

# Thresholds and Impacts of Walkable Distance for Active School Transportation in Different Contexts



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# BACKGROUND

- ❖ **Distance:** One of the strongest correlates of walking to school (WTS)
- ❖ **Questions about “walkable distance” remain**
  - What is the threshold?
  - Does its impact vary by context?
- ❖ **Significance:** Inform school planning & future interventions

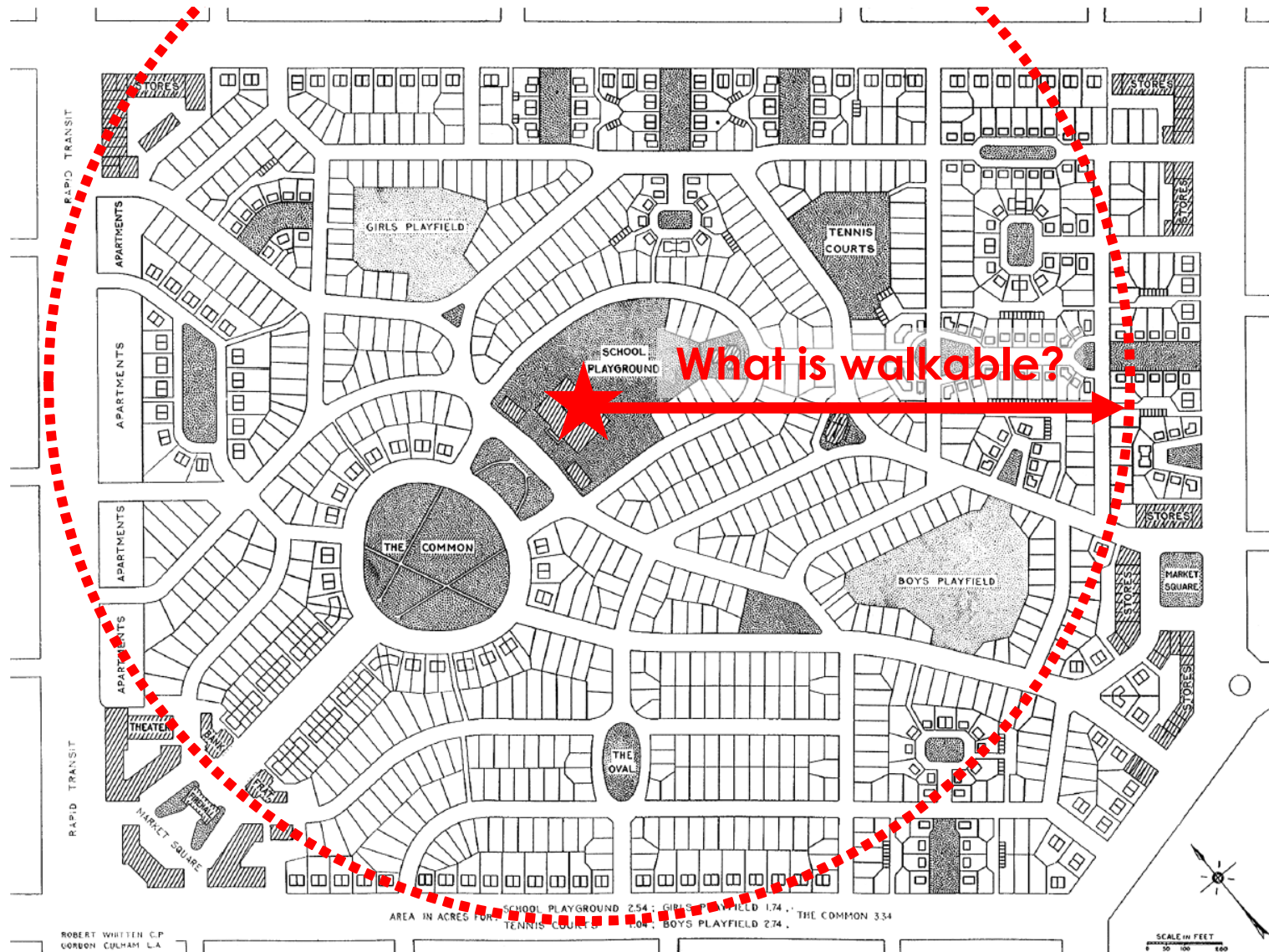


[www.norsesys.com/fleet-maintenance-software-school-bus-routing-24.jpg](http://www.norsesys.com/fleet-maintenance-software-school-bus-routing-24.jpg)



[thinksmartplan.com/wordpress/wp-content/uploads/2010/08/parent-pick-up.jpg](http://thinksmartplan.com/wordpress/wp-content/uploads/2010/08/parent-pick-up.jpg)

# How do we plan for walkable schools/neighborhoods?



Schematic of a neighborhood unit for modest dwellings (Perry, 1929)

# LITERATURE REVIEW

- ❖ **Found 43 studies** that examined impacts of distance
- ❖ **36 reported negative impacts**
  - **21 used continuous variables** of distance  
(**15** based on parental/child estimate,  
**6** based on objective measures)
  - **15 used categorical variables** of distance  
with thresholds of 0.25, 0.5, or 1 mile  
(mostly based on one parental estimate)

# LITERATURE REVIEW

- ❖ A few examined thresholds of walkable distance
  - One asked parents about perceived thresholds
  - A few used cumulative %s of WTS per covered distance
    - 1 km, 0.8 km & 0.5 km ranges used  
(too coarse)
    - **85% & 50% WTS** used to decide the criterion distance
- ❖ A few studied **age/gender-specific thresholds**
- ❖ No studies on **context-specific thresholds**

# STUDY DESIGN

## ❖ Cross-sectional study

## ❖ Data collection

- Parental survey in Austin (2007 & 2010, n=6233)  
(Collected: school travel modes; personal, social & physical environmental factors)
- Geocoding & shortest route analysis

## ❖ Data analysis

- Descriptive statistics: Cumulative %s of WTS ⇒  
Threshold of walkable distance
- Structural Equation Modeling predicting  
“perceived close-enough distance” & “WTS”



