WALKABILITY ASSESSMENT USING PRINCIPAL COMPONENTS ANALYSIS

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Background

- Most American adults are not meeting current recommended levels of physical activity
- Focus on environmental supports for physical activity
- Want to estimate effect of “walkability” in neighborhoods
  - Understanding pathways to physical activity
  - Policy interventions to increase physical activity

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Background

- Problem is: What is a walkable neighborhood?
- Neighborhood walkability is studied two ways:
  1. Entering single items measuring walkability into regression analyses
  2. Building composite measures of walkability from many items

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Background

Creating walkability measures has three key problems:

1. Multicollinearity of items
2. Context-dependence of walkability
   - "Macro" – Across different locations
   - "Micro" – Across definitions of neighborhoods
3. Interpretability of results

Objectives

- Develop a process for creating a summary measure of walkable neighborhoods
- Assess predictive validity of summary measure compared to:
  - Population density
  - Frank & colleagues walkability index
- Examine whether definitions of neighborhoods matter

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Strategy

Using data from New York City:

- Perform principal components analysis (PCA) on typical “walkability” items to uncover structure
- Compare predictive validity of various walkability measures on BMI

Do this for neighborhoods defined as census tracts, zip-codes and 1km buffers

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Neighborhood Walkability Items

1. Population Density
2. Subway stops (0, 1, 2+)
3. Bus stops
4. Land-use mix (entropy measure including only commercial and residential land use)
5. Retail floor area ratio (FAR)
6. Intersection Density
7. Residential units / building area
8. Residential units / land area
9. Percent commercial land use

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Why use PCA?

- High correlation among independent variables measuring built environment

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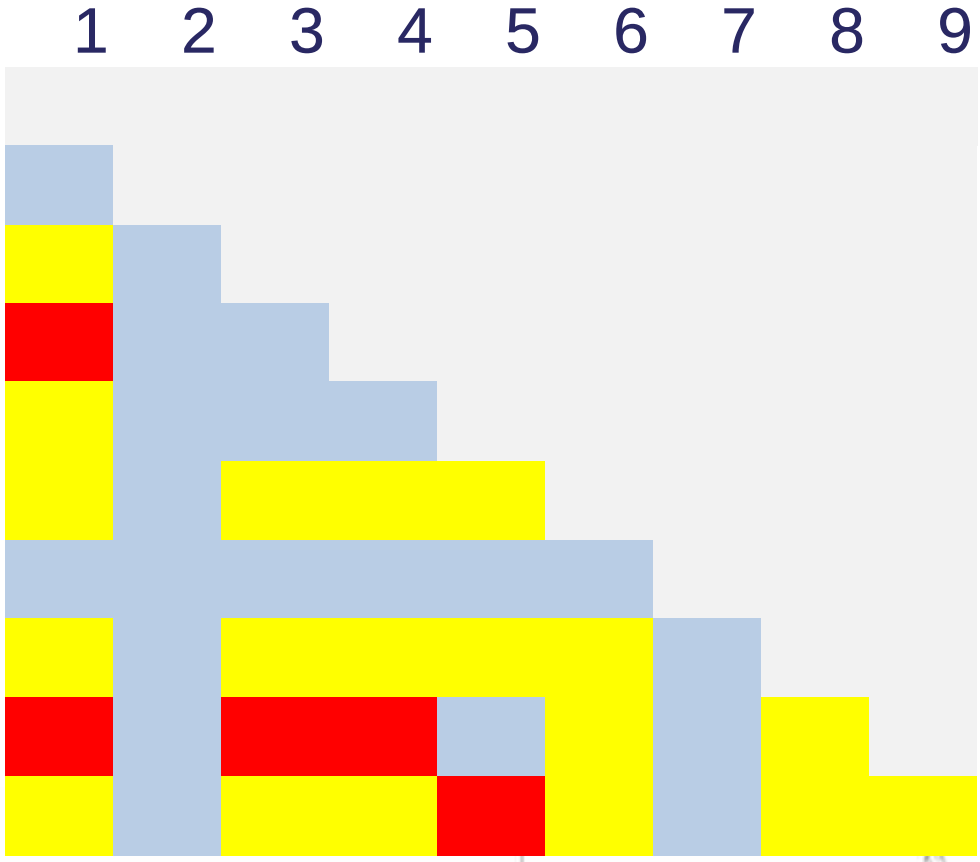
Correlation Matrix

1. Bus stops
2. 1 subway stop
3. 2+ subway stops
4. Pop. Dens.
5. Land use mix
6. Retail FAR
7. Inter. Density
8. Units/Bldg. Area
9. Units/Land Area
10. Percent Comm.



