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Neighborhood Design and Walking Trips in Ten U.S. Metropolitan Areas

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Abstract

Background— Despite substantial evidence for neighborhood characteristics correlating with walking, so far there has been limited attention to possible practical implications for neighborhood design. This study investigates to what extent design guidelines are likely to stimulate walking.

Methods— Four of the New Urbanism Smart Scorecard criteria and two other measures were tested for their influence on walking. Data were obtained from the 1995 National Personal Transportation Survey, U.S. Census 2000, and InfoUSA. Propensity-score methodology was used to control for potential confounders.

Results— Higher levels of business diversity and higher percentages of four-way intersections were associated with more walking. For example, the odds ratio (OR) for walking in a neighborhood with 4 business types present compared to 3 business types was 1.24 (CI 1.07–1.44) and neighborhoods with 50%–74% four-way intersections had an OR for walking of 1.4 (CI 1.09–1.78) relative to those with 25%–49% four-way intersections. The effects of housing density on walking are mixed. Higher parking pressure and older median housing age did not significantly affect walking after covariate adjustment. Block length did not appear to be associated with walking.

Conclusion— When considering the New Urbanism Smart Scorecard from the perspective walking, some, but not all, of its criteria that appear to have a correlation with walking are likely to be useful for designing walkable communities.

INTRODUCTION

Walking, the most common form of physical activity, is known to be an important contributor to health.^{1,2} There is evidence that neighborhood characteristics are correlated with walking,^{3–6} but so far there is limited attention to possible practical implications for neighborhood design. This study investigates to what extent design guidelines are likely to stimulate walking. The measures used are based largely the New Urbanism Scorecard.⁷

The New Urbanism, originally developed to create sustainable communities, reduce sprawl, and limit the destruction of open green spaces and farmlands, is designed in part to make walking a routine activity.^{8,9} New Urbanism has gained support from federal agencies, including the U.S. Environmental Protection Agency.¹⁰ Fleissig and Jacobsen⁷ created the Smart Scorecard to propagate the principles and provide detailed guidelines on new urbanist design by assisting with project-level decisions and evaluating for smart growth principles.

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MATERIALS AND METHODS

Smart Scorecard criteria were selected that aim to increase walking and that can be evaluated by national-scale databases. The four selected measures are:

Housing density

The average number of dwelling units/acre. Density is related to higher prevalence of walking.

Mixed land use

A measure of the diversity of land use. If residential and commercial areas are in close proximity, people are able to walk for their daily errands.

Street network

The degree to which streets are connected as a grid system. Increasing the number of intersections shortens the distance between destinations and may increase walking.

Block lengths

The average length of the long side of a city block. The New Urbanism suggests that best scale for walking is 300 to 600 feet.

The Smart Scorecard evaluates different levels of these built-environment measures as excellent, preferred, acceptable, minimal, or “does not apply” (Table 1). A built environment was hypothesized to be better for walking if the housing density is higher, land use is more mixed, street network is based more on a grid, or block lengths are shorter.

The remaining eight measures that may stimulate walking were not investigated because they were not readily available in national-scale databases. They are: walking distance to transit, street-level uses that generate maximum pedestrian activity, pedestrian amenities for transit, adequate sidewalks, parking facilities behind the building, connections to existing or planned parks and open space, choices in transportation modes, and strong connections to all adjacent natural features such as river-ways or hiking trails.

Two additional measures were included that are not in the Scorecard but related to building sustainable New Urbanist communities:

Available street parking

If street parking space is abundant, people may tend to own more vehicles, use them more, and therefore walk less.^{11–13} This measure was included to hypothesize the importance of a “push” factor as compared with “pull” factors that invite people to walk.

Median age of neighborhood housing

The New Urbanism advocates the creation of neighborhoods with many similarities to those built before people relied on cars; therefore the hypothesis was investigated that extent older neighborhoods are more conducive to walking than newer neighborhoods.

Data

Data on walking trips were obtained from the National Personal Transportation Survey (NPTS) of 1995. The NPTS-1995 includes interviews of 42,033 households nationwide with a detailed survey concerning one randomly selected day for each household member aged five years and older. Individual and family characteristics were also recorded in the survey. Included households are in the ten largest Consolidated Metropolitan Statistical Areas (CMSAs) as

defined for the U.S. Census 2000. The main cities in these ten CMSAs are Boston, Chicago, Dallas, Detroit, Houston, Los Angeles, New York, Philadelphia, San Francisco, and Washington.¹⁴ The most precise geographic description available was the census block-group identifier of the household; which was used to link with other geographic data. The survey asks participants to describe all trips made during one day where “trip” is defined as: any time you went from one address to another in a vehicle or by walking or biking. Each stop you make is a separate trip, including picking up or dropping off someone. Walking trips are the selection of trips where the participant replied “walk” to the question: How did you get to your destination? (That is, what means of transportation did you use for this trip?).