# STUDY SETTING

## Legend

Suburban high-income

Urban mid-income

Urban low-income

Inner-city low-income

• ES Location 2010

## Elementary Schools in AISD

% of free or reduced-price lunch

0.00 - 16.70

16.71 - 61.40

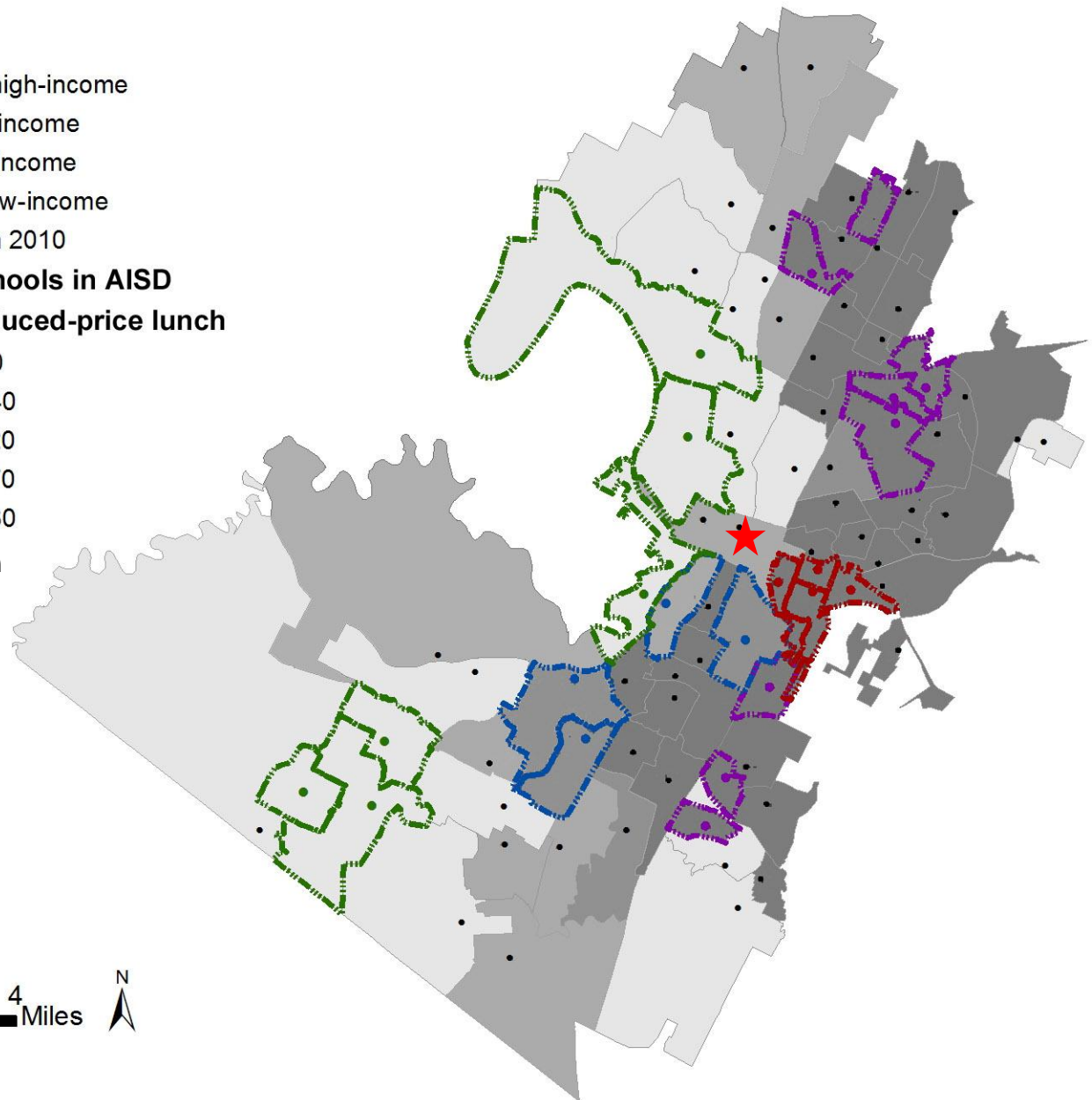
61.41 - 76.20

76.21 - 93.70

93.71 - 97.80

★ Downtown

0.5 1 2 3 4 Miles



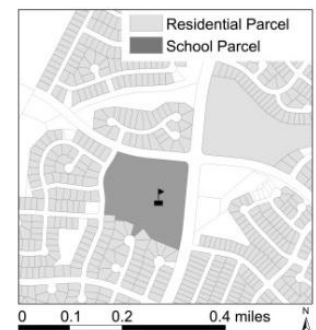
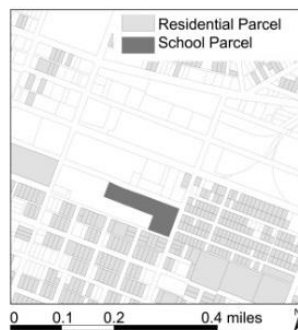


# STUDY SETTING

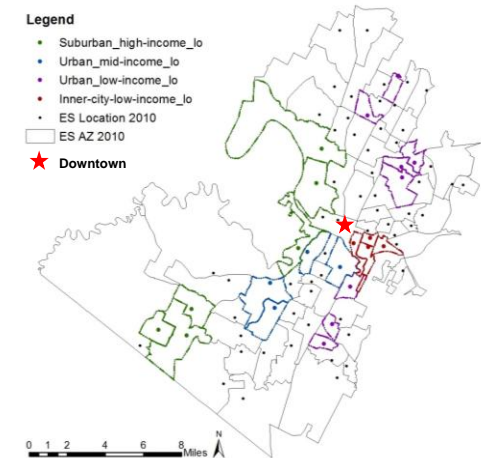
## Mean (Standard Deviation) of Physical Environmental Characteristics

School type	Inner city, low-income (4 schools)	Urban, low-income (8 schools)	Urban, mid-income (4 schools)	Suburban; high-income (6 schools)
Population density (/acre)	9.3 (4.7)	11.2 (3.2)	6.6 (1.5)	2.5 (1.6)
Living within ½ mile (%)	39 (23)	28 (15)	23 (5)	14 (6)
Sidewalk completeness	36 (9)	38 (19)	28 (12)	8 (1)
Street intersection density	0.32 (0.16)	0.18 (0.05)	0.20 (0.06)	0.12 (0.07)
Land use mix	0.57 (0.12)	0.54 (0.15)	0.48 (0.21)	0.18 (0.17)
Crash rate	9.0 (2.5)	6.9 (3.5)	5.1 (3.4)	1.9 (1.3)
Crime rate	100 (35)	102 (52)	40 (15)	10 (8)

### Sample map



# STUDY POPULATION

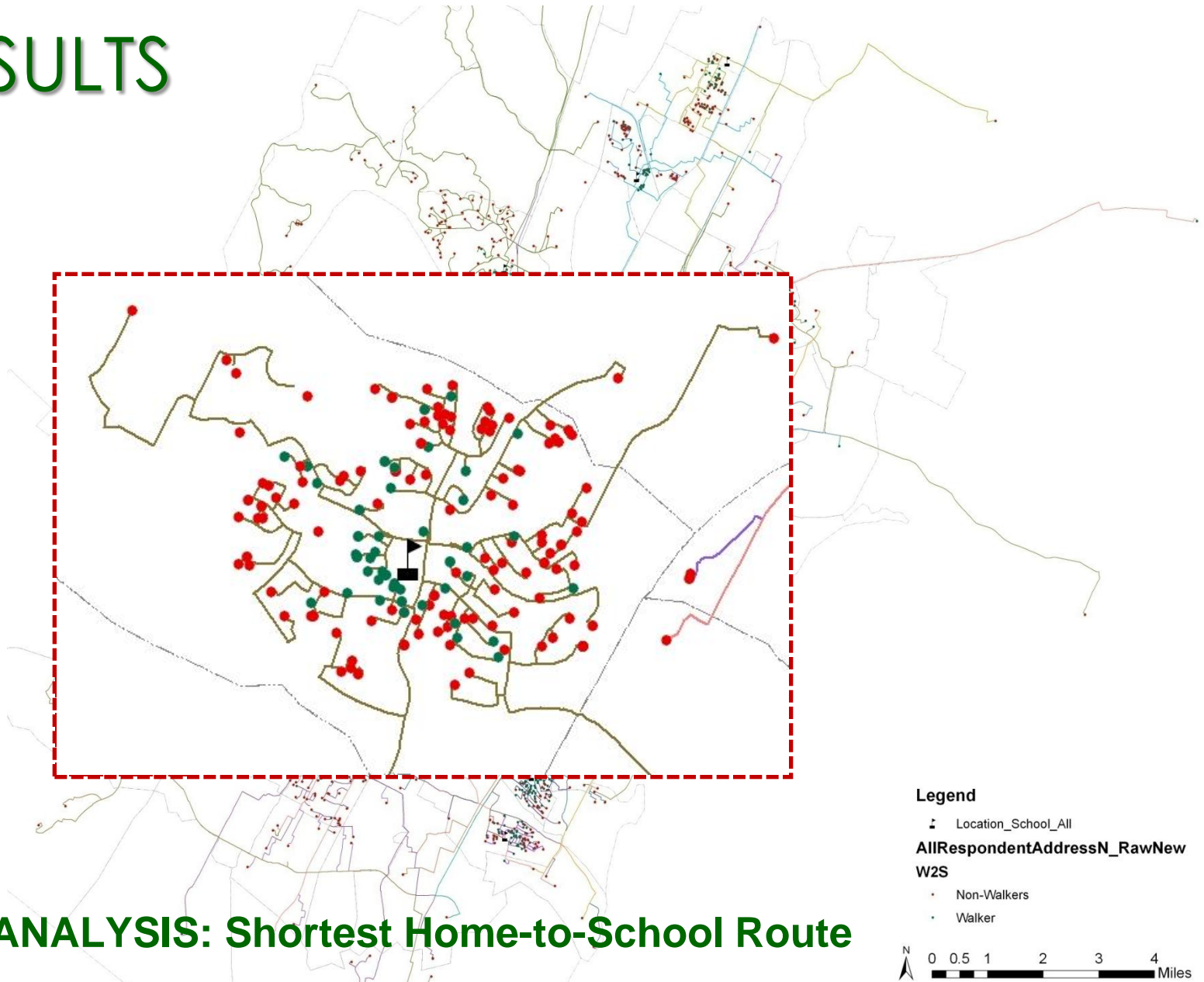


## Mean (Standard Deviation) of Population Characteristics

School type	Inner city, low-income (4 schools)	Urban, low-income (8 schools)	Urban, mid-income (4 schools)	Suburban; high-income (6 schools)
Hispanic (%) <sup>a</sup>	90 (6)	82 (4)	58 (15)	15 (6)
Free or reduced- price lunch (%) <sup>a</sup>	92 (1)	94 (3)	65 (12)	7 (6)
Medium household income <sup>c</sup>	24,303 (1,878)	36,257 (3,737)	45,531 (8,506)	87,123 (21,030)

<sup>a</sup> For total student enrolment at school; <sup>b</sup> For the survey sample; <sup>c</sup> Based on the Census data.

