

More Walkable-oriented zoning and land use laws are associated with active travel to work

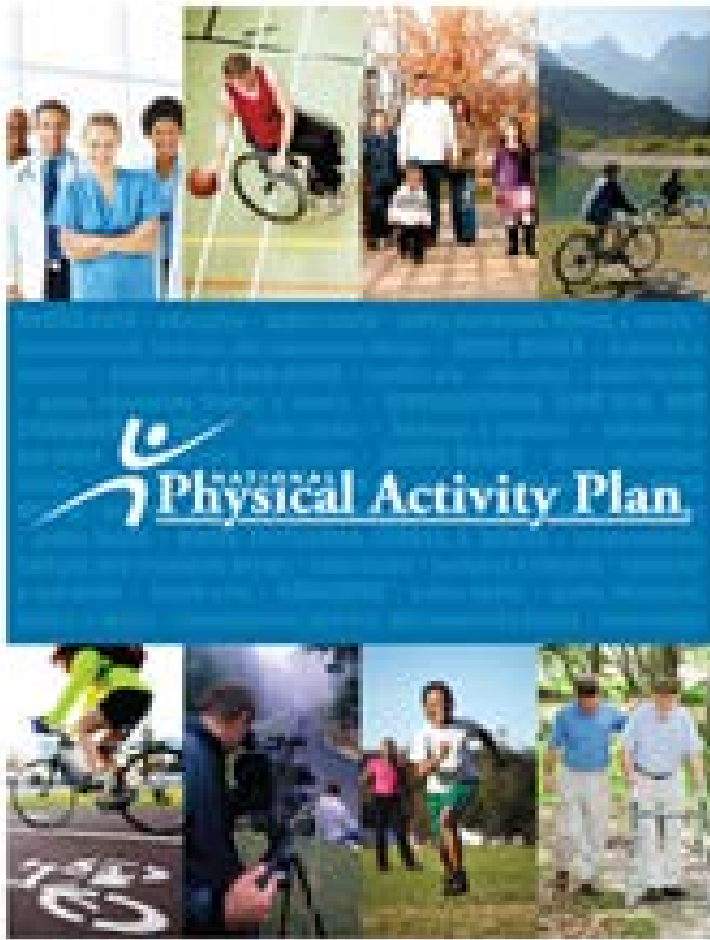
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Research Question

- Are the rates of active travel to work higher in jurisdictions with zoning code reforms and/or other active living-oriented zoning and land use laws?

Why focus on land use and zoning?



- Public health
- Health care
- Education
- Transportation, Land Use, and Community Design
- Parks, Recreation, Fitness and Sports
- Business and Industry (Worksites)
- Voluntary and Non-Profit Organizations
- Mass Media

The *Community Guide* recommends the following environmental and policy approaches to increase physical activity

Environmental Policy Approach	Strategies
Enhanced School-based Physical Education	Increase # of minutes spent in MVPA
Community-Scale and Urban Design Land Use Policies	Mixed use, street connectivity, aesthetics and safety
Street-Scale Urban Design Land Use Policies	Roadway design standards, traffic calming, safe street crossings, street lighting
Transportation and Travel Design Policies and Practices	Facilitating walking, biking, public transportation use, reducing car use

Source: Heath et al., 2006, *AJPM*

Zoning and its relationship to public health

- Zoning/land use laws are exercises of the states' police powers under the 10th Amendment
 - States grant authority to county/municipal governments to promote the health, safety, morals, and general welfare of their citizenry
- Zoning/land use laws can **include provisions for structural improvements to increase opportunities for active travel** such as provisions requiring:
 - Sidewalks, crosswalks, mixed use development, street furniture, pedestrian access, and street connectivity

Zoning Code Reforms

- Potential policy strategy for reducing sprawl, reliance on cars, and increasing physical activity and active travel.¹⁻³
- Seek to create pedestrian-friendly neighborhoods
 - Increased street connectivity, mixed-use and higher density, open space, transportation infrastructure, and a traditional neighborhood structure.¹⁻³

(1) Schilling J, Linton LS. The public health roots of zoning: In search of active living's legal genealogy. *Am J Prev Med.* 2005;28:96-104.

