ETHNIC DISPARITY IN

Environmental Support for Children's Walking to School

BY:

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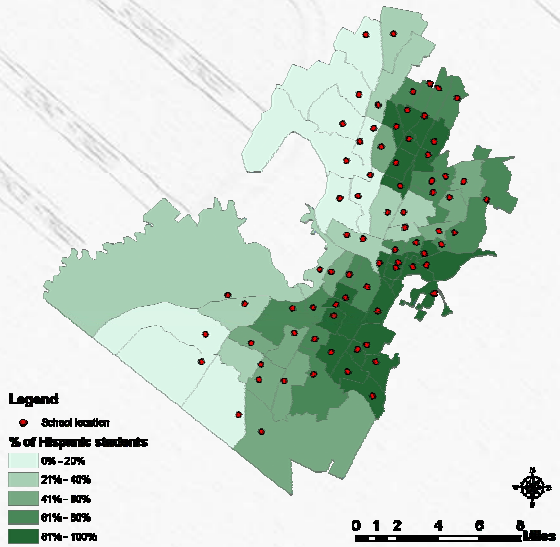


CONTENTS

INTRODUCTION

1. Built environment and children's walking to school
   - ►Insufficient empirical knowledge to guide effective interventions
   - ►Limited methods to assess walkability and safety
   - ►Lack of understanding on ethnic disparities

2. Needs for specific attention on Hispanic children
   - ►High risk of developing obesity – prone to physical inactivity
   - ►Limited transportation mobility – forced to walk to school
   - ►Exposure to poor walking environments

3. Understudied aspects for built environment and general walking of adult populations
   - ►Relationship between
     neighborhood-level walkability (urban forms and land uses) and ***street-level*** walkability (urban design and architectural qualities)
   - ►Relationship between ***walkability*** and ***safety***
   - ►Low-income, minority neighborhoods in high-density, urban areas

INTRODUCTION

AIMS:

- To examine different aspects of the environment potentially associated with children's walking to school and the relationships among them
- To explore disparity issues by examining the differences in walkability and safety of the school's attendance areas, based on the percentage of Hispanic students

HYPOTHESIS:

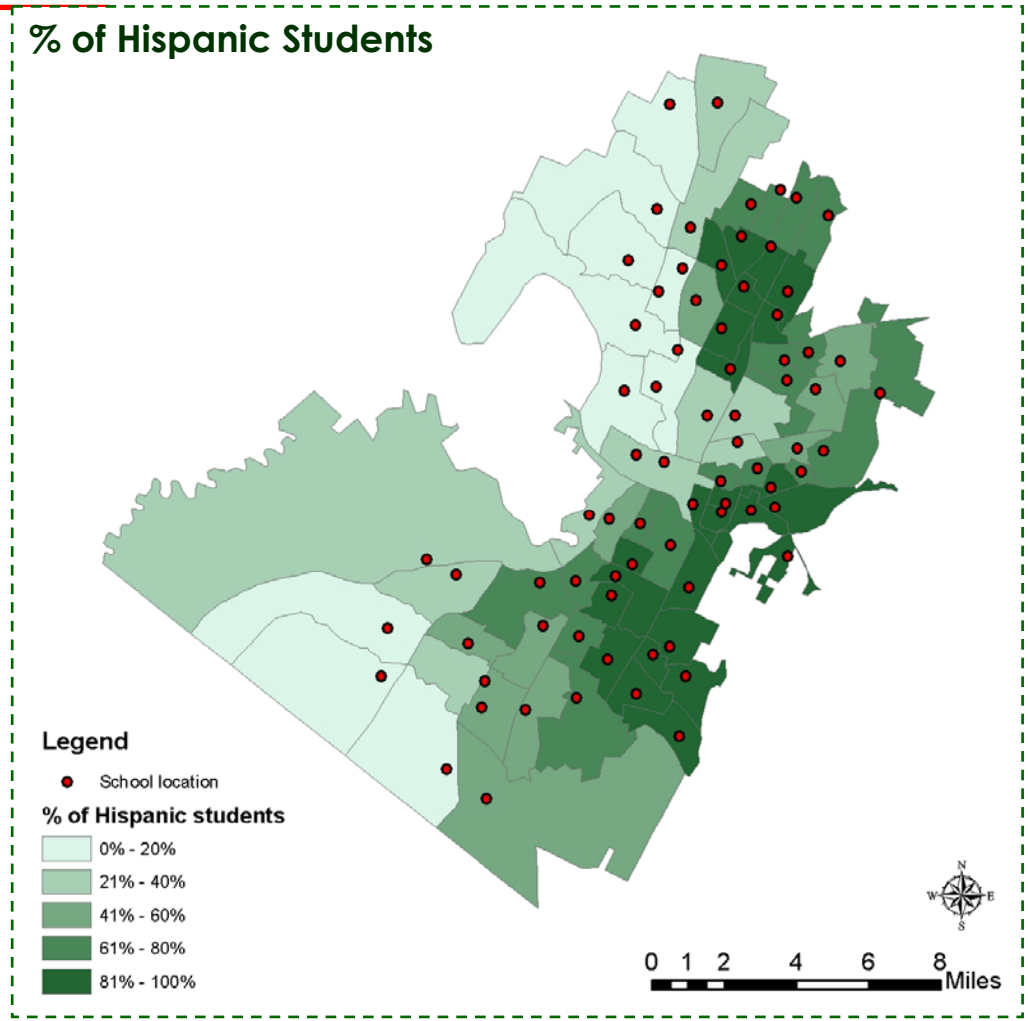
- Schools with ***higher percentages of Hispanic students*** have ***higher neighborhood-level*** (i.e. attendance area's) ***walkability***, yet ***more dangers from traffic and crime***, and ***lower street-level walkability***.