# RESULTS



## GIS ANALYSIS: Shortest Home-to-School Route

# DESCRIPTIVE STATISTICS

## Mean (Standard Deviation) or Frequency of Physical Environmental Characteristics

School type	Inner city, low-income (4 schools)	Urban, low-income (8 schools)	Urban, mid-income (4 schools)	Suburban; high-income (6 schools)
Total Sample size by school	202 (91)	383 (133)	208 (24)	271 (101)
Hispanic students among respondents	90% yes	85% yes	54% yes	13% yes
Highest parental education (range: 1 lowest-6 highest)	2.8 (1.1)	2.7 (1.1)	4.0 (1.4)	5.4 (0.8)
Students walking to/from school	29% Yes	44% Yes	28% Yes	22% Yes
Parents perceiving close-enough distance	40% Yes	55% Yes	47% Yes	56% Yes
Students with school bus service	56% Yes	29% Yes	25% Yes	28% Yes
Home-to-school distance (Mile)	1.45 (1.60)	0.92 (1.35)	1.67 (2.35)	1.87 (2.15)
Child crossing freeway en route to school	19% Yes	15% Yes	15% Yes	18% Yes

# Walkable Distance

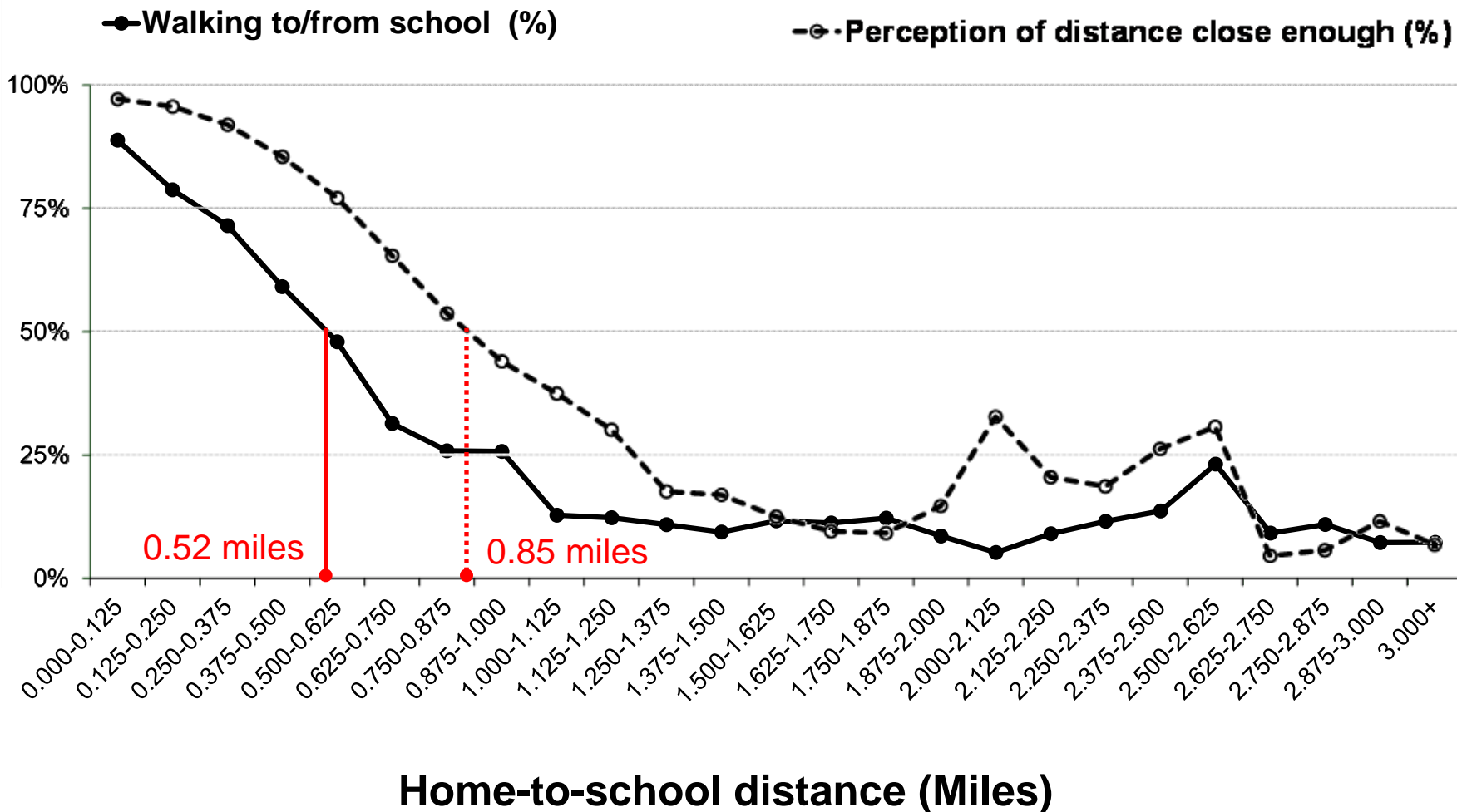
- What is the threshold?
- Does distance & WTS have a linear relationship?
- Does it vary by contexts?

# Home-to-school Distance for Different Groups

## Descriptive statistics for home-to-school distance

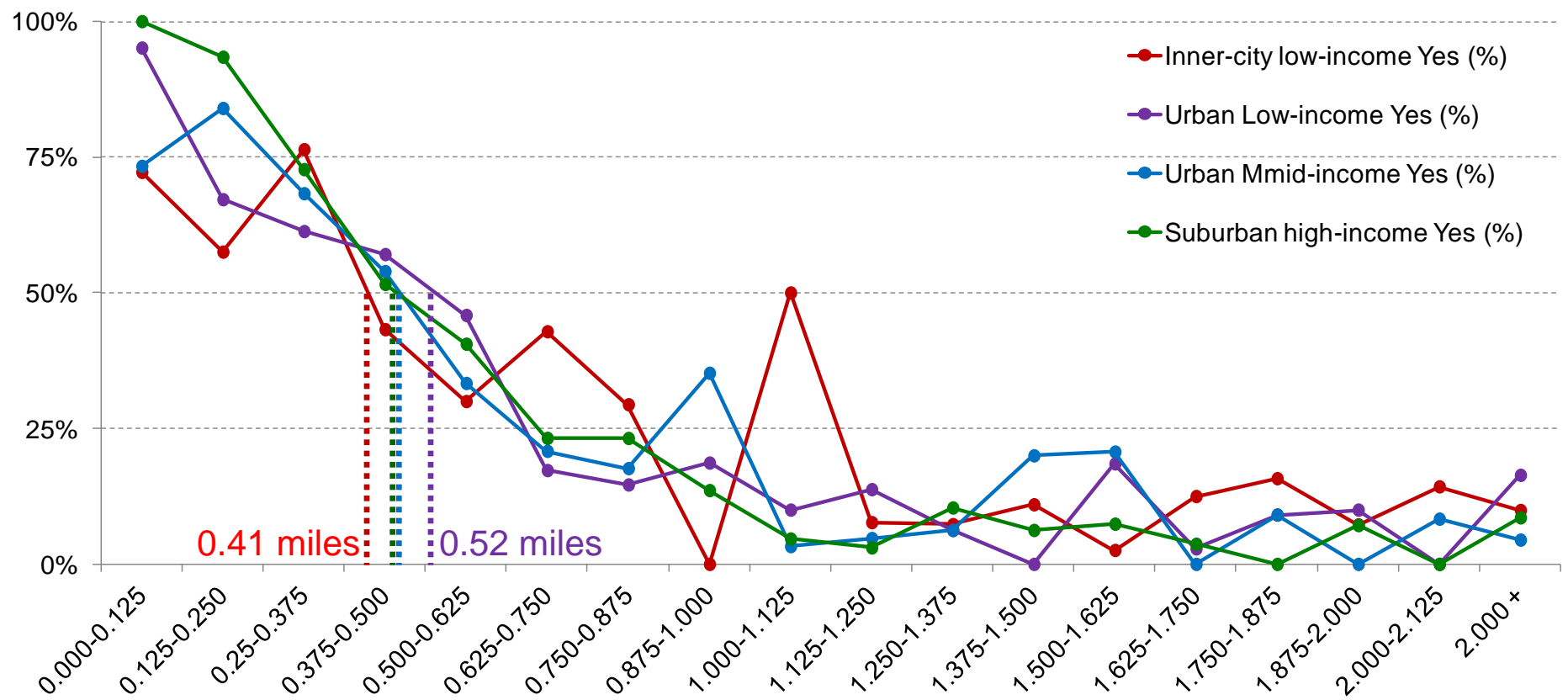
		Perception of Distance close enough		
		Yes	No	Total
Walking to/from school	Yes	Mean= <b>0.550</b>	Mean= <b>1.303</b>	Mean=0.691
		S.D.=0.738	S.D.=2.061	S.D.=1.143
		N=1693 ( <b>27.16%</b> )	N=390 ( <b>6.26%</b> )	N=2083 (33.42%)
	No	Mean= <b>0.864</b>	Mean= <b>2.15</b>	Mean=1.680
		S.D.=0.989	S.D.=2.310	S.D.=2.023
		N=1509 ( <b>24.21%</b> )	N=2641(42.37%)	N=4150 (66.58%)
Total	Mean=0.698	Mean=2.044	Mean=1.349	
	S.D.=0.880	S.D.=2.293	S.D.=1.838	
	N=3202 (51.37%)	N=3031 (48.63%)	N=6233 (100%)	

