

# Racial Differences in the Association Between Built Environment Features and BMI Among Urban Adolescents

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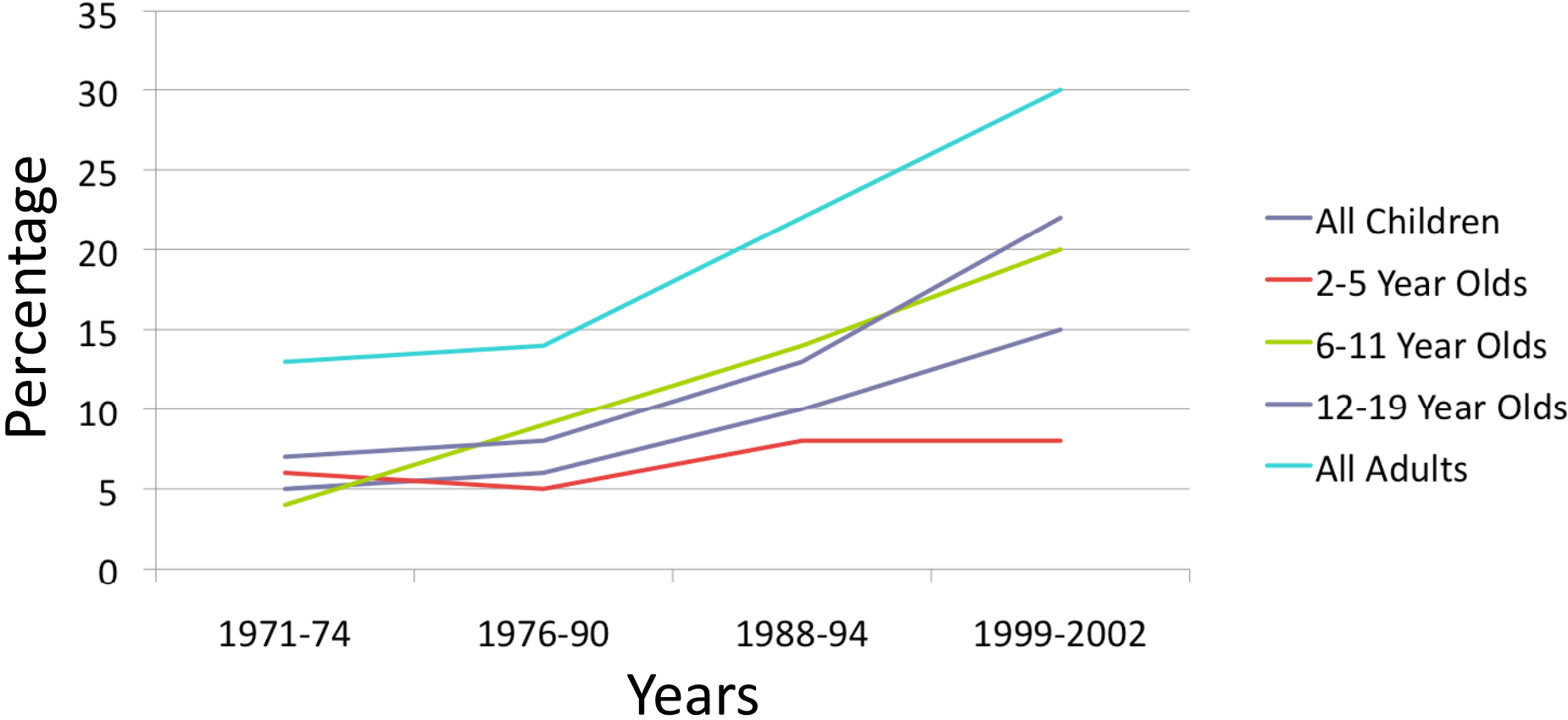
HARVARD YOUTH VIOLENCE PREVENTION CENTER

