Role of transportation and land use in obesity

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

Tuesday, September 12, 2017

Outline

- Transportation elements
  - Street connectivity and walking
  - Traffic
  - Cycling infrastructure
  - Mass transit
- Land development elements
  - Land use, density
- The package of the above

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

Street connectivity and sidewalks

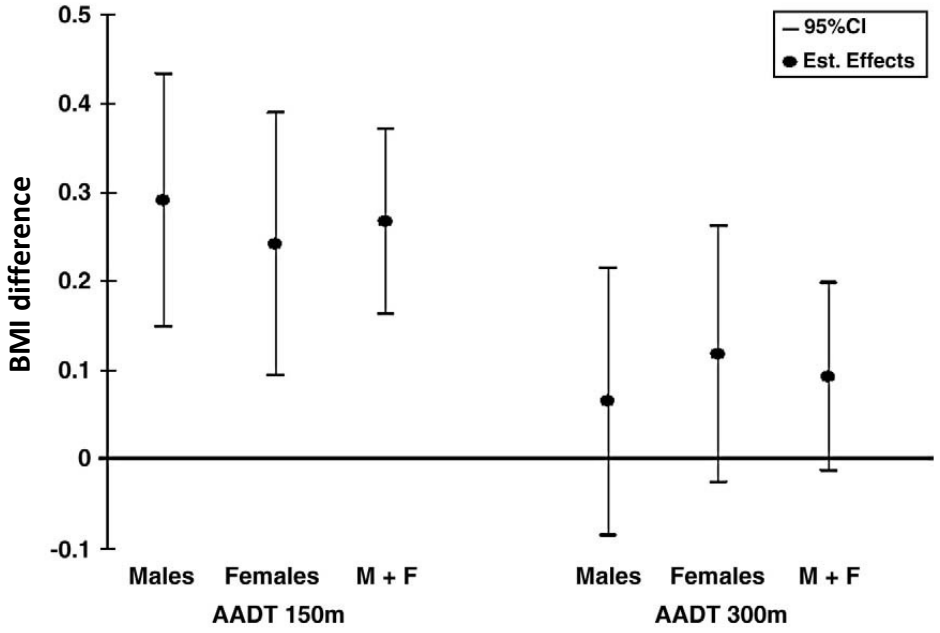
- Higher connectivity: shorter distances; safety from traffic
- RESIDE project, Perth (AU) Knuiman et al 2014
  - n=1813 participants into 73 new developments, 2003-2012
  - Street connectivity associated with higher walking
  - Yet
    - "In low-density cities such as in Australia, installing sidewalks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