# WTS within Different Distance Ranges (Total Sample)

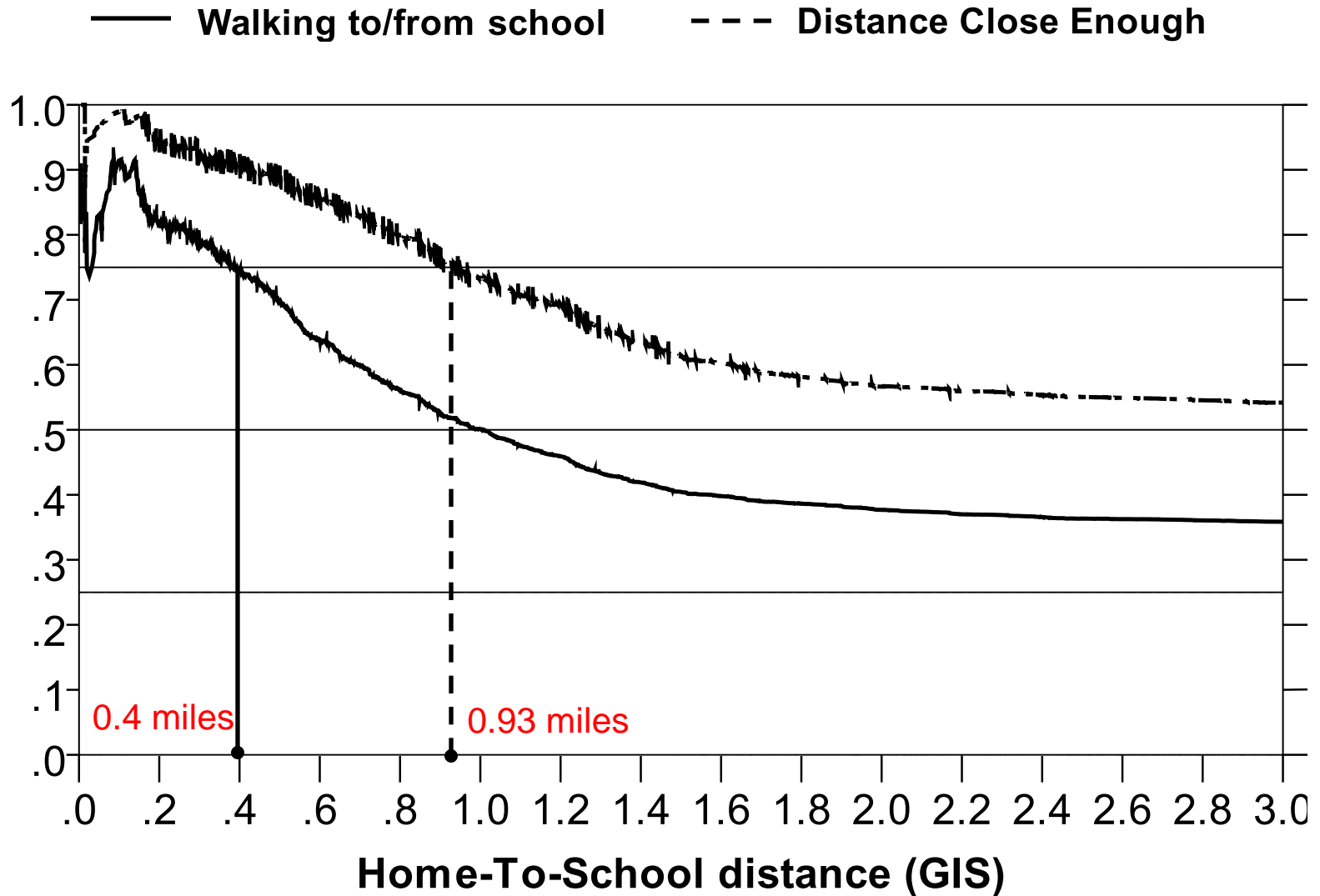




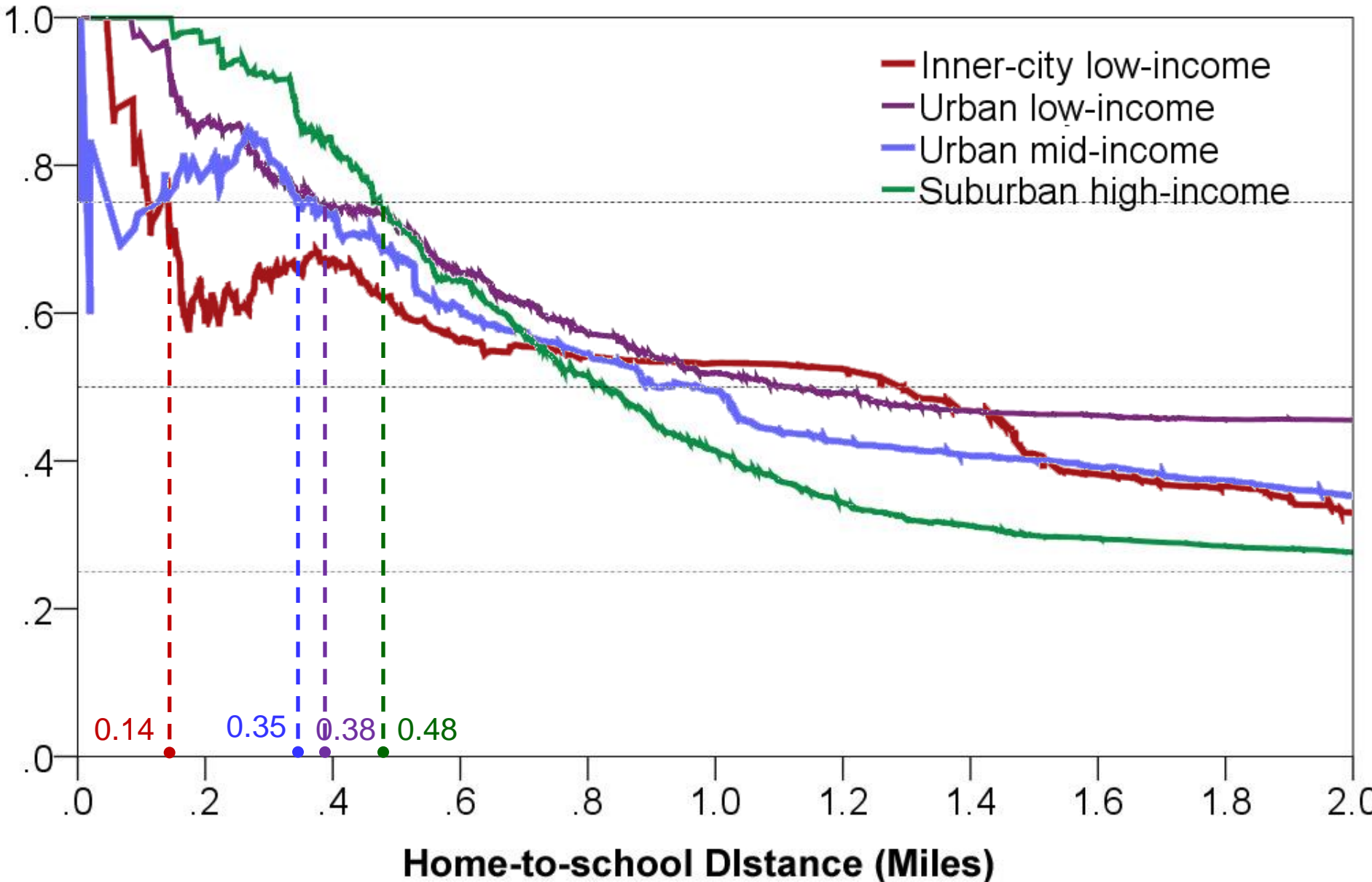
# WTS in Different Distance Ranges (Sub-samples)