(2) Schilling J, Mishkovsky N. *Creating a Regulatory Blueprint for Healthy Community Design: A Local Government Guide to Reforming Zoning and Land Development Codes.* E-43346. 2005. Washington, D.C., ICMA.

(3) American Planning Association. *Planning and Urban Design Standards.* 1st ed. Hoboken, NJ: John Wiley & Sons, Inc., 2006.

Code Reform Examples

- Form-based codes (FBC)
 - Development by “right”
 - Focus on pedestrian accessibility; legalize compact, mixed-use and walkable dev. (compared to traditional Euclidian zoning)
 - **SmartCode** (Duany & Plater-Zyberk, 2005)—the *Transect*—a type of FBC
- Traditional neighborhood dev. (TND)
- Pedestrian-oriented dev./districts (POD)
- Transit-oriented districts (TOD)

Research Question and Hypothesis

- Are the rates of active travel to work higher in jurisdictions with zoning code reforms and/or other active living-oriented zoning and land use laws?
- Hypotheses:
 - Rates of **walking to work** at the municipal/county levels will be higher in communities that have active living-oriented zoning
 - Rates of **public transit use for commuting** at the municipal/county levels will be higher in communities that have active living-oriented zoning

METHODS

Sample

- 315 of the largest counties in the United States covering ~65% of the U.S. population
 - 2,942 municipal jurisdictions located in those counties

Zoning Code Collection and Coding

- Zoning codes compiled via Internet with telephone follow-up for all counties and municipal jurisdictions in the sample
 - Goal was to compile zoning codes effective as of no later than 2010 to account for a policy lag
 - Most coded zoning codes were from the early to mid 2000s
 - Many jurisdictions adopted zoning code reforms after our 2010 cutoff but we did not code those—only the earlier versions
- Zoning codes evaluated by trained Master's level-urban planners using an in-depth coding tool developed by the study team for this study
- RedCap on-line database created for the collection and coding data entry and tracking (through UIC CCTS)

Zoning Coding Markers/Variables

- Code reform zoning (yes/no)
- Complete streets policy (yes/no)
- Zoning code provisions for (each is a separate measure) (yes/no and required/not):
 - Sidewalks
 - Crosswalks
 - Bike-ped connectivity
 - Street connectivity
 - Bike lanes
 - Bike parking (street furniture)
 - Bike-ped trails/paths
 - Other walkability (pedestrian access, traffic calming)
 - Mixed use

SmartCode*
 Full Form-Based Code (n
 Code Reform District(s)/

Y	N	3. Mixed Use Districts Category
		A. Sidewalks
		B. Crosswalks
		C. Bike-Pedestrian Connectivity
		D. Street Connectivity
		E. Bike Lanes
		F. Bike Parking
		G. Bike-Pedestrian Trails-Paths
		H. Other Walkability
		I. Mixed Use
		J. Active Recreation
		K. Passive Recreation

Y	N	4. Park, Rec, Open Space Districts Category	Addressed?		Strength			Type of Use				Citation(s)
			Yes	No	Req	Enc	No	Mixed	Allow	Prohib	None	
		A. Sidewalks	1	0	2	1	0	-	-	-	-	
		B. Crosswalks	1	0	2	1	0	-	-	-	-	
		C. Bike-Pedestrian Connectivity	1	0	2	1	0	-	-	-	-	
		D. Street Connectivity	1	0	2	1	0	-	-	-	-	
		E. Bike Lanes	1	0	2	1	0	-	-	-	-	
		F. Bike Parking	1	0	2	1	0	-	-	-	-	
		G. Bike-Pedestrian Trails-Paths	1	0	2	1	0	-	1	-	0	
		H. Other Walkability	1	0	2	1	0	-	-	-	-	
		I. Mixed Use	1	0	2	1	0	2	1	-1	0	
		J. Active Recreation	1	0	2	1	0	-	1	-	0	
		K. Passive Recreation	1	0	2	1	0	-	1	-	0	