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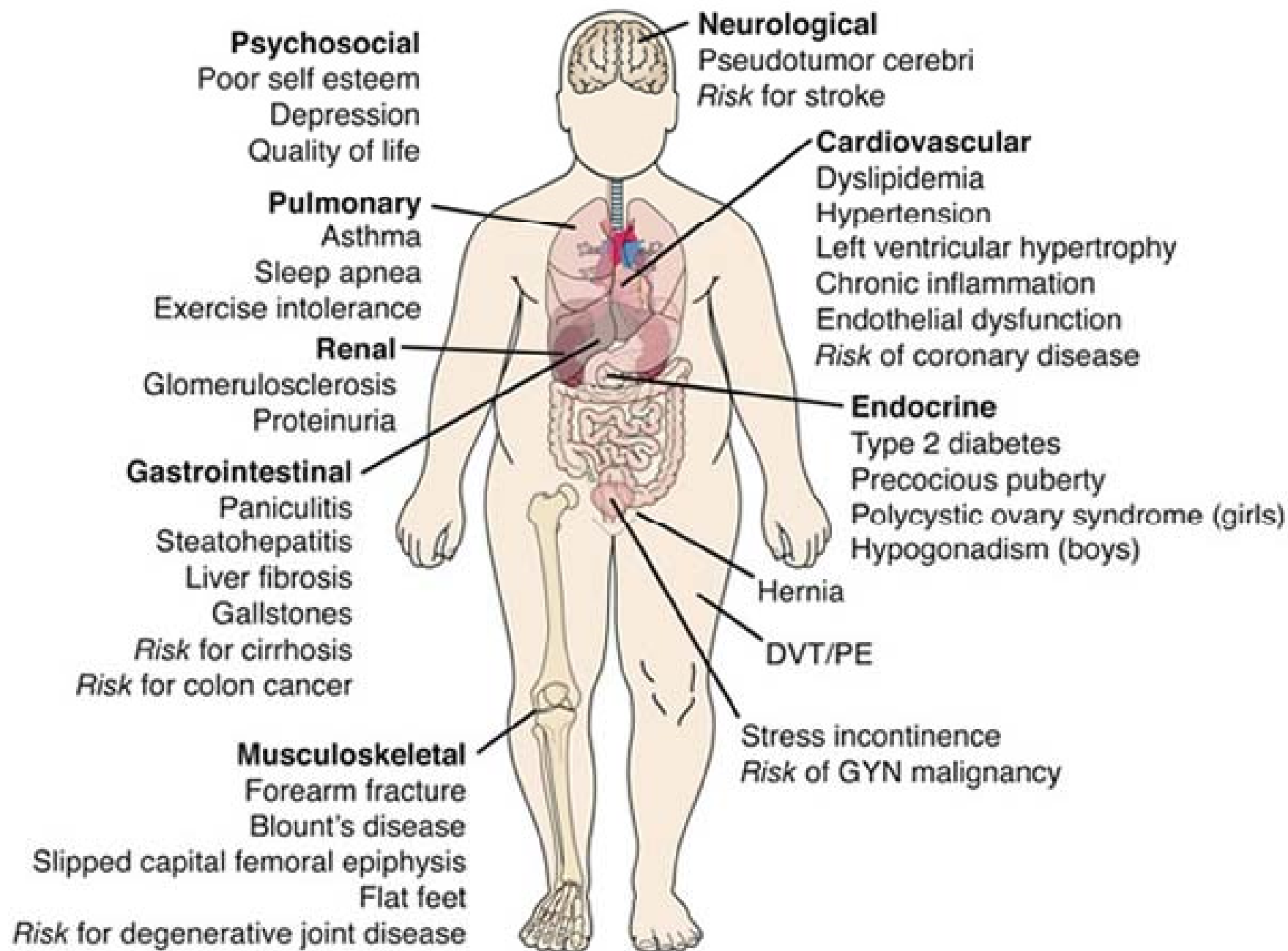


# Percentage of US Population That Is Obese



Anderson PM, Butcher KE. Childhood obesity: trends and potential causes. *Future Child*. 2006 Spring;16(1):19-45.

## Complications of Childhood Obesity





# Obesogenic Environments



# Built Environment & Obesity Risk

- Built environment features of neighborhoods may be a determinant of adolescent obesity and perhaps also an explanation for obesity-related health disparities.
- Neighborhoods have been defined differently across studies and most studies assume spatial independence of observations from neighborhoods.