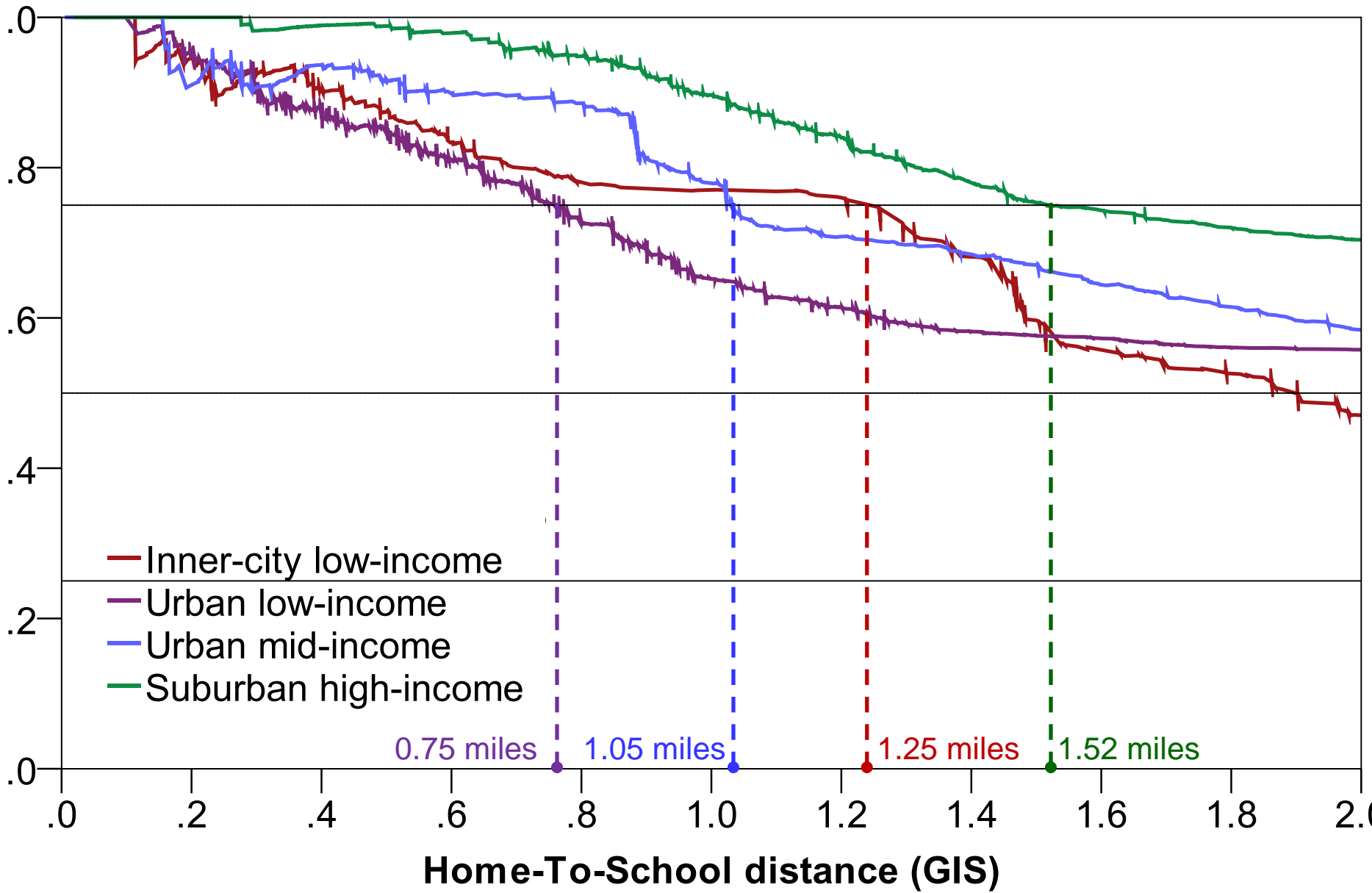
## Cumulative % of WTS & Perceived Close-Enough Distance, by Home-to-School Distance



**Cumulative % of Walking to/from School by Distance in Different Contexts**



Cumulative % of Perceiving Close-enough Distance in Different Contexts

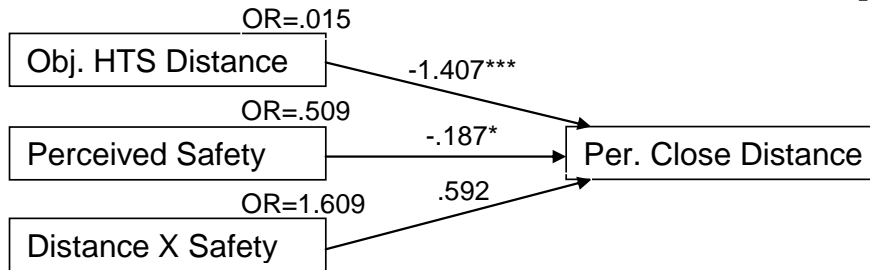


# Predict Perceived Walkable Distance

- Completed analysis: used the 2007 survey sample
- Final analysis: will combine 2007 & 2010 samples & run separate models for 4 types of contexts

# Model Comparison

➤ A:

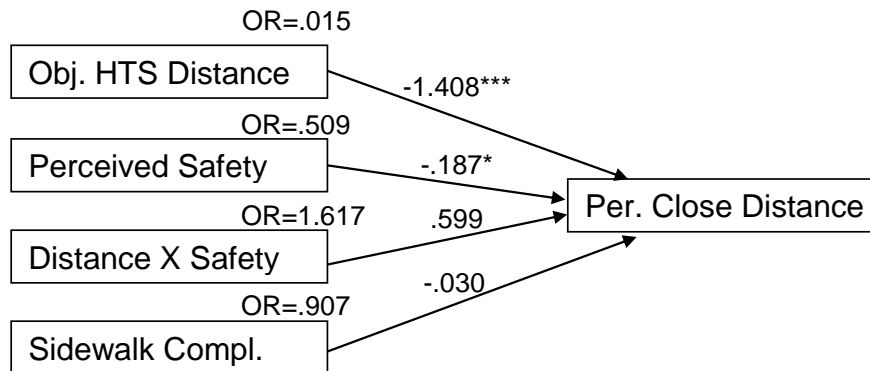


AIC: 2487.433; BIC: 2510.881;

Adjusted BIC: 2498.172

R-square: .834

➤ B:

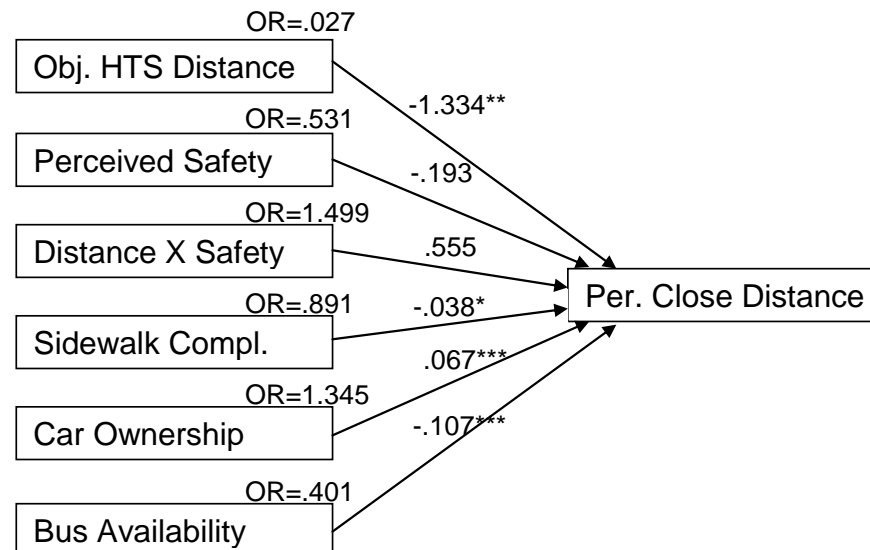


AIC: 2482.903; BIC: 2512.214;

Adjusted BIC: 2496.327

R-square: .834

➤ C:



AIC: 2383.706; BIC: 2424.741;

Adjusted BIC: 2402.500

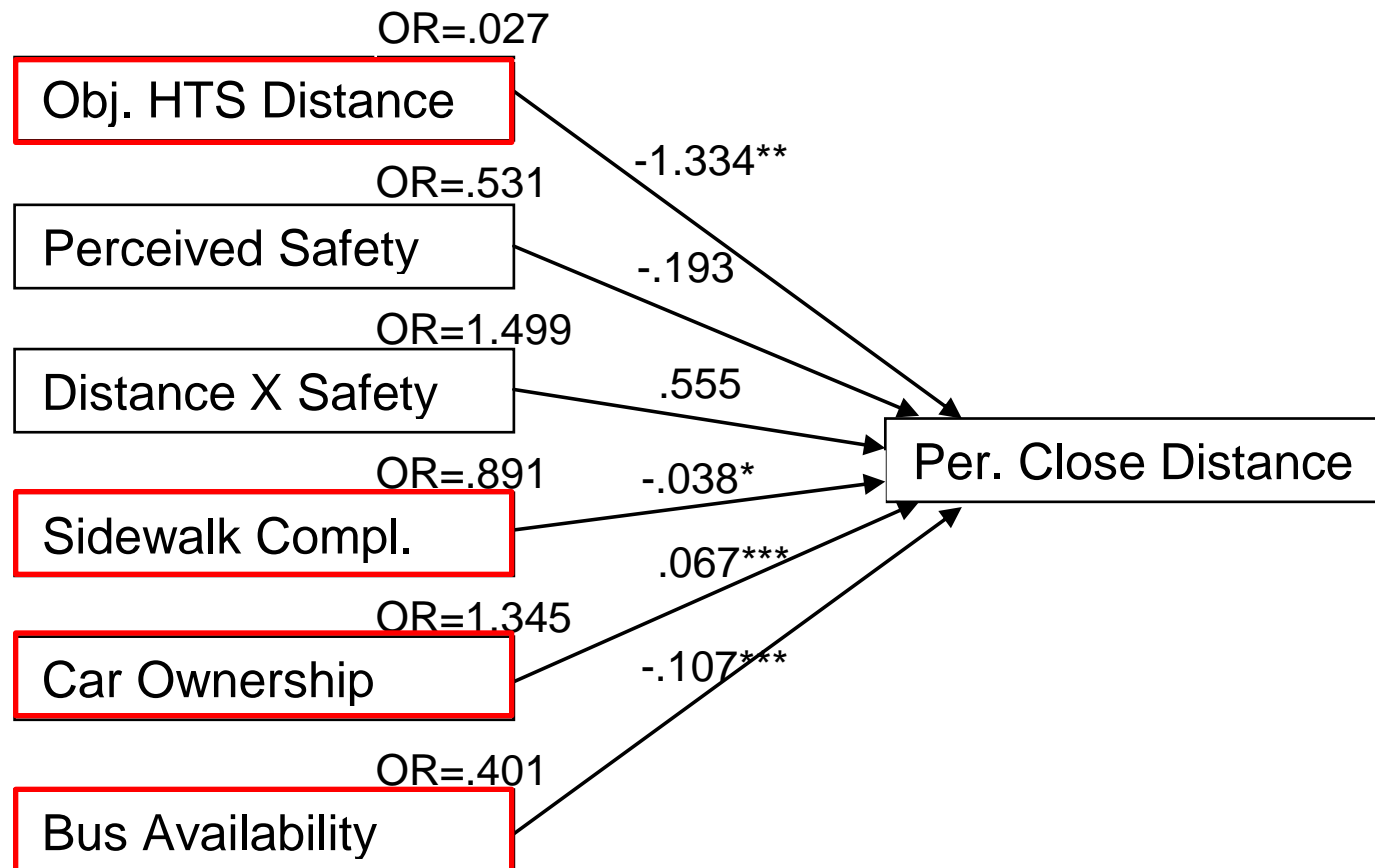
R-square: .799

(Note: Standardized results)

## ❖ SEM Predicting Perceived Close Distance: Model C

AIC: 2383.706; BIC: 2424.741; Adjusted BIC: 2402.500

R-square: .799





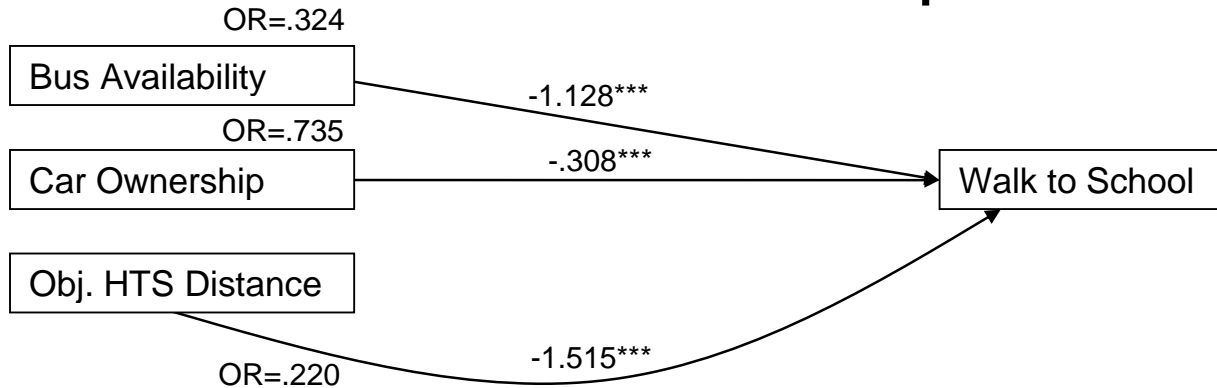
# Predict Walking to/from School

1. Test the mediator role of  
“perceived walkable distance”  
in influencing WTS
2. Predict WTS using personal,  
social & physical environmental  
variables