Y	N	5. Planned Unit Development (PUD) Category	Addressed?		Strength			Type of Use				Citation(s)
			Yes	No	Req	Enc	No	Mixed	Allow	Prohib	None	
		A. Sidewalks	1	0	2	1	0	-	-	-	-	
		B. Crosswalks	1	0	2	1	0	-	-	-	-	
		C. Bike-Pedestrian Connectivity	1	0	2	1	0	-	-	-	-	
		D. Street Connectivity	1	0	2	1	0	-	-	-	-	
		E. Bike Lanes	1	0	2	1	0	-	-	-	-	
		F. Bike Parking	1	0	2	1	0	-	-	-	-	
		G. Bike-Pedestrian Trails-Paths	1	0	2	1	0	-	1	-	0	
		H. Other Walkability	1	0	2	1	0	-	-	-	-	
		I. Mixed Use	1	0	2	1	0	2	1	-1	0	
		J. Active Recreation	1	0	2	1	0	-	1	-	0	
		K. Passive Recreation	1	0	2	1	0	-	1	-	0	

Y	N	6. Public, Civic, Gov't Districts Category	Addressed?		Strength			Type of Use				Citation(s)
			Yes	No	Req	Enc	No	Mixed	Allow	Prohib	None	
		A. Sidewalks	1	0	2	1	0	-	-	-	-	
		B. Crosswalks	1	0	2	1	0	-	-	-	-	
		C. Bike-Pedestrian Connectivity	1	0	2	1	0	-	-	-	-	
		D. Street Connectivity	1	0	2	1	0	-	-	-	-	
		E. Bike Lanes	1	0	2	1	0	-	-	-	-	
		F. Bike Parking	1	0	2	1	0	-	-	-	-	
		G. Bike-Pedestrian Trails-Paths	1	0	2	1	0	-	1	-	0	
		H. Other Walkability	1	0	2	1	0	-	-	-	-	
		I. Mixed Use	1	0	2	1	0	2	1	-1	0	
		J. Active Recreation	1	0	2	1	0	-	1	-	0	
		K. Passive Recreation	1	0	2	1	0	-	1	-	0	

Y	N	7. Residential Districts Category	Addressed?		Strength			Type of Use				Citation(s)
			Yes	No	Req	Enc	No	Mixed	Allow	Prohib	None	
		A. Sidewalks	1	0	2	1	0	-	-	-	-	
		B. Crosswalks	1	0	2	1	0	-	-	-	-	
		C. Bike-Pedestrian Connectivity	1	0	2	1	0	-	-	-	-	
		D. Street Connectivity	1	0	2	1	0	-	-	-	-	
		E. Bike Lanes	1	0	2	1	0	-	-	-	-	
		F. Bike Parking	1	0	2	1	0	-	-	-	-	
		G. Bike-Pedestrian Trails-Paths	1	0	2	1	0	-	1	-	0	
		H. Other Walkability	1	0	2	1	0	-	-	-	-	
		I. Mixed Use	1	0	2	1	0	2	1	-1	0	
		J. Active Recreation	1	0	2	1	0	-	1	-	0	
		K. Passive Recreation	1	0	2	1	0	-	1	-	0	

County Name: _____
 State Name: _____
 Keep Level: _____
B. Coder and Zoning Code
 Coder ID Number: 1 0 ____
 Coding Date: ____ / ____ / ____
 Community: _____
 County: _____
 Place: _____
 Zoning Code Status:
 Zoning code exists
 No zoning code (verified)
 Missing zoning code (non-responder)
If "Zoning code exists" is selected, continue

Code Reform = Form-Based
 Commercial = Commercial
 Mixed Use = Mixed Use
 Park, Rec, Open Space =
 Planned Unit Development
 Public, Civic, Gov't = Public
 Residential = Residential
 General Zoning Provision
 Req (Required) = strongest
 Enc (Encouraged) = strong
 No = strongest provision
 Allow (Allowed) = permitted
 None = use not specified
 [Prohib (Prohibited) = prohibited
 [Mixed = both allowed and