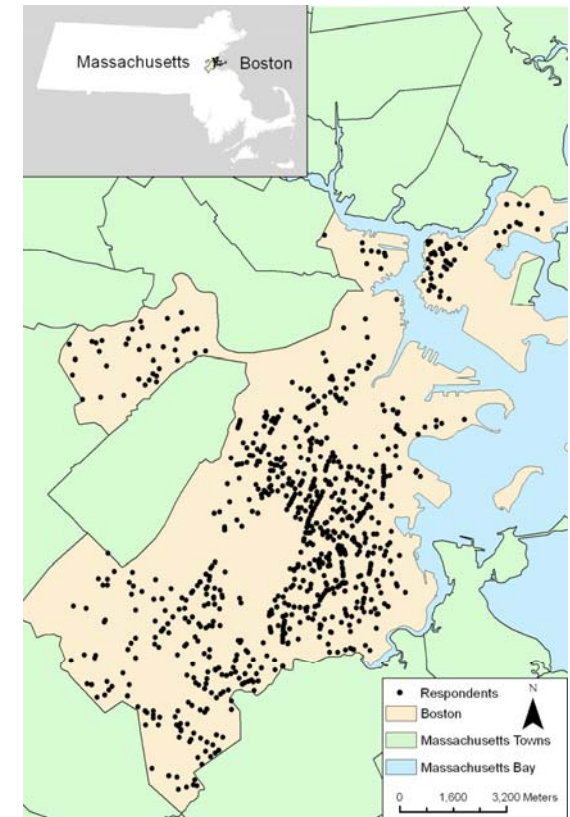
# Specific Aims

- To evaluate associations between various built environment features and BMI using street network buffer neighborhood definitions of 400-meters and 800-meters, and to evaluate if race/ethnicity modifies the studied association.



# Study Design and Sample

- 2008 Boston Youth Survey (BYS)
  - Paper-and-pencil survey of public high school students in Boston Public Schools
  - 22 (of 32) Boston public high schools participated
  - Administered Spring of 2008 during class periods
- Sample
  - Georeferenced residential information
  - Valid height, weight and BMI data
  - N= 1,041 adolescents



# Access to Walking Destinations

- Recreational facilities (density)
- Parks (density)
- Bus stops (density)
- Subway stops (density)
- Retail destinations (density)
- Services destinations (density)
- Cultural/educational destinations (density)



\* All density measures are expressed as per square kilometer.

# Community Design

- Walking destination mix diversity
- Sidewalk on one side
- Sidewalk on both sides
- Average speed limit
- Intersection density
- Residential density



\* All density measures are expressed as per square kilometer.

# Other Variables

- Individual-level Covariates
  - Gender
  - Race/ethnicity
  - Age
  - Nativity
  - Siblings
- Neighborhood-level Covariates
  - Percent Black
  - Percent Hispanic
  - Percent household poverty
  - Percent foreign born