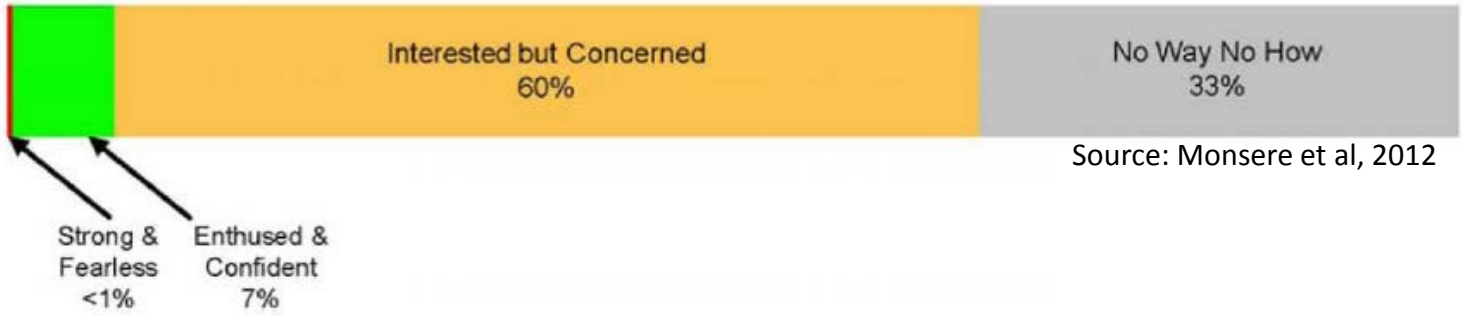


Confounders: Ethnicity/Race, Gender, Cohort variables, in addition, adjusted for Parental Education, Personal Weekly Smoking, Second Hand Smoke (Current + Past), Ever Asthma, Buffer Population, Gamma Index, Proportion of Below Poverty People within Census Block, NDVI, Foreign Born, Town Level Violent 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

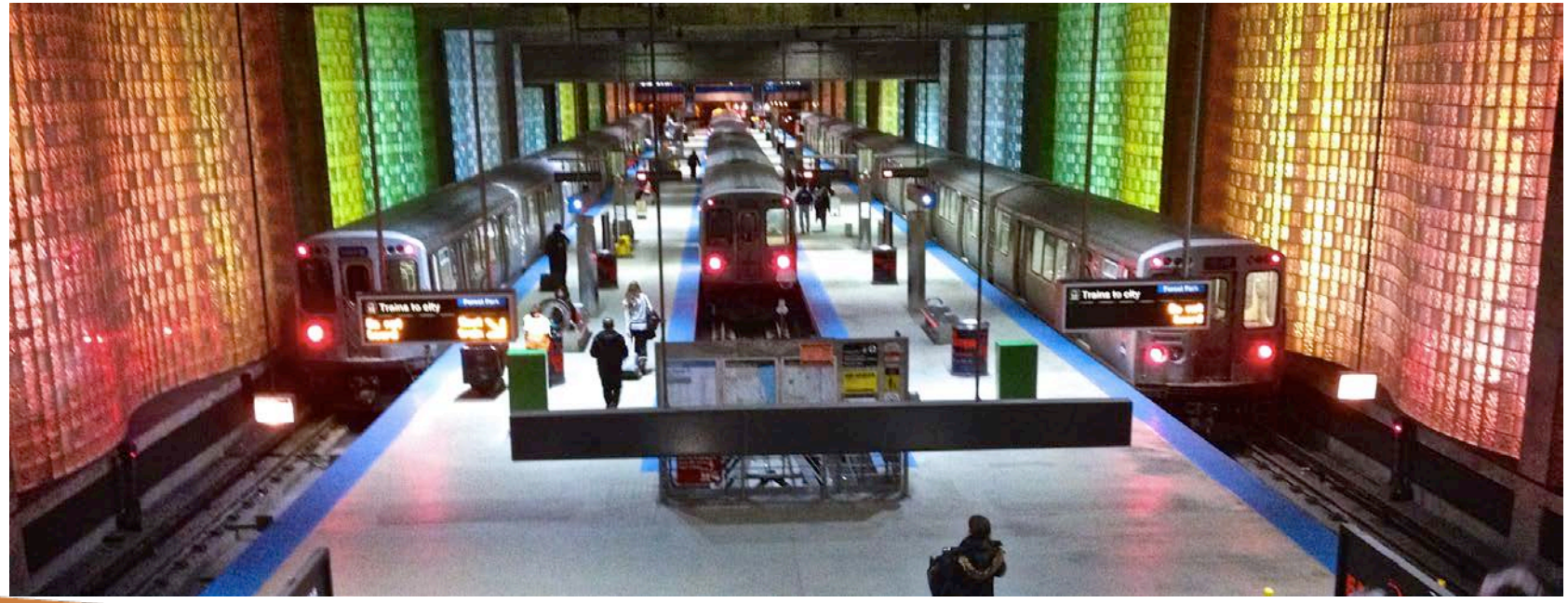
- New bicycle lanes in Salt Lake City, Brown et al, 2016
  - Tracked bicycling activity over two years using accelerometers and GPS loggers
    - Pre-post construction, n=536 adults (MAPS study)
  - Greater use of a urban bicycle lane related to lower BMI and more calories burned