Zoning Measures

- For each county and municipal jurisdiction, each marker (code reform and each of the active living markers) was coded as follows:
 - Addressed (0/1)
 - Any requirement across the districts/zones included in the given municipality's zoning code (0/1)

County-level Zoning Measure Construction

- For each municipal jurisdiction and zoning variable, created population-weighted measure: **zoning measure (0/1) * %age county population**
 - Similar measure created for unincorporated areas of the county using county zoning codes
- County-aggregated zoning measure: **\sum pop. weighted municipal zoning measure (for each zoning measure)**
 - Continuous measure ranging from 0-1 (1=all localities in the county exposed to the measure; 0.5=50% of the localities in the county exposed to measure)
- For example, city A is located in county B
 - City A's population represents 10% of county B's population
 - City A had code reform zoning (=1)
 - City A code reform variable coding (=1) * 0.10=0.10 for code reform variable
 - Population-weighted muni code reform variables summed across county B to derive a population-weighted county-aggregated measure of code reform zoning within the county
 - For example, if 50% of the County B's population is located in a city with code reform zoning, the code reform zoning measure=0.50 for county B

Active Travel to Work and Contextual Variables

- **Active travel to work outcome variables (ACS 2009-2013, 5-year estimates)—obtained at the municipal and county levels**
 - % walk to work
 - % public transit use for commuting to work
- **Controls (ACS 2009-2013, 5-year estimates) – obtained at the municipal and county levels**
 - % families with children living in poverty
 - % non-Hispanic White
 - % non-Hispanic Black
 - % Hispanic
 - Median household income
 - Median age
 - Region
- Community walkability scale (constructed using Ewing et al.'s methods and includes: % 4 way intersections, total intersection density, housing density, and population density). It is a measure of compactness and density of a community.

Analyses

- Zoning data lagged onto ACS outcomes
- Linked using county and municipal geocodes
- Multivariate linear regression models, controlling for municipal and/or county controls
- Municipal-level analyses clustered on county to account for homogeneity among jurisdictions within a given county
- Robust standard errors
- All analyses conducted using STATA SE v. 13.0.1