II METHODS

- **DESIGN:**
  cross-sectional study

- **SETTINGS:**
  73 public elementary schools in Austin, TX, with a wide range in the % of Hispanic students (mean = 59.1%)

- **MEASURES:**
  1. **GIS measure for *neighborhood-level walkability* and *safety***
  2. **Field audits for *street-level walkability***
  3. **Spatial autocorrelation and Gini coefficient**



A. GIS MEASURES

Unit of analysis: school's attendance area

TABLE 1. Definitions, equations, descriptive statistics, and Gini coefficients for variables of neighborhood-level walkability and safety

Variable	Definition	Equation	Mean	SD	Gini coefficient
Neighborhood-level walkability					
Distance to school	Percentage of residential units located within half a mile street network distance from school	Number of residential units located within half a mile street network distance / total number of residential units	0.343	0.198	0.322
Pedestrian Facilities	Sidewalk completeness	Total miles of sidewalks / (total miles of streets * 2)	0.267	0.137	0.286
	Traffic signal density	Number of traffic signals / total miles of streets	0.266	0.198	0.361
Residential density	Gross population density	Total population / total acres of the area	6.815	3.717	0.305
Street connectivity	Street density	Total footage of streets / total acres of the area	136.067	48.678	0.195
	Street intersection density	Number of street intersections (> 3-way) / total acres of the area	0.197	0.113	0.287
Land-use mix[a]	Evenness of distribution of residential (R), commercial (C), and office (O) land use	(-1) * [(area of R / total area of R, C, and O) * ln (area of R / total area of R, C, and O) + (area of C / total area of R, C, and O) * ln (area of C / total area of R, C, and O) + (area of O / total area of R, C, and O) * ln (area of O / total area of R, C, and O)] / ln (number of land use present)	0.451	0.242	0.305
Safety					
Traffic safety	Average traffic volume	Average daily traffic count of sampled locations	8552.000	3873.000	0.250
	Percentage of high-speed streets	Total footage of streets with speed limit > 30 miles per hour / total footage of all streets	0.208	0.077	0.211
Crime safety	Offenses per 1,000 persons per year	(Number of offenses in year 2004 and 2005 * 1000) / (total population *2)	238.976	182.432	0.334

