DENSITY DIFFERENCES: exploring built environment relationships with **walking between and within** metropolitan areas

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Introduction

The overarching goal of this study is to explore the consistency of relationships between walking behavior and the built environment across and within different urban areas with an interest in the transferability of results from one location to another. We focus specifically on the relationship between density and walking, which may vary across different cities with different scales of development, as well as within cities. This paper examines this relationship by comparing the results of analyses of household travel survey data from various US cities and one international city – Santiago, Chile. For this task, we match trip ends to density measures at the block group level (or zonal level in the case of Santiago). Next, we examine the relationships of various built environment measures to the probability of walking, thus analyzing the relations among cities and testing their equivalence. To test the share of walking trips in each region, we use simple linear regressions. To test for the probability of walking on an individual trip, we use a binary logit to model the modal outcomes of walking or use of another mode.

Methodology

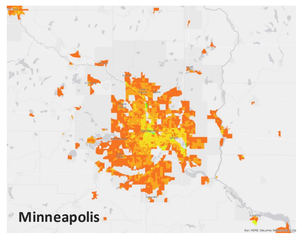
For this task, we use data and methods that are comparable across our study locations. Two main data sources are compiled: a) walk and non-walk trips, obtained from regional travel surveys, and b) consistent built environment measures. We assembled four US travel surveys: those covering the state of California as well as the metropolitan areas of Minneapolis–St. Paul, Portland, and Seattle. The California travel survey allowed for the inclusion of the Metropolitan Statistical Areas of Los Angeles, San Diego, and San Francisco-Oakland (without San Jose), bringing the total of US regions to six. In addition, we used the *Encuesta Origen-Destino 2012,* the travel survey of the metropolitan area of Santiago, Chile, as an example to examine consistency in non-US cities. For the purpose of this research, the linked trip files of all regions were used; thus, "trips" represent a full journey from an origin to a destination, encompassing any changes of mode along the way. In our definition of a walk trip for this analysis, we considered only trips where walking was the sole mode of transport for the entire linked trip, excluding trip segments where walking was used to access/egress other modes such as public transit.

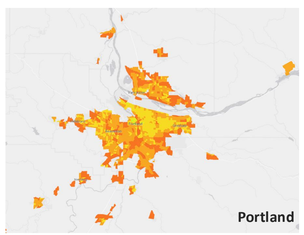
Built environment measures (population density, employment density, and intersection density) for the US regions were obtained from the Smart Location Database (SLD), version 2.0 (*14*). The SLD is a nationwide geographic data resource for measuring location efficiency collected by the US Environmental Protection Agency using data collected by the 2010 US Census and other sources. The Santiago data was constructed from EOD 2012 (*13*). The analysis of the household survey was done at traffic analysis zones (TAZ) for population density. Unfortunately, the survey did not include the intersection density or the employment density. Thus, only population density of Santiago is used in this analysis.

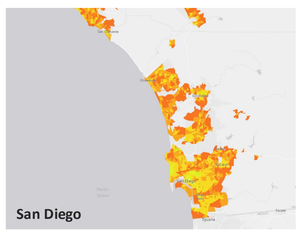
Data

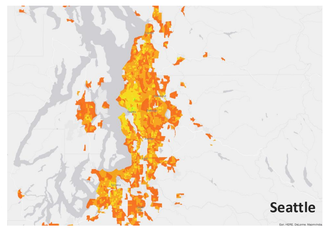
TABLE 1. Year, total trips, walk trips, zones in each metro area

MODE	LOS ANGELES	MINNEAPOLIS – ST. PAUL	PORTLAND	SAN DIEGO	SAN FRANCISCO	SANTIAGO	SEATTLE
Year of survey	2010-12	2010	2011	2010-12	2010-12	2012	2006
Total trips	32.8M	11.1M	6.5M	7.8M	13.4M	17.7M	M
Population	12.8M	3.3M	2.2M	3.1M	4.3M	6.7M	3.4M
Walking (%)	11.0%	6.2%	8.6%	8.5%	15.9%	34.9%	7.9%
No. of block groups (or zones*)	8248	2314	1555	1795	2903	790	2483
Avg. population	1555	1417	1567	1724	1493	8420	1385

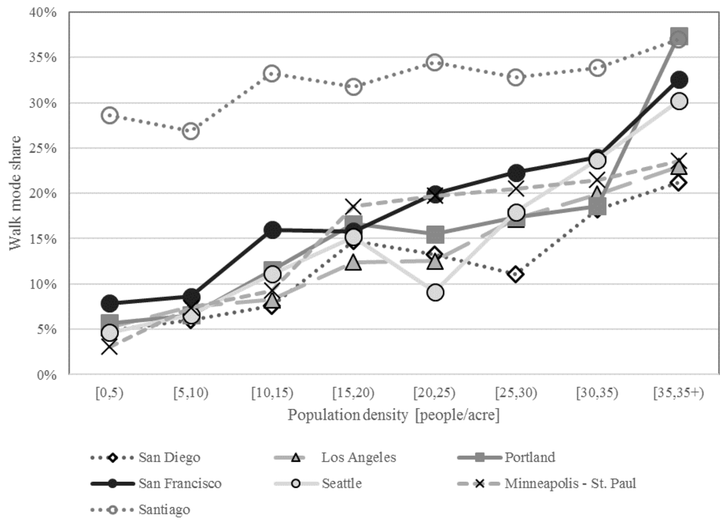


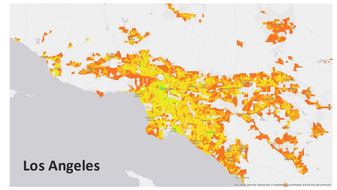


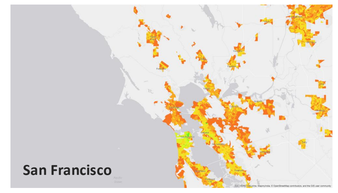


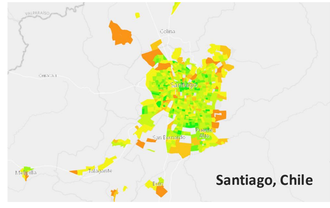


Results









Findings

The standardized coefficients from each of the univariate models are consistent across US regions. Overall, population density appears to have both larger and more stable values for the standardized and unstandardized coefficients. This suggests that residential density may be the most important built environment factor associated with the odds of walking. Intersection density also shows strong but less consistent associations with walking; Los Angeles had the weakest correlation. Employment density has varying relationships with walking across each of the different cities. Portland has the larger impact. This analysis also indicates that, overall, entertainment and retail job density may have a stronger association with the odds of walking than total job density. San Diego was the one exception.

Within regions, a graphical inspection reveals a relationship between population density and walk mode shares that is roughly linear and of nearly equal magnitude across US regions in densities below 20 persons/acre (as shown in Figure 1 below). Above that, the relationships are less clear. These findings raise concerns about assuming that results from one city are applicable to another. The relationship between density and walking activity may be transferable across lower density areas in US cities; however, this does not offer much guidance to planners since these are not the locations from which to model new walkability standards.

Conclusions

The analysis of aggregate and disaggregate pedestrian trips presented here examined the potential transferability of relationships between walking and the built environment within and across different regions, with a specific focus on population density. Although support for transferability is discouraging, the consistency of 20 person/acre offers as a breakpoint in the regimes offers some promise. In addition, the distribution of densities in comparison to the total area appears to be important and raises the issue of the role of the larger urban spatial structure in walkability. As work in this area matures, fine-grained built environment measures should be complemented with constructs that describe the metropolitan structure, including density distributions and gradients, poly-centricity, and spatial extent of the urban area.

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