RESULTS

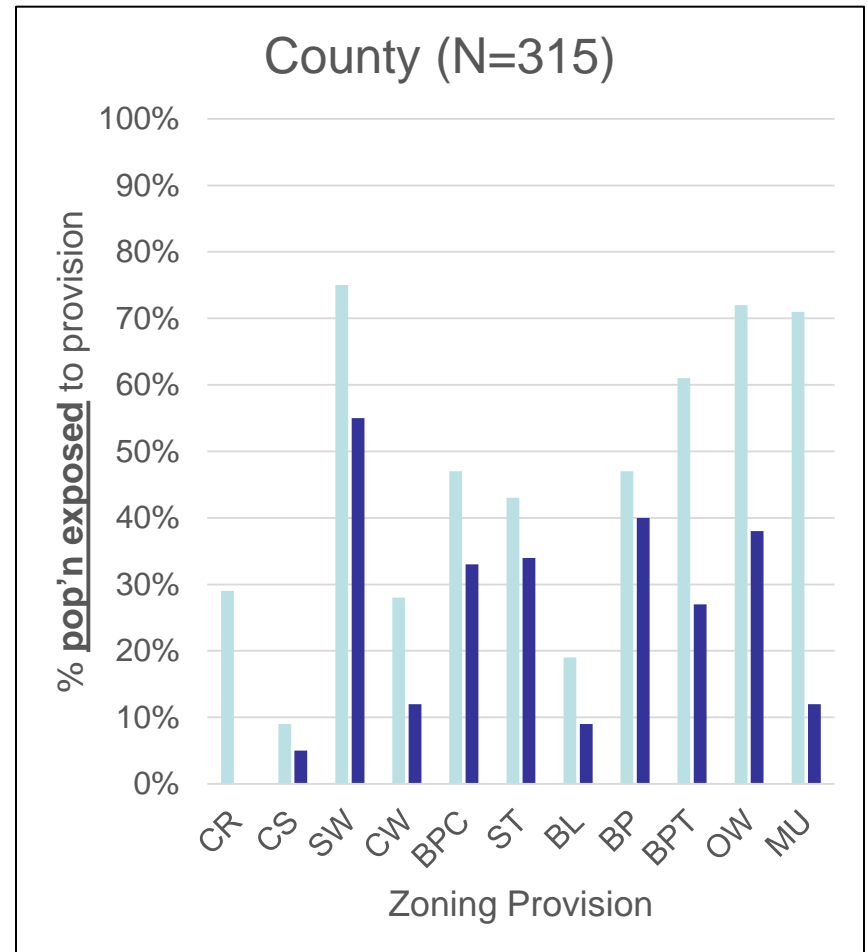
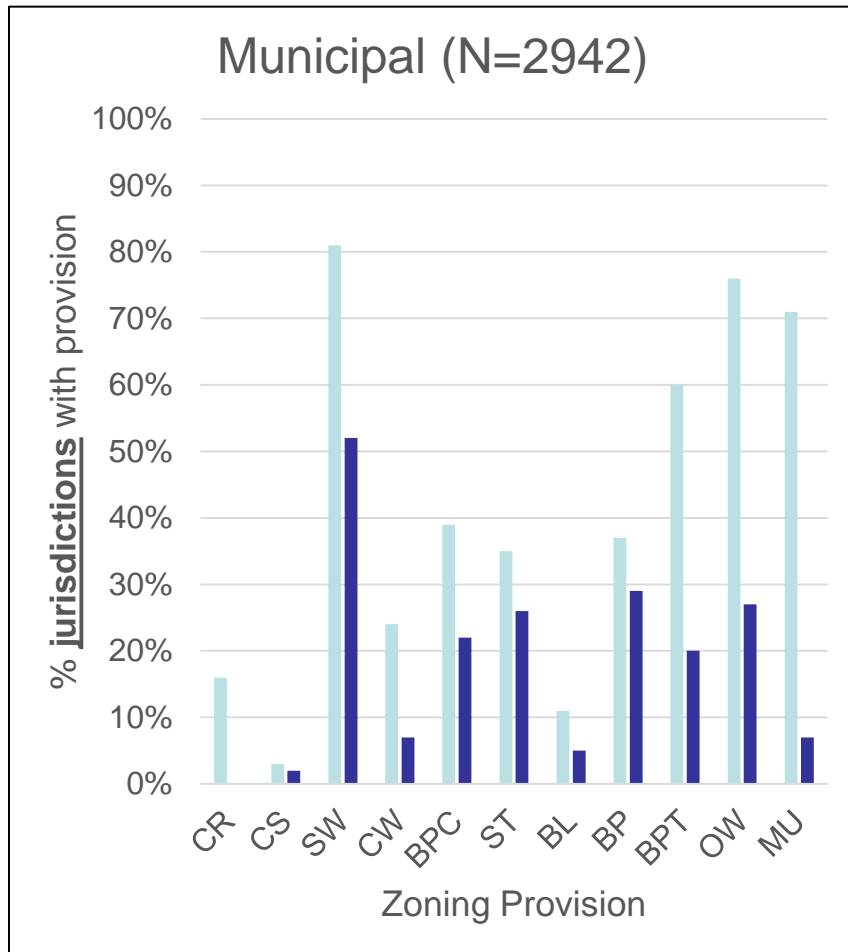
Sample Characteristics