SD, standard deviation

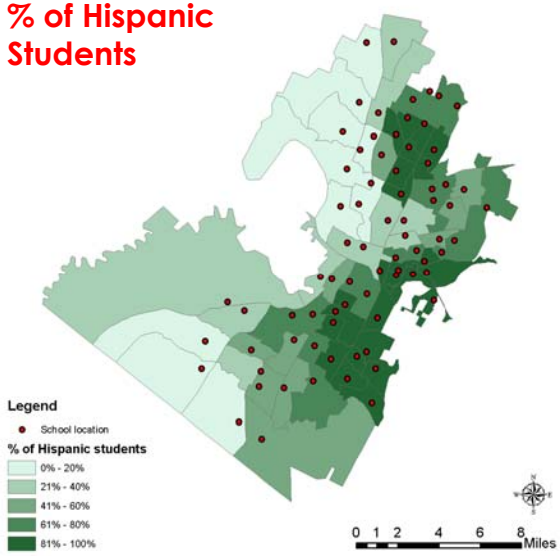
[a] The measure for land-use mix was adopted from the SMARTRAQ study [24].

A. GIS MEASURES

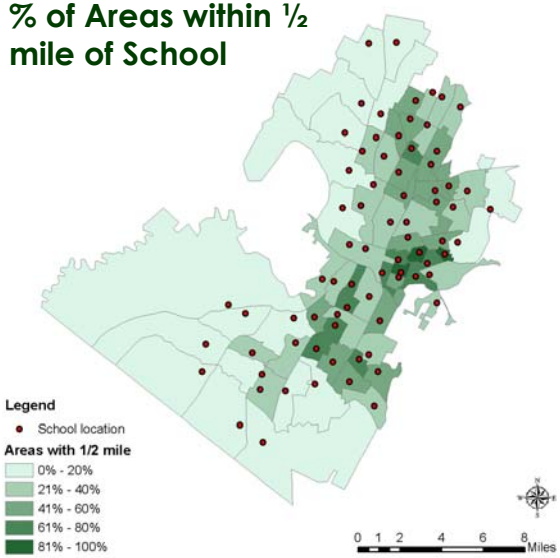
Unit of analysis: school's attendance area

► GIS Maps

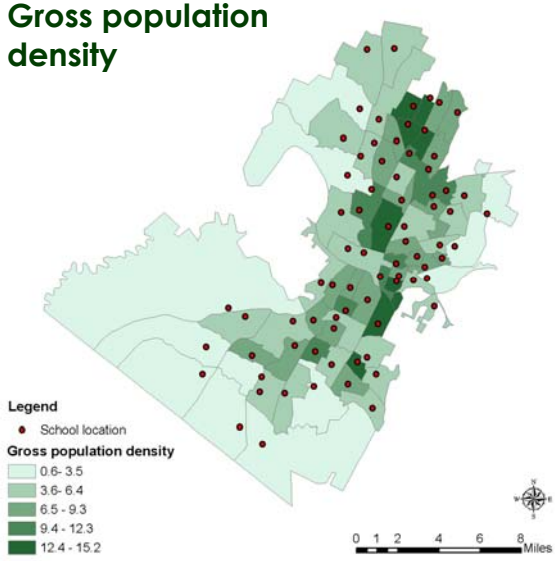
% of Hispanic Students



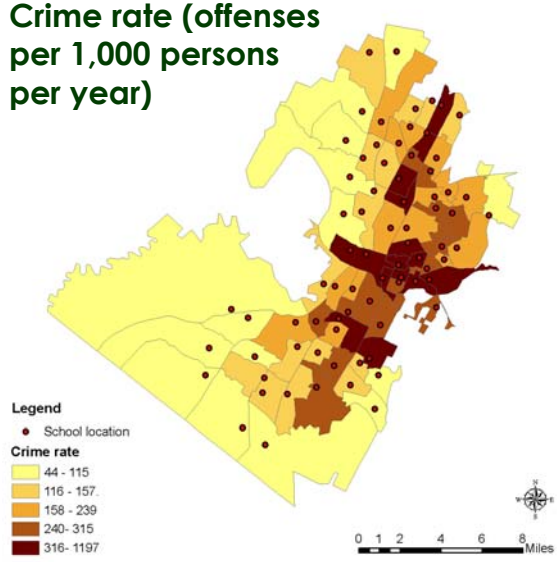
% of Areas within ½ mile of School



Gross population density



Crime rate (offenses per 1,000 persons per year)