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 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

	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

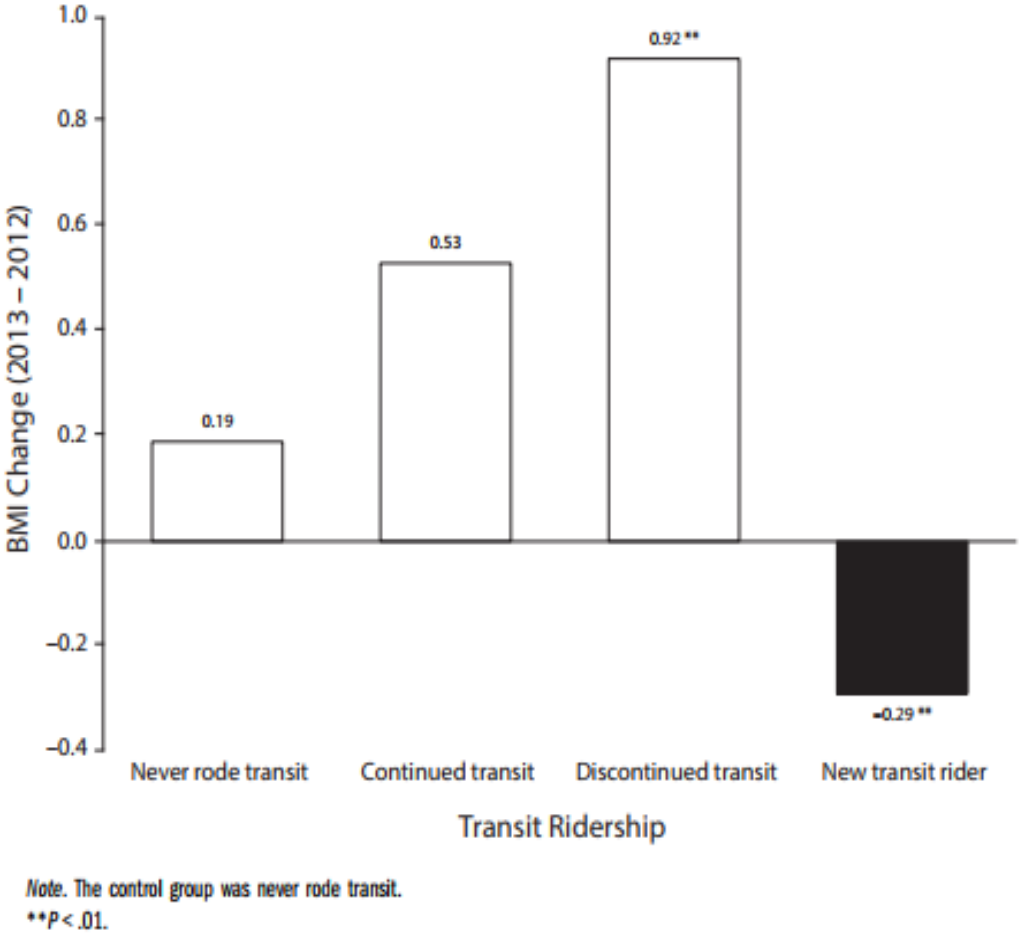
Note: Baseline plans to use LRT (=1) and race (black=1) were controlled for.
B, linear coefficient; LRT, light rail transit