Characteristic	Municipal Mean (SD)	County Mean (SD)
% families with children living in poverty	15.25 (12.97)	16.72 (7.59)
% non-Hispanic White	68.63 (24.64)	63.65 (18.96)
% non-Hispanic Black	9.10 (14.66)	13.29 (13.39)
% Hispanic	15.22 (18.92)	15.42 (15.43)
Median household income (\$)	63,450 (26,644)	58,146 (15,178)
Median age	38.15 (6.27)	37.12 (3.96)
South	0.25 (0.44)	0.37 (0.48)
West	0.23 (0.42)	0.22 (0.41)
Midwest	0.29 (0.45)	0.20 (0.40)
Northeast	0.23 (0.42)	0.22 (0.41)
Walkability scale (Muni Max=21; county max=18)	1.00 (1.00)	1.12 (1.23)

Note: With the exception of the walkability scale (constructed with GIS measures) all items obtained from the American Community Survey 5-year estimates for 2009-2013

Zoning Code Provisions

■ Provision addressed ■ Any requirement for provision



Zoning Code Walkability Scales

Zoning Code Walkability Scales	Municipal Mean (SD) Range	County Mean (SD) Range
# markers addressed (max=9)	4.34 (2.48) 0-9	4.64 (2.45) Range: 0-9
# markers required (max =9)	1.94 (2.10) 0-9	2.60 (2.10) Range: 0-8.38

Active Transport to Work

ACS 2009-2013

Activity	Municipal		County-aggregated	
	Mean (SD)	Range	Mean (SD)	Range
% walk to work	2.54 (3.07)	0-40.13	2.72 (2.11)	0.46-22.42
% use public transit to commute to work	3.80 (6.28)	0-63.67	4.58 (8.59)	0.12-63.67

Municipal level analyses: Association between zoning provisions and % WALKING TO WORK

Zoning Measure	Zoning provision addressed		Any zoning required	
	Coeff.	95% CI	Coeff.	95% CI
Code reform	0.27 ⁺	-0.01, 0.55	--	--
Complete streets policy	0..997*	0.19, 1.8	1.55**	0.52, 2.57
<i>Zoning requirements</i>				

On average, 2.54% of the municipal population walked to work. If a municipality's zoning code addressed mixed use development, walking to work could go up by from 2.54% to to 2.88% of the population. Small but an incremental change.

Bike parking (street furniture)	0.44**	0.17, 0.71	0.52**	0.21, 0.82
Bike-ped trails/paths	0.21 ⁺	-0.04, 0.46	0.09	-0.16, 0.34
Other walkability	0.29*	0.04, 0.54	0.21	-0.04, 0.46
Mixed use	0.34**	0.10, 0.59	0.15	-0.21, 0.50
Zoning walkability scale	0.06*	0.01, 0.11	0.04	-0.15, 0.10

All models controlled for muni-level variables

***p<.001 **p<.01 *p<.05 +p<.10

Municipal level analyses: Association between zoning provisions and % PUBLIC TRANSIT USE

Zoning Measure	Zoning provision addressed		Any zoning required	
	Coeff.	95% CI	Coeff.	95% CI

On average, 3.8% of the municipal population used public transit for commuting. If a municipality's zoning code addressed bike lanes, public transit use could go up by nearly 1 percentage point from 3.8% to 4.75% of the municipal population.

Street connectivity	0.15	-0.27, 0.58	0.05	-0.43, 0.54
Bike lanes	0.95*	0.06, 1.84	0.13	-0.53, 0.78
Bike parking (street furniture)	0.89***	0.44, 1.33	1.03***	0.52, 1.55
Bike-ped trails/paths	0.18	-0.21, 0.57	0.10	-0.49, 0.68
Other walkability	0.95**	0.40, 1.49	0.33	-0.15, 0.81
Mixed use	0.49*	0.12, 0.87	1.29+	-0.17, 2.59
Zoning walkability scale	0.15**	0.06, 0.25	0.13*	0.00, 0.25

All models controlled for muni-level variables

***p<.001 **p<.01 *p<.05 +p<.10

County-aggregated analyses: Association between % county pop'n exposed to zoning provisions and % WALKING TO WORK