B. FIELD AUDITS

for street-level walkability (urban design & architectural qualities)

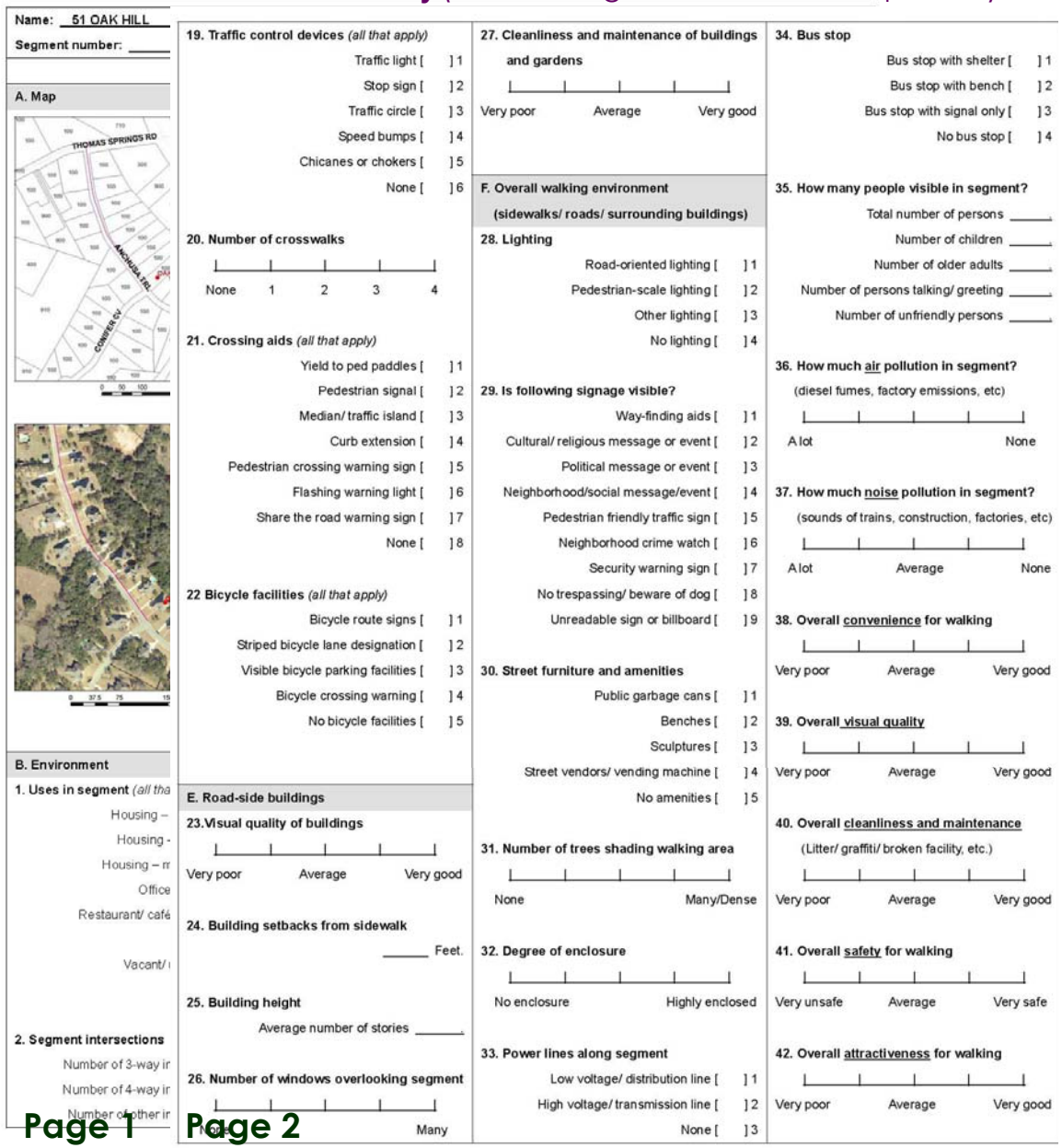
1. SAMPLING:

A 200-meter street segment, close to the geographic center of the school's attendance area, and:

- ►has a posted speed limit of 30 mph;
- ►has > 80% of road-side parcels being residential development;
- ►has sidewalks on at least one side of the street;
- ►is not a dead-end street.