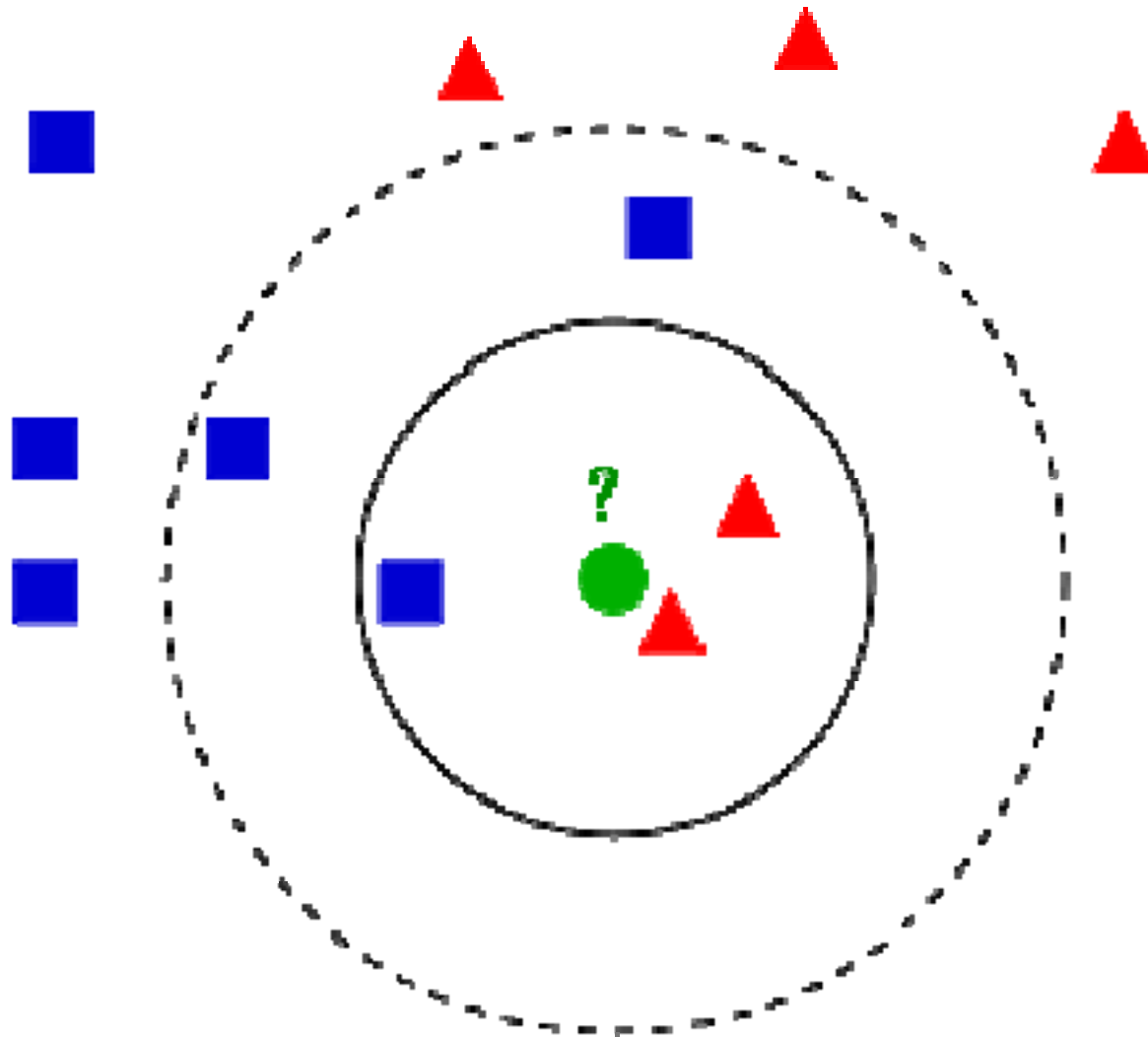


# Spatial Analyses

- Exploratory Spatial Data Analyses
  - Geovisualization
  - Cluster Detection
    - Global Moran's  $I$  assessed via Monte Carlo simulation of 999 random replications
- Regression Analyses
  - Standard Regression Model
    - Ordinary Least Squares Regression
  - Spatial Autocorrelation in OLS Residuals
    - Global Moran's  $I$  and Lagrange Multiplier
  - Spatial Regression Model
    - Spatial Error Model