Zoning Measure	Zoning provision addressed		Any zoning required	
	Coeff.	95% CI	Coeff.	95% CI
Code reform	0.50 ⁺	-0.05, 1.05		
Complete streets	0.52	-0.71, 1.75	1.78*	0.20, 3.36
<i>Zoning Provisions</i>				
Sidewalks	0.12	-0.62, 0.87	-0.47	-1.19, 2.24
Crosswalks	-0.13	-0.80, 0.55	-0.30	-1.28, 6.89
Bike-ped connectivity	-0.40	-1.08, 0.28	0.32	-0.29, 0.94
Street connectivity	0.40	-0.19, 0.99	0.26	-0.34, 0.87
Bike lanes	0.15	-0.34, 0.65	0.06	-0.49, 0.62
Bike parking (street furniture)	0.59*	0.13, 1.06	0.88**	0.38, 1.38
Bike-ped trails/paths	0.25	-0.44, 0.94	-0.24	-0.73, 0.24
Other walkability	0.33	-0.29, 0.94	0.05	-0.55, 0.66
Mixed use	0.26	-0.40, 0.92	0.77 ⁺	-0.09, 1.64
Zoning walkability scale	0.04	-0.06, 0.14	0.04	-0.06, 0.15

All models controlled for county-level variables

***p<.001 **p<.01 *p<.05 +p<.10

County-aggregated analyses: Association between % county pop'n exposed to zoning provisions and % PUBLIC TRANSIT USE

Zoning Measure	Zoning provision addressed		Any zoning required	
	Coeff	95% CI	Coeff	95% CI
Code reform	1.62 ⁺	-0.01, 3.25	--	--

On average, public transit use at the county level was 4.58%. For a 1-point increase in the proportion of the county population exposed to zoning for mixed use, public transit use would increase by 3.54 percentage points from an average of 4.58% to over 8% of the county population.

Bike lanes	0.62	-0.61, 1.64	0.51	-0.64, 1.66
Bike parking (street furniture)	3.58***	1.79, 5.46	3.81***	1.82, 5.79
Bike-ped trails/paths	0.83	-0.87, 2.53	0.52	-0.85, 1.89
Other walkability	4.02**	1.43, 6.60	2.03 ⁺	-0.14, 4.19
Mixed use	3.54**	1.00, 6.08	0.33	-2.48, 3.14
Zoning walkability scale	0.52**	0.19, 0.85	0.46**	0.14, 0.79

All models controlled for county-level variables

***p<.001 **p<.01 *p<.05 +p<.10

Study Limitations

- Used ACS 2009-2013, 5-year estimates because most reliable for muni-level analyses when using small jurisdictions
 - Downside is that not much of a lag time for some jurisdictions
 - Future analyses will utilize later years of data and multiple years of data
- Cross-sectional analysis—associations not causation
- Future studies ideally would include a longitudinal panel but hard with a nationwide study of this size and scope

What about the ecological fallacy?

- Limited policy lag leads to questions about what came first—the active living oriented zoning or physically active adults seeking more active living-oriented communities?
 - We tried to ensure that coding was done on zoning provisions enacted 2010 or earlier (most were several years prior (if not a decade or more))
 - Data indicate that many jurisdictions have adopted code reforms since our 2010 cutoff that we did not code (but we have)
 - Perhaps a counterfactual argument could be made that even if the associations from this study were because adults purposefully selected active living-oriented communities... **such a finding could still be useful in discussions with planning/zoning officials as to the importance of active living-oriented zoning either to facilitate active transport or because people will want to live there!**



Implications for Practice and Policy

- Implementing changes to zoning codes to be more active living-oriented may be a key strategy for improving adult population-level active transport
 - **At the municipal level**, key zoning elements include: bike lanes, street furniture/bike parking, pedestrian access, mixed use, and having more provisions
- When aggregating up to the county level, zoning tends to be associated with public transit use more than walking, particularly in rural areas
 - **Key zoning elements**: sidewalks, crosswalks, bike parking/street furniture, pedestrian access, mixed use, having more provisions
- Transportation and public health officials should work with **planning and zoning officials/urban planners** in the community to facilitate zoning changes to make them more active living oriented

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THANK YOU!