2. INSTRUMENT:

- ►Adopted from PEDS
- ►Intraclass Correlation Coefficients tested



Name: 51 OAK HILL

Segment number: ____

A. Map

B. Environment

1. Uses in segment *(all tha*

Housing –
Housing -
Housing – m
Office
Restaurant/ café
Vacant/ (

2. Segment intersections

Number of 3-way ir
Number of 4-way ir
Number of other ir

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19. Traffic control devices *(all that apply)*

Traffic light [ ] 1
Stop sign [ ] 2
Traffic circle [ ] 3
Speed bumps [ ] 4
Chicanes or chokers [ ] 5
None [ ] 6

20. Number of crosswalks

None 1 2 3 4

21. Crossing aids *(all that apply)*

Yield to ped paddles [ ] 1
Pedestrian signal [ ] 2
Median/ traffic island [ ] 3
Curb extension [ ] 4
Pedestrian crossing warning sign [ ] 5
Flashing warning light [ ] 6
Share the road warning sign [ ] 7
None [ ] 8

22 Bicycle facilities *(all that apply)*

Bicycle route signs [ ] 1
Striped bicycle lane designation [ ] 2
Visible bicycle parking facilities [ ] 3
Bicycle crossing warning [ ] 4
No bicycle facilities [ ] 5

E. Road-side buildings

23.Visual quality of buildings

Very poor Average Very good

24. Building setbacks from sidewalk

____ Feet.

25. Building height

Average number of stories ____

26. Number of windows overlooking segment

Many

27. Cleanliness and maintenance of buildings and gardens

Very poor Average Very good

F. Overall walking environment (sidewalks/ roads/ surrounding buildings)

28. Lighting

Road-oriented lighting [ ] 1
Pedestrian-scale lighting [ ] 2
Other lighting [ ] 3
No lighting [ ] 4

29. Is following signage visible?

Way-finding aids [ ] 1
Cultural/ religious message or event [ ] 2
Political message or event [ ] 3
Neighborhood/social message/event [ ] 4
Pedestrian friendly traffic sign [ ] 5
Neighborhood crime watch [ ] 6
Security warning sign [ ] 7
No trespassing/ beware of dog [ ] 8
Unreadable sign or billboard [ ] 9

30. Street furniture and amenities

Public garbage cans [ ] 1
Benches [ ] 2
Sculptures [ ] 3
Street vendors/ vending machine [ ] 4
No amenities [ ] 5

31. Number of trees shading walking area

None Many/Dense

32. Degree of enclosure

No enclosure Highly enclosed

33. Power lines along segment

Low voltage/ distribution line [ ] 1
High voltage/ transmission line [ ] 2
None [ ] 3

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34. Bus stop

Bus stop with shelter [ ] 1
Bus stop with bench [ ] 2
Bus stop with signal only [ ] 3
No bus stop [ ] 4

35. How many people visible in segment?

Total number of persons ____
Number of children ____
Number of older adults ____
Number of persons talking/ greeting ____
Number of unfriendly persons ____

36. How much air pollution in segment?

(diesel fumes, factory emissions, etc)

A lot None

37. How much noise pollution in segment?

(sounds of trains, construction, factories, etc)

A lot Average None

38. Overall convenience for walking

Very poor Average Very good

39. Overall visual quality

Very poor Average Very good

40. Overall cleanliness and maintenance

(Litter/ graffiti/ broken facility, etc.)

Very poor Average Very good

41. Overall safety for walking

Very unsafe Average Very safe

42. Overall attractiveness for walking

Very poor Average Very good

B. FIELD AUDITS

Unit of analysis: 200-meter street segment

Table 2. Intra-class coefficients (ICCs), descriptive statistics, and Gini coefficients for variables of street-level walkability[a]