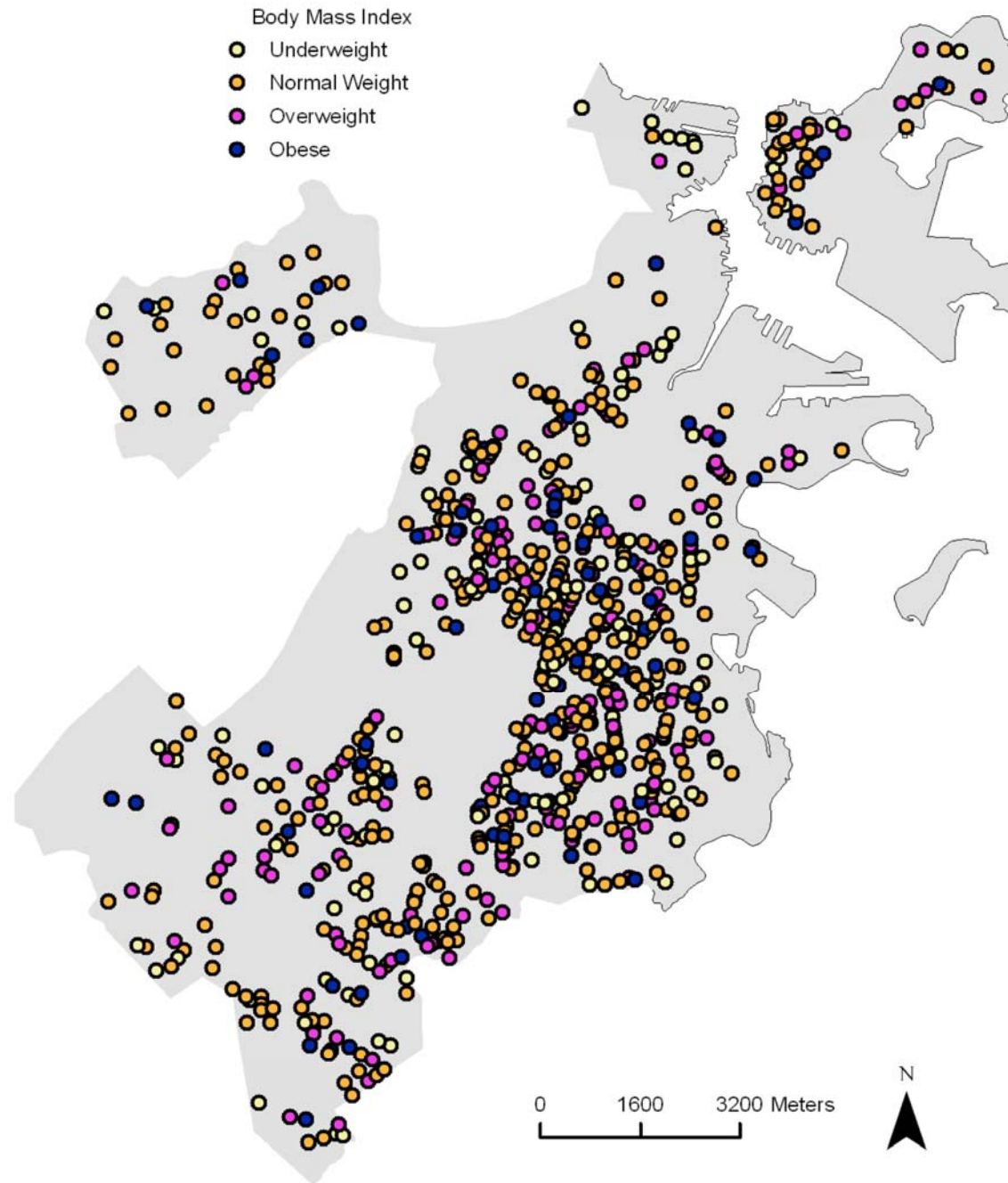


# Spatial Weights Matrix



# Sample Characteristics

Age in years (mean, SD)	16.32 (1.26)
Body Mass Index (mean, SD)	23.95 (4.90)
Gender (%)	
Male	44.17
Female	55.83
Race/Ethnicity (%)	
White, Non-Hispanic	10.47
Black, Non-Hispanic	42.07
Hispanic	32.78
Asian	7.63
Other	7.05
Nativity Status (%)	
US Born	73.71
Foreign Born	26.29
Having a Sibling (%)	
Yes	85.57
No	14.42





# Spatial Autocorrelation

	400-meter Network Buffer Neighborhood	800-meter Network Buffer Neighborhood
<b>Access to Walking Destinations</b>		
Recreational facilities (density)	0.79	0.89
Parks (density)	0.69	0.80
Bus stops (density)	0.66	0.84
Subway stops (density)	0.60	0.88
Retail destinations (density)	0.74	0.83
Service destinations (density)	0.63	0.67
Cultural/educational destinations (density)	0.77	0.90
*The pseudo p value for the Global Moran's $I$ are all 0.001.		

# Spatial Autocorrelation

	400-meter Network Buffer Neighborhood	800-meter Network Buffer Neighborhood
<b>Community Design</b>		
Walking destination mix diversity	0.64	0.68
Sidewalk on one side	0.79	0.89
Sidewalk on both sides	0.74	0.85
Average speed limit	0.76	0.89
Highway density	0.69	0.84
Intersection density	0.85	0.94
Residential density	0.93	0.96
*The pseudo p value for the Global Moran's $I$ are all 0.001.		

# Testing OLS Model Assumptions

- Global Moran's I indicated spatial autocorrelation in OLS regression residuals
- Lagrange multiplier term indicated that the spatial error model was appropriate

**Table 3. Spatial Error Model Estimation of the Association Between Access to Access to Walking Destinations and Body Mass Index by Neighborhood Definition <sup>a</sup>**

