Urban design and mobility among children aged 5-15 in California cities in 2017

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BACKGROUND & STUDY AIMS

- Road traffic crashes are a leading cause of injury and death among children aged 5 to 15 years in the US.[1]
- Crash incidence is substantially greater in cities where transportation networks are laid out in ways that encourage motor vehicle use.[2]
- Currently available strategies are insufficient in reducing the immense toll of crashes on children.[3]
- Reconfiguring transportation networks may be a strategy to reduce crash incidence

Aim: This study aims to investigate the relationship between present-day urban design and child mobility in California cities.

Hypothesis: Children living in areas with urban designs that encourage motor vehicle travel will be less mobile (i.e., leave home less frequently) and will use fewer active transit modes (e.g., walking, bicycling) than children living in areas that encourage additional modes of travel.

METHODS

Data source: Data from the 2017 National Household Travel survey (NHTS) California add-on were utilized to investigate the association between urban design and children's mobility. The survey collects self-reported data from 26,095 sample households residing in California on demographic and socioeconomic composition, as well as as detailed information on travel behavior for one assigned day from April 19, 2016, through April 25, 2017.

Study population: The study population was restricted to a sample of 1,477 children aged 5-15 who made a trip to school on the assigned travel day and resided in one of the 265 California cities with complete urban design measure data.

Measures:

- **Outcome**: Travel mode taken to school, operationalized as a categorical variable "Trip Mode" with 4 categories: "Foot", "Bicycle", "Public Transit" (including the school bus), and "Motor Vehicle".
- **Exposure**: Transportation network "Geographic Density", operationalized as $\frac{network\ distance}{land\ area}$ is intended to characterize the density of footway, cycleway, and roadway transportation networks in each study city.

Covariates:

- **Trip-level**: Distance to school (miles)
- **Person-level**: Age (years), biological sex (male/female), race/ethnicity (non-Hispanic white, non-Hispanic Black, Hispanic/Latino, Asian and multiracial/other)
- **Household-level**: Family income ($0-$24,999, $25,000-$74,999, $75,000-$124,99, $125,000-$199,999, >$200,000), vehicle count per household member (0, 0.001- 0.25, 0.251-0.5, 0.501-0.75, >0.75)
- **City-level**: Population density as persons per square mile in the census block group of the household's home location (<1,999, 2,000-3,999, 4,000-9,999, >9,999), Rural-Urban Commuting Area (RUCA) code (urban, large rural, small rural or isolated)

Statistical analyses: Multinomial logistic regression, adjusted for covariates, was used to determine the associations between cities' transportation network geographic density, and children's travel mode to school. Analyses were conducted using R Statistical Software (version 4.1.2) using the nnet (version 7.3.17) and tmap (version 3.3.3) packages.

RESULTS

Table 1. Descriptive statistics by trip mode categorization

	Total (N=1477)	Trip Mode: Foot (N=226)	Bicycle (N=55)	Public Transit (N=93)	Motor Vehicle (N=1103)
Distance to School Mean (SD)	3.0 (± 4.0)	0.61 (± 0.48)	1.0 (± 0.65)	4.3 (± 4.4)	3.5 (± 4.3)
Age Mean (SD)	10 (± 3.1)	9.8 (± 3.0)	11 (± 2.8)	12 (± 2.8)	9.9 (± 3.2)
Biological Sex N (%)					
Male (ref)	735 (50%)	118 (52%)	34 (62%)	56 (60%)	527 (48%)
Female	742 (50%)	108 (48%)	21 (38%)	37 (40%)	576 (52%)
Race and Ethnicity N (%)					
Non-Hispanic White (ref)	706 (48%)	92 (41%)	35 (64%)	40 (43%)	539 (49%)
Non-Hispanic Black	62 (4%)	12 (5%)	2 (4%)	9 (10%)	39 (4%)
Hispanic	336 (23%)	68 (30%)	2 (4%)	25 (27%)	241 (22%)
Asian	180 (12%)	27 (12%)	8 (15%)	8 (9%)	137 (12%)
Other	193 (13%)	27 (12%)	8 (15%)	11 (12%)	147 (13%)
Family Income N (%)					
$0 to $24,999	160 (11%)	38 (17%)	2 (4%)	25 (27%)	95 (9%)
$25,000 to $74,999	370 (25%)	56 (25%)	10 (18%)	40 (43%)	264 (24%)
$75,000 to $124,999	342 (23%)	56 (25%)	8 (15%)	8 (9%)	270 (24%)
$125,000 to $199,999	358 (24%)	47 (21%)	17 (31%)	9 (10%)	285 (26%)
$200,000 or more (ref)	247 (17%)	29 (13%)	18 (33%)	11 (12%)	189 (17%)