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 activity



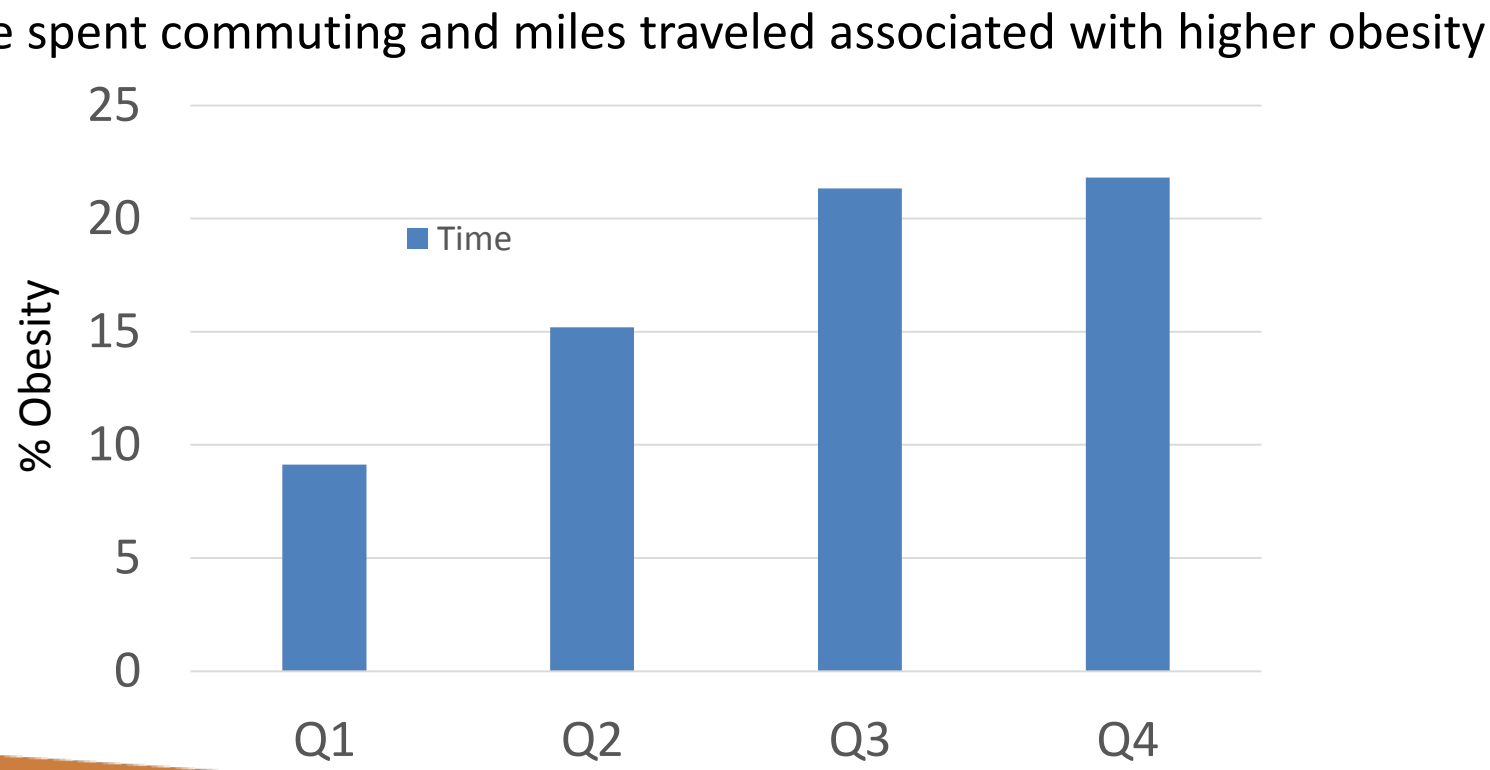
Note. The control group was never rode transit.
**$P < .01$.