Variable	Single measure ICC	Average measure ICC	Mean or %	SD	Gini coefficient
Subjective variables measured on five-point Likert scale					
Sidewalk maintenance	0.619	0.764	2.676	0.728	0.152
Road maintenance	0.559	0.717	3.179	0.581	0.101
Building maintenance	0.770	0.870	2.556	0.777	0.170
Visual quality of buildings	0.741	0.851	2.460	0.742	0.163
Degree of tree shade	0.681	0.810	2.684	0.813	0.158
Degree of enclosure	0.322	0.487	2.705	0.599	0.115
Degree of surveillance from windows overlooking sidewalks	0.405	0.577	2.775	0.533	0.107
Air quality	0.172	0.294	3.397	0.499	0.078
Quietness (noise level)	0.377	0.547	3.020	0.767	0.140
Overall convenience	0.576	0.731	2.921	0.680	0.130
Overall visual quality	0.658	0.794	2.620	0.695	0.146
Overall amenities	0.625	0.769	2.461	0.718	0.162
Overall maintenance	0.723	0.839	2.487	0.783	0.176
Overall perceived safety	0.536	0.698	2.916	0.635	0.123

(To be continued)

B. FIELD AUDITS

Unit of analysis: 200-meter street segment

(Continued) Table 2. Intra-class coefficients (ICCs), descriptive statistics, and Gini coefficients for variables of street-level walkability[a]

Variable	Single measure ICC	Average measure ICC	Mean or %	SD	Gini coefficient
Objective variables measured with absolute values					
Sidewalk's distance from curbs (ft)	--	--	2.726	1.850	0.361
Sidewalk width (ft)	--	--	4.137	0.502	0.056
Number of connections to other sidewalks/crosswalks	--	--	0.850	0.981	0.598
Buildings' setback from roads (ft)	0.771	0.871	32.185	12.101	0.170
Objective variables measured with binary values (1 = yes; 0 = no)					
Presence of slope	--	--	57.6%	--	0.425
Presence of sidewalk obstructions	--	--	45.2%	--	0.548
Presence of buffers between sidewalks and roads	--	--	74.0%	--	0.260
Presence of on-street parking	--	--	94.5%	--	0.055
Presence of power lines	--	--	39.7%	--	0.603

[a] Some other variables were also measured in field audits, yet reached same results for all sample segments. These constructs were sidewalk material (concrete), presence of pedestrian-oriented lighting (no), presence of off-street parking lots (no), the need to walk through parking lots in order to access buildings (no), number of lanes (2), and presence of street furniture (no).

SD, standard deviation

B. FIELD AUDITS

- Photos from field audits

High street-level walkability ⟷ **Low** street-level walkability

C. DATA ANALYSIS

1. Exploratory Analysis

- **Spatial autocorrelations and Gini coefficients** to understand the relative magnitude of disparity
- **GIS Maps** to understand spatial patterns

2. Regression Analysis

examined the association between the percentage of Hispanic students within school and each environmental variable

(The % of Hispanic students was converted into a five-category variable based on the percentiles, and treated as a continuous variable.)

- **Simple linear regression** for continuous variables
- **Binary logistic regression** for dichotomous variables

3. Analysis of Variance

compared the means of the environmental variables for the bottom and the top quartile schools, based on the % of Hispanic students

4. Pearson Correlation and Factor Analysis

explored relationships among various environmental variables

III RESULTS

HYPOTHESIS:

Higher percentages of Hispanic students in the school is associated with

- **Higher** neighborhood-level walkability √
- **More** dangers from traffic X
- **More** dangers from crime √
- **Lower** street-level walkability √

Table 3. Results from Regression Analysis[a] and Analysis of Variance (ANOVA)[b]

Variable	Linear regression			ANOVA
	β	Standard error	R^2	EMD
Neighborhood-level walkability	(+)			(+)
Distance (% of residential units within 1/2 mile street network distance)	0.072**	0.014	0.521	0.279**
Sidewalk completeness (%) (n = 72)	0.040**	0.010	0.178	0.150**
Traffic signal density (per mile of street) (n = 72)	--	--	--	0.099*
Gross population density (per acre)	1.167**	0.274	0.204	4.268**
Street density (feet per acre)	8.234*	3.895	0.059	--
Street intersection density (per acre)[c] (n = 68)	--	--	--	0.082**
Land-use mix (range: 0-1)	0.055**	0.019	0.108	0.165*
Safety				
Average traffic volume	--	--	--	--
Percentage of high-speed streets	-- (+)	--	--	-- (+)
Crime rate (n = 68)	47.300**	13.965	0.139	162.4**

To be continued.