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Why use PCA?

- High correlation among independent variables measuring built environment
- Uncover different dimensions of variation
- Resulting variables (scales) are uncorrelated with each other

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PCA Results / Dimensions of Built Environment

Three dimensions found in the built environment data for New York City:

First Dimension: **Population Density**

Second Dimension: **Commercial Land Use**

Third Dimension: **Subway Density**

PCA results are similar across tracts, zip codes and 1-km buffers

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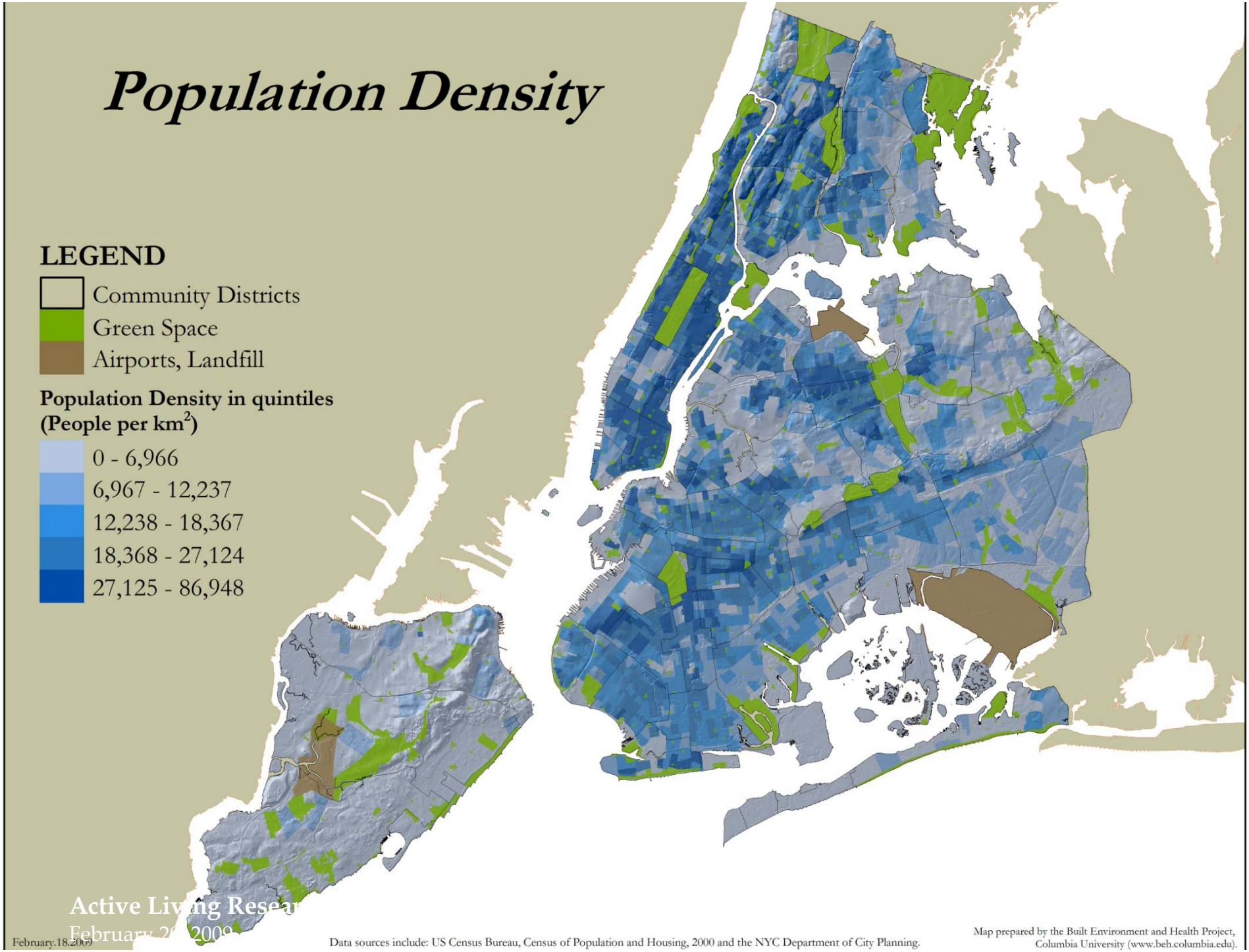
Population Density
LEGEND
Community Districts
Green Space
Airports, Landfill
Population Density in quintiles
(People per km2)
0 - 6,966
6,967 - 12,237
12,238 - 18,367
18,368 - 27,124
27,125 - 86,948
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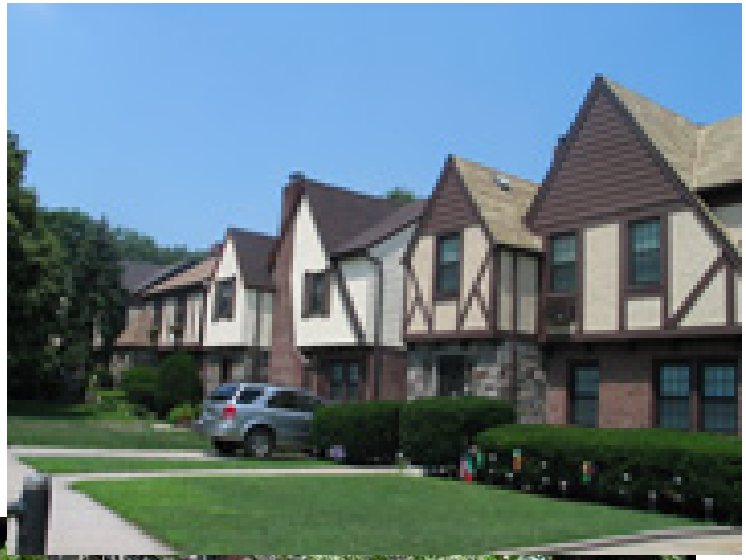
Data sources include: US Census Bureau, Census of Population and Housing, 2000 and the NYC Department of City Planning.
Map prepared by the Built Environment and Health Project,
Columbia University (www.beh.columbia.edu).