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



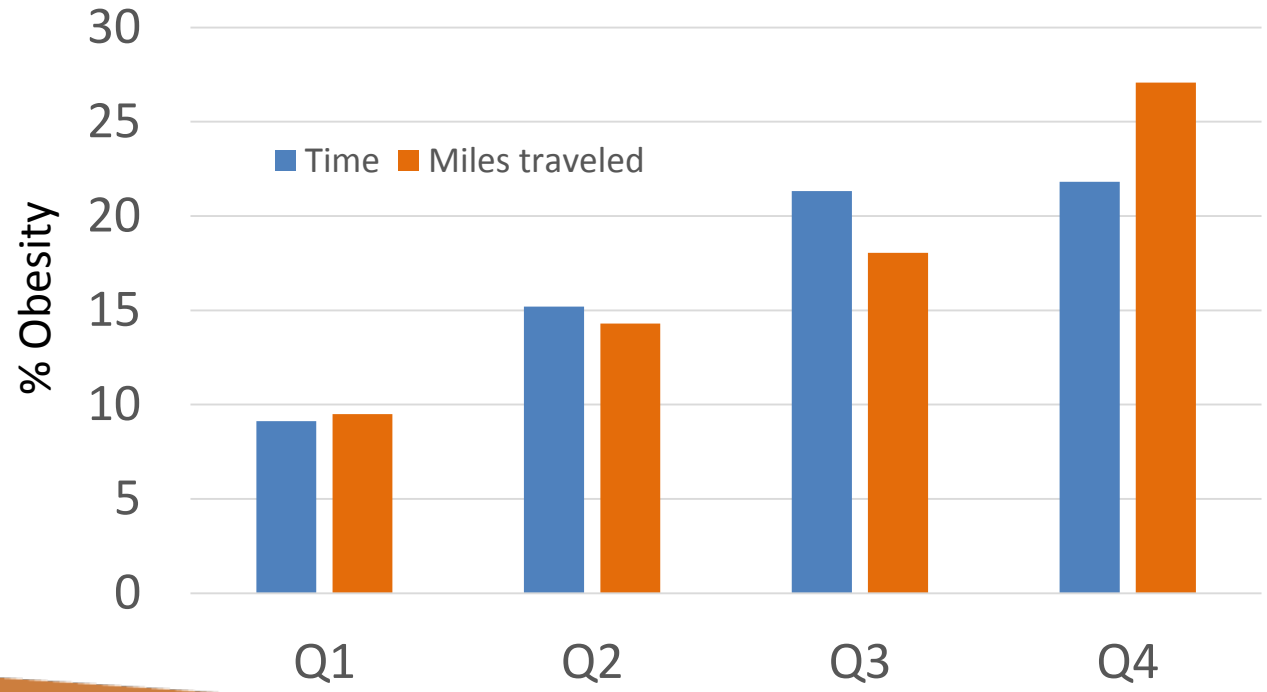
Source: Lopez-Zetina et al 2006

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.

Cars

- California ecological analysis, at county level

Time spent commuting and miles traveled associated with higher obesity

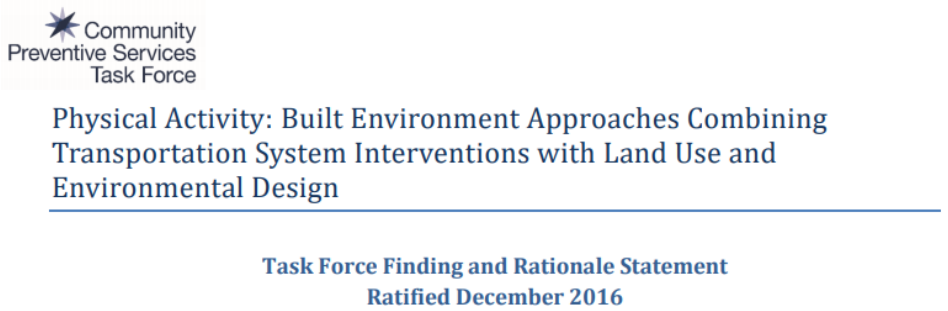


Source: Lopez-Zetina et al 2006

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, sidewalks



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"