	400-meter Network Buffer		800-meter Network Buffer	
	Coefficient	SE	Coefficient	SE
<b>A. Recreational facilities (density)</b>				
Model 1				
A: Total Sample	-0.032	0.042	-0.082	0.077
Model 2				
A: White	0.137	0.107	-0.046	0.178
A X Black	-0.152	0.125	0.118	0.207
A X Hispanic	-0.193	0.125	-0.087	0.202
A X Asian	-0.259~	0.152	-0.300	0.269
A X Other	-0.307~	0.182	-0.137	0.288
<b>B. Parks (density)</b>				
Model 1				
B: Total Sample	-0.021	0.057	0.035	0.133
Model 2				
B: White	-0.295~	0.164	-0.422	0.326
B X Black	0.368~	0.188	<b>0.866*</b>	0.388
B X Hispanic	0.184	0.191	0.119	0.388
B X Asian	0.449~	0.235	0.542	0.476
B X Other	0.394	0.271	0.629	0.564
<b>C. Bus stops (density)</b>				
Model 1				
C: Total Sample	0.001	0.013	0.006	0.023
Model 2				
C: White	0.050	0.039	<b>0.161*</b>	0.066
C X Black	-0.050	0.043	<b>-0.167*</b>	0.072
C X Hispanic	-0.056	0.045	<b>-0.182*</b>	0.075
C X Asian	-0.017	0.058	-0.111	0.094
C X Other	-0.125~	0.065	<b>-0.259*</b>	0.106
<b>D. Subway stops (density)</b>				
Model 1				
D: Total Sample	-0.171	0.105	-0.176	0.152
Model 2				
D: White	-0.075	0.260	-0.168	0.388
D X Black	-0.257	0.305	-0.071	0.471
D X Hispanic	0.152	0.321	0.230	0.458
D X Asian	-0.273	0.344	-0.138	0.448
D X Other	0.039	0.527	-0.279	0.712



	400-meter Network Buffer		800-meter Network Buffer	
	Coefficient	SE	Coefficient	SE
<b>E. Retail destinations (density)</b>				
Model 1				
E: Total Sample	-0.006	0.008	-0.005	0.011
Model 2				
E: White	-0.011	0.022	0.017	0.028
E X Black	-0.002	0.026	-0.031	0.037
E X Hispanic	-0.025	0.026	-0.002	0.034
E X Asian	-0.008	0.026	-0.040	0.033
E X Other	-0.018	0.042	-0.051	0.058
<b>F. Service destinations (density)</b>				
Model 1				
E: Total Sample	-0.032	0.045	-0.030	0.042
Model 2				
E: White	0.025	0.105	0.054	0.060
E X Black	-0.016	0.147	-0.306~	0.156
E X Hispanic	-0.010	0.137	-0.112	0.141
E X Asian	-0.129	0.130	-0.136	0.090
E X Other	-0.180	0.202	-0.392	0.277
<b>G. Cultural/educational destinations (density)</b>				
Model 1				
E: Total Sample	0.008	0.013	0.001	0.015
Model 2				
E: White	0.015	0.027	0.019	0.030
E X Black	0.003	0.035	-0.010	0.042
E X Hispanic	0.011	0.037	-0.004	0.044
E X Asian	-0.040	0.039	-0.040	0.038
E X Other	-0.059	0.061	-0.053	0.077
SE= Standard Error				
~ p < 0.10; * p < 0.05 (bold); ** p < 0.01 (bold)				
<sup>a</sup> Model 1 estimates the association between the built environment and body mass index among the total sample; Model 2 estimates the studied association and includes an interaction for race/ethnicity. For each model, we evaluate the estimated effect of each built environment feature separately. All models are adjusted for individual-level race/ethnicity, individual-level gender, individual-level age, individual-level nativity, individual-level family structure (having siblings), neighborhood-level percent of Black residents, neighborhood-level percent of Hispanic residents, neighborhood-level percent of households below poverty and neighborhood-level percent foreign born within the corresponding neighborhood buffer size. Regression estimates are also controlled for school using indicator variables.				
Note: All density measures are expressed as per square kilometer.				