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Predictive Validity

- Data: New York Cancer Project Cohort (N=13,201)
- Control for individual characteristics
  - age, gender, race/ethnicity, education
- Control for neighborhood characteristics
  - % black, % Hispanic, % poor
- Generalized estimation equations clustered by Universal Hospital Fund districts (N=42)

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Tract-Level Results

	1		2		3		4	
Pop. Density	-0.421	***						
Density Factor			-0.367	**	-0.357	**		
Commercial Factor					-0.094			
Subway Factor					0.114			
Walkability Index							-0.462	***
r^2	0.102		0.101		0.102		0.098	

- Explained variance is similar with pop. density among the highest

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1km Buffer-Level Results

	1		2		3		4	
Pop. Density	-0.539	***						
Density Factor			-0.343	***	-0.362	***		
Commercial Factor					-0.227	***		
Subway Factor					0.038			
Walkability Index							-0.360	**
r^2	0.102		0.101		0.102		0.098	

- Explained variance of Pop. Density is just as high
- Second dimension – commercial presence – provides independent information

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Conclusions

- Population density is as good as any single composite measure of walkability in New York City
- Multiple influences of built environment on BMI revealed through PCA
- PCA measures are similar across neighborhood definitions, but effects are not

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Conclusions

- PCA measures are similar across neighborhood definitions
- Population density is as good as any **single** composite measure of walkability **in New York City**
- PCA reveals that two built environment constructs are associated with BMI
- Results somewhat dependent on neighborhood defintion

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Implications & Limitations

- Context is important
  - We describe a process that can be used to build and test composite measures
  - Replication required in different contexts
- Need to explore behavior-related outcomes (e.g. walking)
- Cross-sectional and observational design leaves us vulnerable to selection problems

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Future Directions

- Measures of neighborhood walkability vs. walkable types of neighborhoods
  - Variable-centered vs. neighborhood-centered approaches
- Multi-context studies exploring built environment influences across different locations
- Methods to account for selection
- Process can be used for other complex concepts (e.g. safety)

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More Info!

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