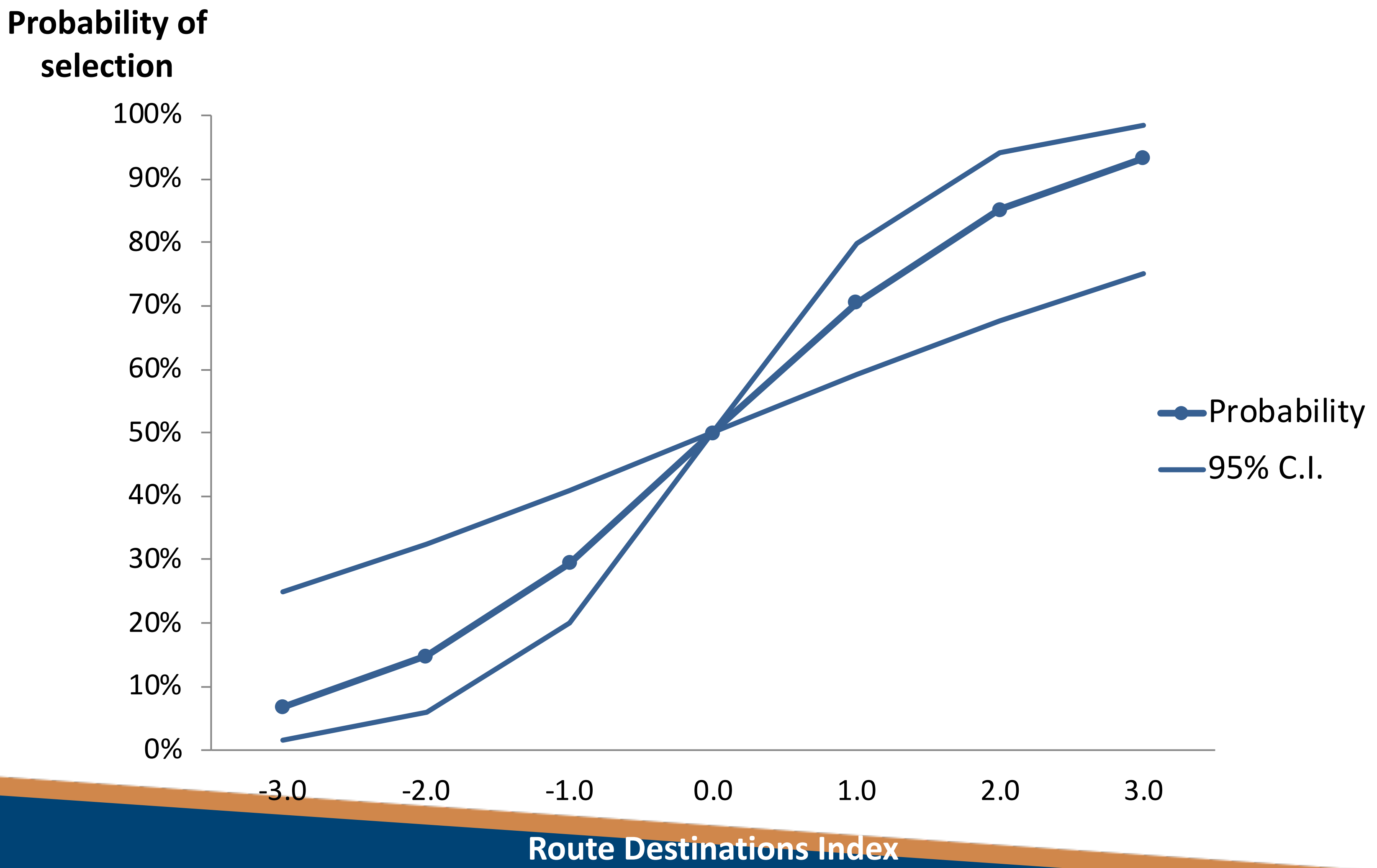
Source:nolli.uoregon.edu/map/

Safety in San Diego



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

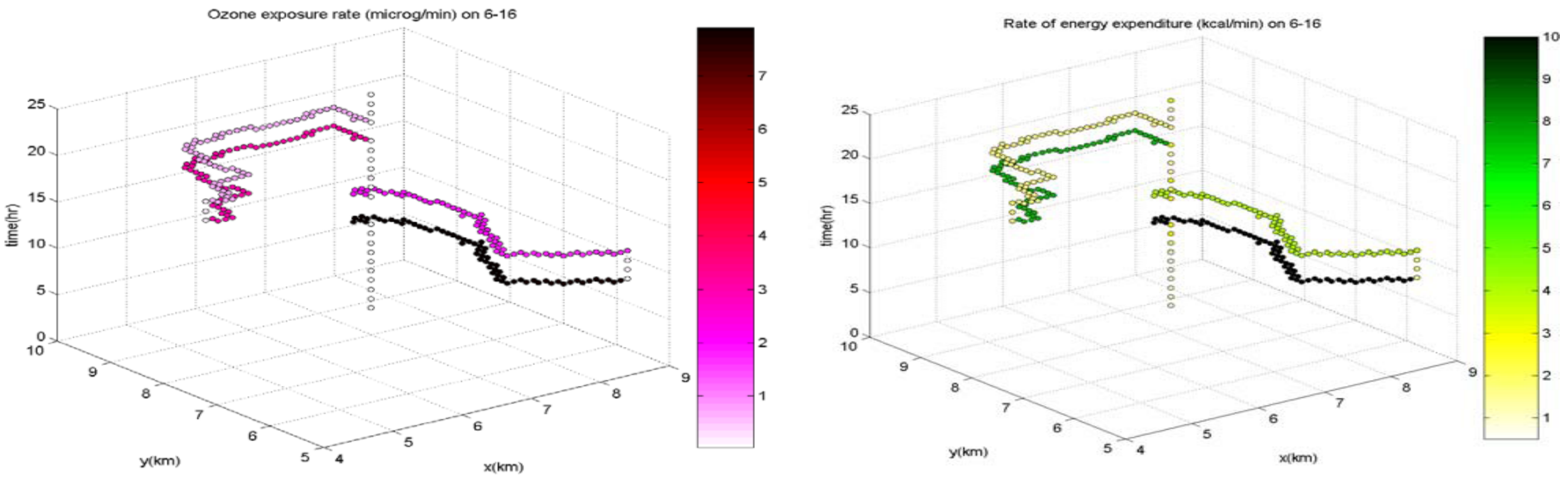
Destinations in Minneapolis



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



Source: de Nazelle and Rodriguez, 2009

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

Thank you!

danrod@berkeley.edu