# ❖ mediator role of “perceived walkable distance”:

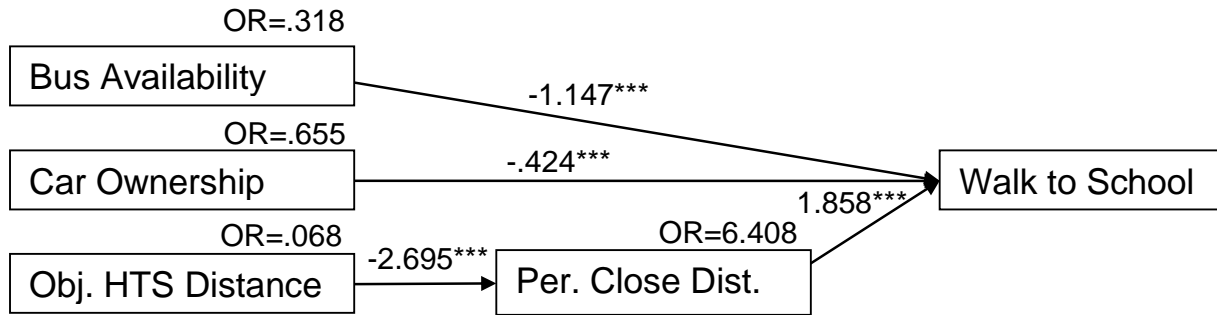
## Model Comparison

➤ **A:**



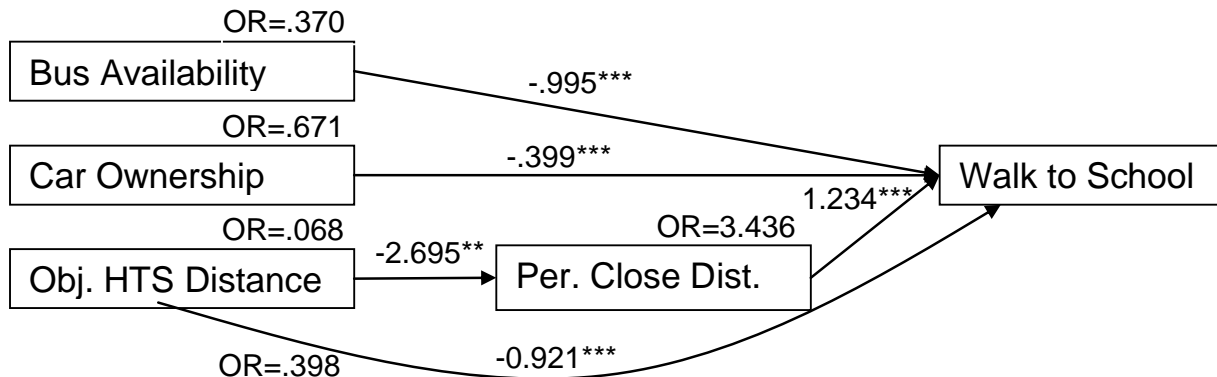
AIC: 9559.448;  
BIC: 9594.621;  
Adjusted BIC: 9575.557

➤ **B:**



AIC: 8503.845;  
BIC: 8544.888;  
Adjusted BIC: 8522.647

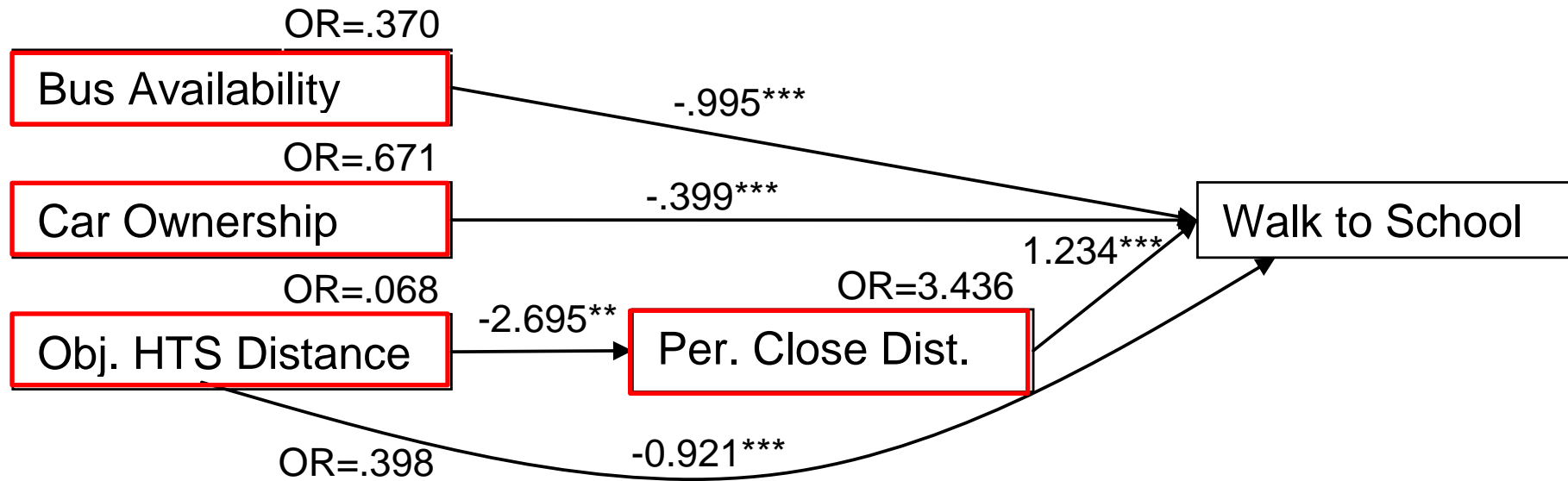
➤ **C:**



AIC: 8395.326;  
BIC: 8442.222;  
Adjusted BIC: 8416.804

## ❖ SEM Predicting WTS: Model C

AIC: 8395.326; BIC: 8442.222; Adjusted BIC: 8416.804



(Unstandardized results.)