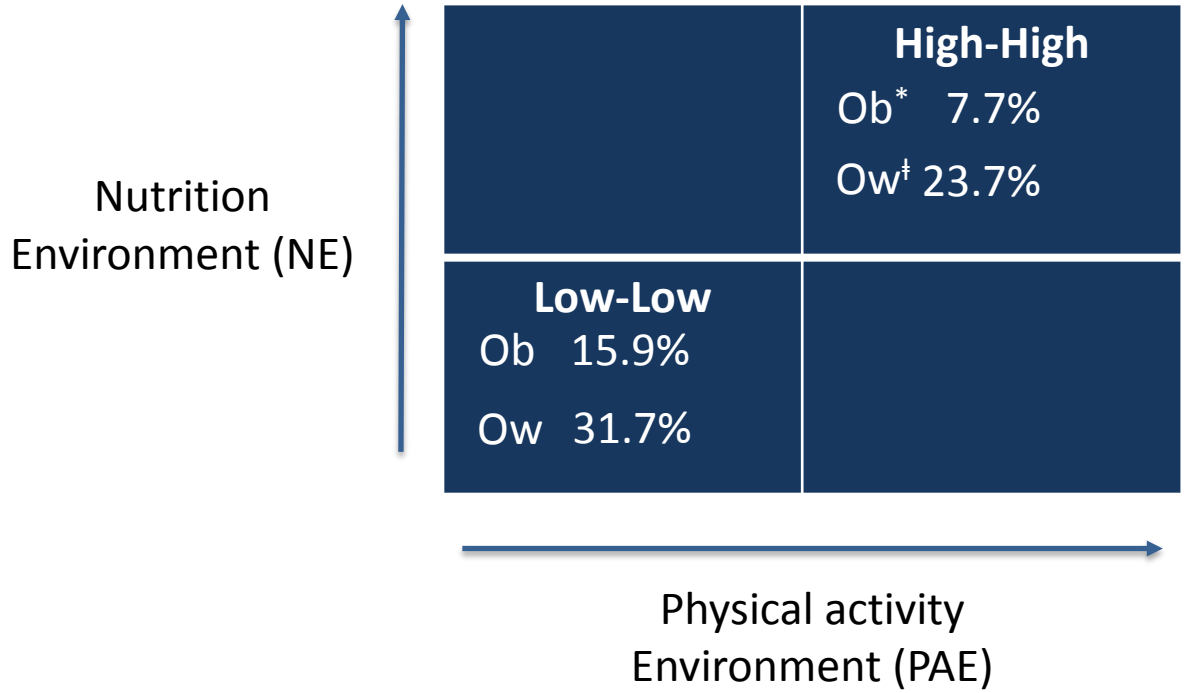
- Walkability
  - Density, land use mix, connectivity, safety, overall location
  - As a score or index (walkscore®, walkability index, etc.)

- 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

‡ 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	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