(Continued) Table 3. Results from Regression Analysis[a] and Analysis of Variance [b]

Variable	Linear regression			ANOVA
	β	Standard error	R^2	EMD
Street-level walkability				
Subjective variables (measured on five-point Likert scale)				
Sidewalk maintenance	-0.189**	0.056	0.140	-0.879**
Road maintenance	--	--	--	--
Building maintenance	-0.282**	0.055	0.273	-1.206**
Visual quality of buildings	-0.268**	0.052	0.271	-1.156**
Degree of tree shade	--	--	--	--
Degree of enclosure	--	--	--	-0.425*
Degree of surveillance from windows overlooking sidewalks	--	--	--	--
Air quality (n = 70)	-0.108**	0.039	0.097	-0.625**
Quietness (noise) (n = 72)	-0.166**	0.060	0.096	-0.730**
Overall convenience	-0.113*	0.055	0.057	-0.518*
Overall aesthetics	-0.242**	0.050	0.251	-1.035**
Overall amenities (n = 72)	-0.258**	0.051	0.267	-1.069**
Overall maintenance	-0.277**	0.056	0.260	-1.127**
Overall perceived safety	-0.210**	0.046	0.226	-0.866**

To be continued.

(-) (-)

(Continued) Table 3. Results from Regression Analysis[a] and Analysis of Variance (ANOVA)[b]

Variable	Linear regression			ANOVA
	β	Standard error	R^2	EMD
Street-level walkability				
Objective variables (measured with absolute values)				
Sidewalk's distance from curbs	--	--	--	--
Sidewalk width (unit: feet)	--	--	--	--
Number of connections to other sidewalks/crosswalks	--	--	--	--
Buildings' setback from roads	-2.361*	0.958	0.079	-10.374**
Objective binary variables (0 = no, 1 = yes)	**Logistic regression[e]**			
	β	Standard error	Estimated odds ratio	
Presence of slope	-0.658**	0.196	0.518	
Presence of sidewalk obstruction	(0.290)[d]	(0.170)	(1.336)	
Presence of buffers between sidewalks and roads	--	--	--	
Presence of on-street parking	(1.725)	(0.957)	(5.614)	
Presence of power lines	(0.299)	(0.174)	(1.348)	

[a] In the Linear Regression, the percentage of Hispanic students was converted into a five-category variable and treated as a continuous variable. N = 73, unless specifically noted

[b] In the ANOVA, the estimated mean difference (EMD) was calculated between the top quartile with the highest percentage of Hispanic students and the bottom quartile.

[c] A natural logarithm transformation was used for intersection density in ANOVA.

[d] Results in the parenthesis were marginally significant at the 0.1 level.

** $P < 0.01$; * $P < 0.05$; β, unstandardized beta coefficient

Pearson correlations and Factor Analysis

examined relationships among various environmental variables

Table 4. Factor analysis for standardized scores of variables for macro-level walkability and safety

	Component		
	1	2	3
Distance (% of residential units within 1/2 mile street network distance)	**0.672**	0.289	-0.308
Sidewalk completeness	0.190	**0.808**	0.102
Traffic signal density	0.553	0.234	**0.627**
Population density	0.302	**0.857**	-0.008
Street density	**0.780**	0.420	0.101
Street intersection density	**0.808**	0.330	0.078
Land-use mix	0.408	0.215	**0.640**
Traffic volume	-0.169	0.452	**0.657**
Percentage of high-speed roads	-0.029	-0.339	**0.741**
Crime rate	**0.804**	-0.181	0.296

IV DISCUSSION

- Important to address ***crime prevention*** and ***improvement of street-level walkability*** in low-income, Hispanic neighborhoods

- Need for a ***comprehensive approach*** in research and promotion efforts to encourage walking to school

  - Neighborhood-Level Walkability (urban forms and land uses) vs. street-Level Walkability (urban design qualities)
  - Walkability vs. Safety

- Need to consider ***composite measures*** to capture the environmental support of walking to school

- Need for ***tailored intervention strategies*** for specific geographic contexts and populations

THANKS!

Questions?