# ❖ SEM Predicting WTS:

➤ Measurement models tested first

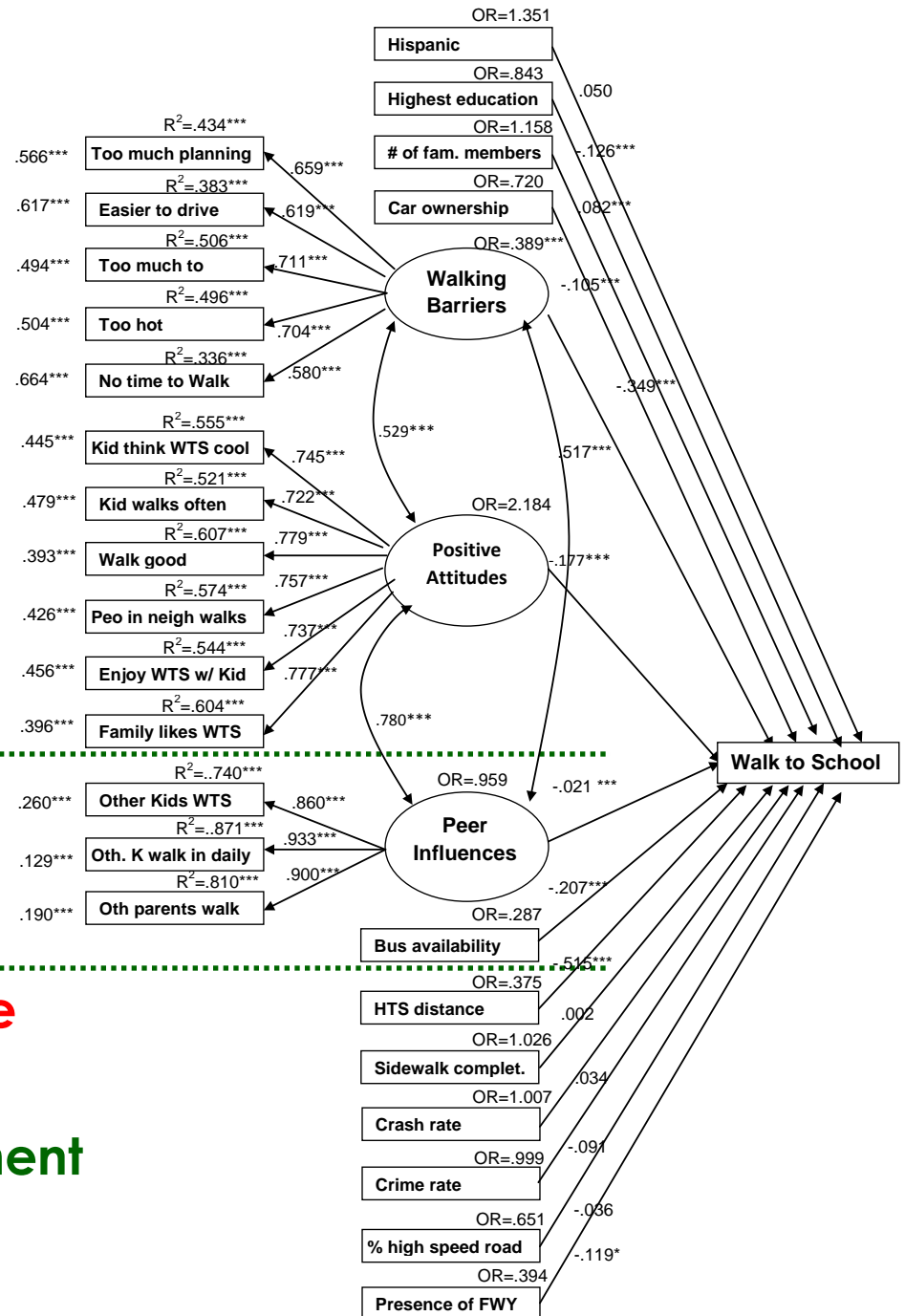
➤ Model fit tested

➤ N=2,569

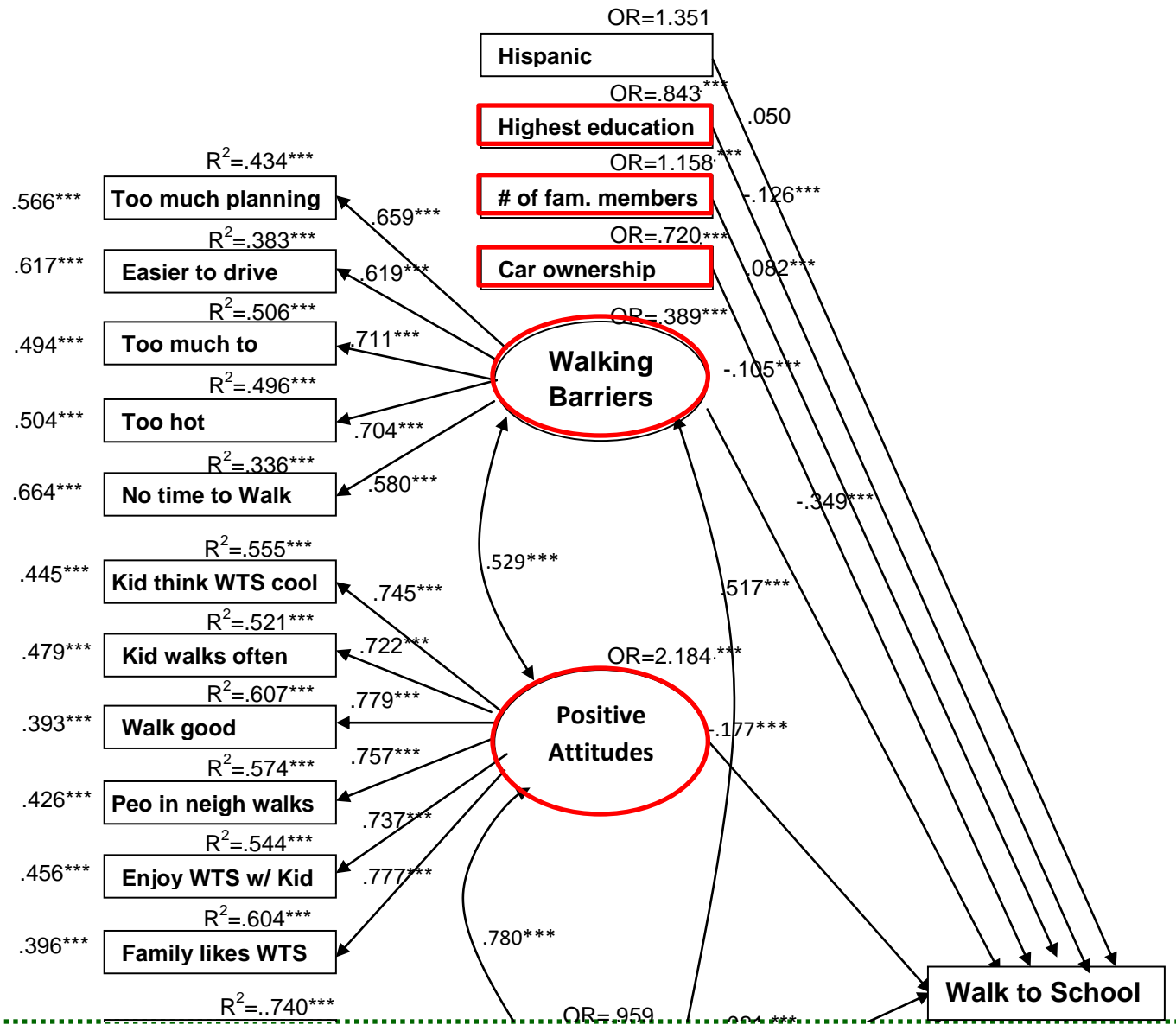
Personal  
factors

Social  
factors

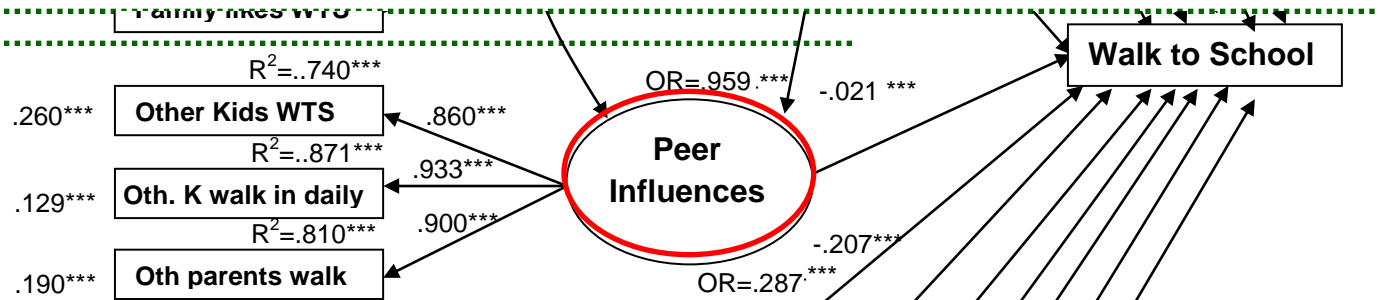
Objective  
physical  
environment



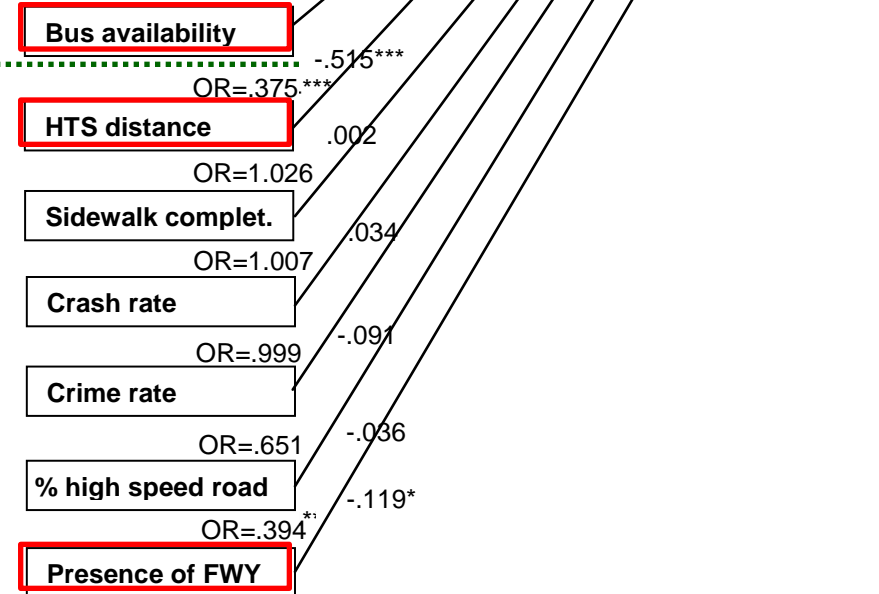
# Personal factors



## Social factors



## Objective physical environment



# DISCUSSIONS

- ❖ **0.5-mile threshold** for walkable distance  
(Consistent with some previous studies.)
- ❖ **Perception of walkable distance** is influenced by non-distance related factors & acts as a **significant mediator in influencing WTS**.  
(Implications for interventions.)
- ❖ Distance vs. walking to school is **not necessarily a linear relationship**, as shown in sub-group analysis, & the relationship **varies by context**.
- ❖ **Distance & freeway are 2 significant physical environmental factors**.  
(Future school/neighborhood planning should respond to this.)