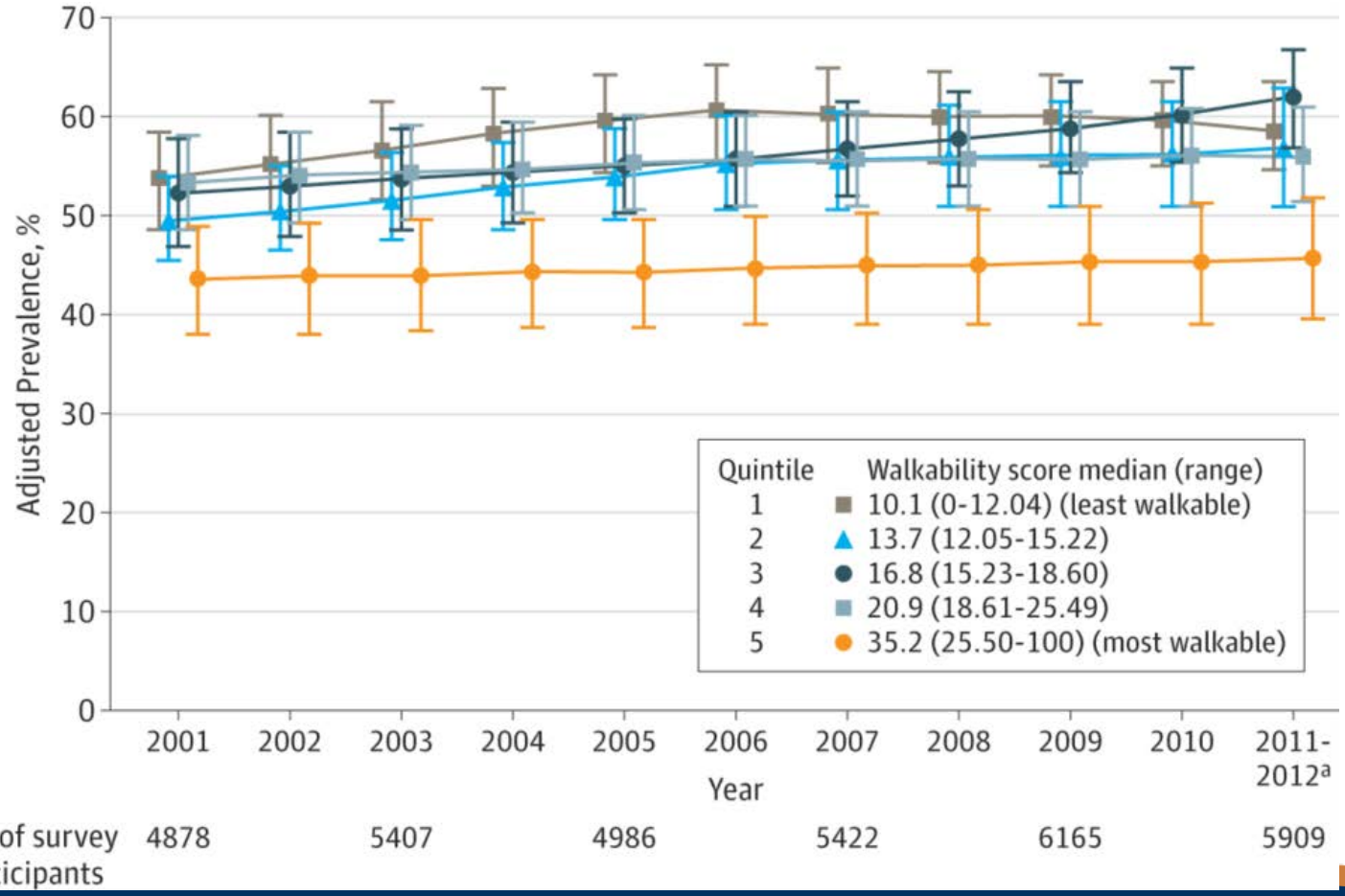
Density
Destinations
Street connectivity
} Walkability, in quintiles

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

Conclusions

- Magnitude of challenge (and the potential of actions)
  - Nationally, 53% of population (~170 million) in suburban environments
    - Using a meager 4 household per acre
- Planners at the heart of the issue
  - Transportation, land use, community development
  - Both as contributing cause and remedy
- Stitching together change

	Metro	Share of households living in low-density neighborhoods (<1 household per acre)
1	Los Angeles-Long Beach-Anaheim, CA	5.1 percent
2	Miami-Fort Lauderdale-West Palm Beach, FL	7.7 percent
3	San Jose-Sunnyvale-Santa Clara, CA	9.6 percent
4	San Francisco-Oakland-Hayward, CA	11.5 percent
5	Las Vegas-Henderson-Paradise, NV	11.7 percent
6	New York-Newark-Jersey City, NY-NJ-PA	13.2 percent
7	Salt Lake City, UT	13.4 percent
8	San Diego-Carlsbad, CA	14.2 percent
9	Denver-Aurora-Lakewood, CO	17.2 percent
10	Urban Honolulu, HI	17.3 percent

Source: Census

Kolko, 2105