<b>Table 4. Spatial Error Model Estimation of the Association Between Community Design Attributes and Body Mass Index by Neighborhood Definition <sup>a</sup></b>				
	<b>400-meter Network Buffer</b>		<b>800-meter Network Buffer</b>	
	Coefficient	SE	Coefficient	SE
<b>A. Walking destination mix diversity</b>				
Model 1				
A: Total Sample	-0.004	0.007	0.006	0.015
Model 2				
A: White	-0.011	0.016	-0.086~	0.052
A X Black	0.018	0.019	<b>0.128*</b>	0.057
A X Hispanic	0.004	0.020	0.089	0.056
A X Asian	0.007	0.028	0.094	0.069
A X Other	-0.027	0.029	0.011	0.075
<b>B. Sidewalk on one side</b>				
Model 1				
B: Total Sample	-0.025~	0.013	<b>-0.046*</b>	0.020
Model 2				
B: White	-0.018	0.047	-0.085	0.066
B X Black	-0.030	0.051	0.014	0.071
B X Hispanic	0.022	0.052	0.072	0.073
B X Asian	0.013	0.071	0.096	0.093
B X Other	-0.024	0.070	0.017	0.099
<b>C. Sidewalk on both sides</b>				
Model 1				
C: Total Sample	<b>0.020*</b>	0.010	<b>0.036**</b>	0.013
Model 2				
C: White	0.037	0.031	<b>0.070*</b>	0.034
C X Black	-0.001	0.034	-0.024	0.039
C X Hispanic	-0.047	0.035	-0.064	0.040
C X Asian	-0.005	0.045	-0.038	0.052
C X Other	0.002	0.051	-0.004	0.062
<b>D. Average speed limit</b>				
Model 1				
B: Total Sample	-0.028	0.103	-0.107	0.158
Model 2				
B: White	0.222	0.425	0.585	0.481
B X Black	-0.412	0.451	-0.934~	0.542
B X Hispanic	-0.066	0.451	-0.515	0.535
B X Asian	-0.402	0.496	-0.777	0.558
B X Other	-0.320	0.563	-1.039	0.733

	400-meter Network Buffer		800-meter Network Buffer	
	Coefficient	SE	Coefficient	SE
<b>E. Highway density</b>				
Model 1				
C: Total Sample	-0.034	0.075	-0.064	0.090
Model 2				
C: White	-0.122	0.185	0.030	0.193
C X Black	0.089	0.260	-0.125	0.322
C X Hispanic	0.089	0.221	-0.180	0.245
C X Asian	0.126	0.212	-0.055	0.236
C X Other	-0.142	0.751	-0.312	0.481
<b>D. Intersection density</b>				
Model 1				
D: Total Sample	0.006	0.005	0.006	0.007
Model 2				
D: White	0.005	0.011	0.015	0.015
D X Black	0.011	0.014	0.009	0.018
D X Hispanic	-0.004	0.014	-0.022	0.018
D X Asian	-0.013	0.017	-0.026	0.021
D X Other	0.007	0.022	-0.009	0.027
<b>E. Residential density</b>				
Model 1				
E: Total Sample	-0.000	0.001	0.000	0.001
Model 2				
E: White	0.002	0.002	0.002	0.002
E X Black	-0.002	0.002	-0.001	0.003
E X Hispanic	-0.001	0.002	-0.002	0.003
E X Asian	-0.003	0.003	-0.004	0.003
E X Other	-0.002	0.003	-0.002	0.004
SE= Standard Error				
~ p < 0.10; * p < 0.05 (bold); ** p < 0.01 (bold)				
<sup>a</sup> Model 1 estimates the association between the built environment and body mass index among the total sample; Model 2 estimates the studied association and includes an interaction for race/ethnicity. For each model, we evaluate the estimated effect of each built environment feature separately. All models are adjusted for individual-level race/ethnicity, individual-level gender, individual-level age, individual-level nativity, individual-level family structure (having siblings), neighborhood-level percent of Black residents, neighborhood-level percent of Hispanic residents, neighborhood-level percent of households below poverty and neighborhood-level percent foreign born within the corresponding neighborhood buffer size. Regression estimates are also controlled for school using indicator variables.				
Note: All density measures are expressed as per square kilometer.				

# Key Findings

- Park density and walking destination mix diversity was associated with higher BMI among Blacks; bus stop density was associated with higher BMI among Whites, but lower among other groups; sidewalks showed mixed findings.
- BMI was not associated with subway density, retail destinations, cultural/educational destinations, average speed limit, highway density, intersection density or residential density.

# Limitations

- Cross-sectional design
- Self-reported height and weight data
- Residual confounding
- Generalizability

# Strengths

- Spatial modeling strategy
- Socially meaningful neighborhoods
- Modifiable areal unit problem
- Race/ethnicity as an effect modifier

# Overall Conclusions

- Built environment was associated with obesity risk, but sometimes in the unexpected direction
- Race/ethnicity and neighborhood definition matters in research on the built environment and BMI

# Funding



Center on the Developing Child  HARVARD UNIVERSITY





# Thank You!

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