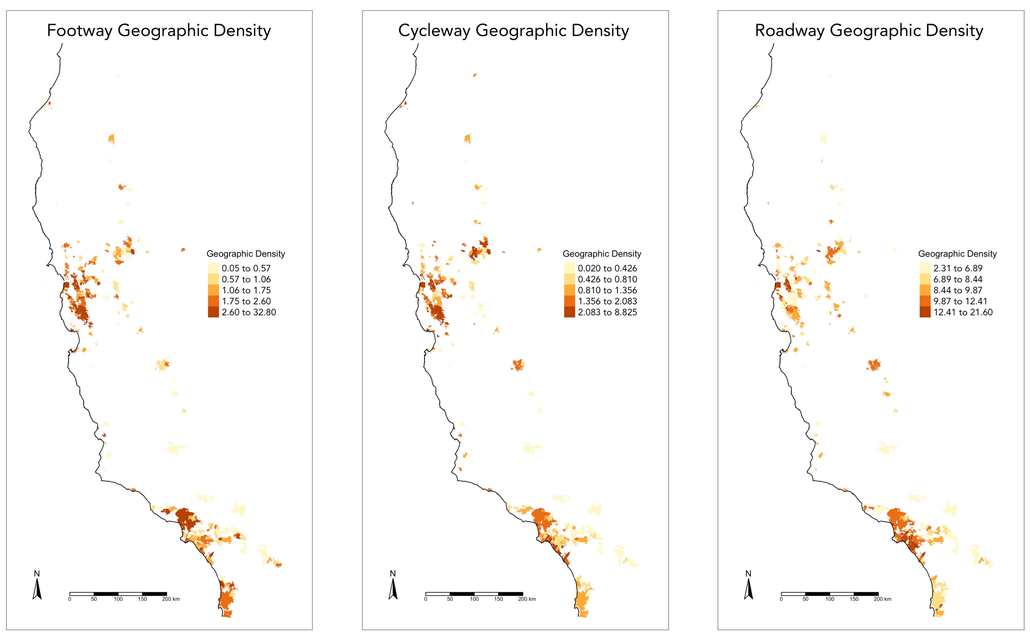
Table 1 (Continued). Descriptive statistics by trip mode categorization

	Total (N=1477)	Trip Mode: Foot (N=226)	Bicycle (N=55)	Public Transit (N=93)	Motor Vehicle (N=1103)
Vehicle Count N (%)					
Less than 0.001	30 (2%)	16 (7%)	1 (2%)	9 (10%)	4 (0%)
0.001 to 0.25	136 (9%)	30 (13%)	6 (11%)	17 (18%)	83 (8%)
0.251 to 0.5	736 (50%)	104 (46%)	25 (45%)	39 (42%)	568 (51%)
0.501 to 0.75	403 (27%)	49 (22%)	18 (33%)	16 (17%)	320 (29%)
More than 0.75 (ref)	172 (12%)	27 (12%)	5 (9%)	12 (13%)	128 (12%)
Population Density N (%)					
0-1,999	251 (17%)	18 (8%)	7 (13%)	20 (22%)	206 (19%)
2,000-3,999	280 (19%)	26 (12%)	12 (22%)	18 (19%)	224 (20%)
4,000-9,999	696 (47%)	134 (59%)	24 (44%)	33 (35%)	505 (46%)
More than 9,999 (ref)	250 (17%)	48 (21%)	12 (22%)	22 (24%)	168 (15%)
RUCA Code N (%)					
Urban (ref)	1375 (93%)	221 (98%)	51 (93%)	85 (91%)	1018 (92%)
Large Rural	91 (6%)	5 (2%)	1 (2%)	7 (8%)	78 (7%)
Small Rural or Isolated	11 (1%)	0 (0%)	3 (5%)	1 (1%)	7 (1%)
Land Area Mean (SD)	180 (± 260)	220 (± 310)	84 (± 100)	180 (± 270)	170 (± 250)
Network Distance Mean (SD)					
Footway	490 (± 1200)	580 (± 1200)	450 (± 1300)	390 (± 1000)	490 (± 1200)
Cycleway	240 (± 400)	320 (± 520)	180 (± 220)	240 (± 430)	230 (± 370)
Roadway	1600 (± 2400)	2100 (± 3100)	800 (± 1000)	1700 (± 2600)	1500 (± 2300)
Geographic Density Mean (SD)					
Footway	2.5 (± 3.7)	2.6 (± 3.6)	4.6 (± 5.9)	1.6 (± 2.8)	2.5 (± 3.6)
Cycleway	1.5 (± 1.2)	1.6 (± 1.3)	2.8 (± 2.1)	1.3 (± 1.1)	1.4 (± 1.1)
Roadway	9.3 (± 2.4)	9.6 (± 2.1)	9.7 (± 2.3)	9.2 (± 2.3)	9.3 (± 2.4)

Table 2. Results of multinomial logistic regression analyses to examine urban design measures associated with children's travel to school, OR (CI)

	Trip Mode: Foot		Bicycle		Public Transit	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Geographic Density						
Footway	0.96 (0.90, 1.02)	0.14	0.96 (0.89, 1.03)	0.29	0.91 (0.81, 1.02)	0.10
Cycleway	**1.24 (1.03, 1.48)**	**0.02**	**1.72 (1.36, 2.19)**	**0.00**	1.04 (0.79, 1.37)	0.79
Roadway	0.95 (0.86, 1.04)	0.26	0.89 (0.77, 1.04)	0.14	1.00 (0.89, 1.14)	0.95

Figure 1. Geographic density values for the footway, cycleway, and roadway transportation networks in each of the study cities in California



Regression model results:

- After adjusting for covariates, a one-unit increase in cycleway geographic density is associated with a statistically significant increase in children biking to school (OR = 1.72, 95% CI: 1.36, 2.19) and walking to school (OR = 1.24, 95% CI: 1.03, 1.48) relative to taking a motor vehicle.

CONCLUSIONS

- Higher geographic density of cycleway networks in cities is strongly associated with both taking a bicycle to school and walking to school relative to taking a motor vehicle among children aged 5-15 in California.
- Urban design can be improved by reconfiguring transportation networks to encourage active modes of transport (e.g., walking, cycling) among school-aged children.

REFERENCES

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