Census 2000 data were obtained for information on population, number of housing units, housing age, and land area at the block-group level. The Census Topologically Integrated Geographic Encoding and Referencing system (TIGER) data were used for the two measures: street network connectivity and block size.

The InfoUSA database (October 2001 extraction) concerning location of many possible destinations for trips: businesses, public buildings, and facilities, was used to assess business diversity by counting the number of different types of businesses within the neighborhood.¹⁵

The United States Historical Climatology Network (HCN) Serial Temperature and Precipitation Data were used to adjust for temperature and rain effects during the surveyed travel day.¹⁶ All built-environment variables concern the neighborhood, which was defined by block groups whose centroid is within 1/4-mile radius of the centroid of the block group of the household. The centroid was defined as the population weighted mean center of the block group.

The radius of 1/4 mile was chosen because it was the median length of a daily walking trip in NPTS-1995. Some households in NPTS-1995, whose block group does not exist in Census 2000, were excluded from analysis. This reduced the data set from 31,761 individuals in 13,694 households to 30,025 individuals in 13,012 households. Analysis was conducted in 2005 and 2006.

Outcome Measure

In the NPTS-1995, the purposes and modes of each trip of the travel day were surveyed. People who made at least one walking trip were compared to those without any walking trips. Information on length of walking trips was generally disregarded because they are usually derived from reported blocks walked, which is an inaccurate measure because block lengths vary considerably. Moreover, block length was investigated as explanatory variable. Where walking trips lengths were reported, trips to and from home were assumed to concern the average neighborhood block length, and other trips the average CMSA block length.

Built-Environment Measures

Housing density was transformed into a categorical variable according to the Scorecard (Table 1). “Street network is based on a grid system” was operationalized as the fraction of four-way intersections in the neighborhood (because a grid pattern includes 100% four-way intersections) and categorized according to the Scorecard. The categories for block length are: <400 feet: excellent; 400–500 feet: preferred; 500–600 feet: acceptable; and >600 feet: minimal. However, 96.2% of the sampled individuals lived in neighborhoods with average block lengths >600 feet (Table 1), therefore the observations with block lengths >600 feet were categorized into five groups of equal size. When using a covariate adjustment, block lengths <600 feet were considered as one category. Mixed land use was operationalized as the number of different types of businesses in a neighborhood. Businesses, coded by the Standardized

Industrial Classification system (SIC), were categorized as: service (major group SIC codes 43,58,60,72,76,80,81,83,86), retail (52–54,56,57,59); cultural (84); educational (82); recreation (79); neighborhood serving/retail (79); and employment (73, 87,89).¹⁷ Therefore, business diversity scores range from 0 to 7, indicating the number of different categories of businesses in the neighborhood. Parking pressure was measured as the number of residents per foot of parkable street length, estimated by street length reported by the TIGER data minus 20 feet from the center roadway of intersecting streets to account for loss of parking space at corners. This definition implies that measures such as off-street parking and diagonal parking are implemented as the result of parking pressure. It was categorized according to the 10th, 25th, 50th, 75th, and 90th percentiles. Median housing age includes six categories: built before 1939; 1940–1949; 1950–1959; 1960–1969; 1970–1979; and 1980–2000.

Individual and Household Characteristics and Control Variables

The following individual and household characteristics were included in the model: individual education; job status (full, part time, or no job last week); age; gender; household size; Hispanic ethnicity; race; Consolidated Metropolitan Statistical Area (CMSA); and household life cycle (classified as follows: one adult, not retired; two or more adults, none retired; one adult, retirement status unknown, youngest child aged 0–5; two or more adults, retirement status unknown, youngest child aged 0–5 years; one adult, retirement status unknown, youngest child aged 6–15 years; two or more adults, retirement status unknown; youngest child aged 6–15 years; one adult, retirement status unknown, youngest child aged 16–21 years; two or more adults, retirement status unknown, youngest child aged 16–21 years; one adult, retired; two or more adults, retired). Month, precipitation, and average temperature on the reported travel day were also included.

Method

The propensity-scoring method was used to control for potential confounders because it is a closer approximation of causal inference-based than traditional regression methods.¹⁸ The propensity score is defined as the probability that a study subject belongs to one of the treatment groups, depending on all relevant covariates. Adjusting for differences in the propensity scores between treatment groups removes bias related to differences in pre-treatment variables more effectively than multivariate analysis. After adjusting, covariates should be approximately equally distributed over the treatment groups. Failure of this usually signifies that the treatment groups are too different. Traditional regression methods do not reveal such problems and therefore may lead to invalid conclusions.

To apply the propensity scoring method, each category of built environment was considered as a treatment. For a measure with n levels, $n-1$ analyses were made by comparing only adjacent pairs of treatments. For example, individuals with Level 1 and 2 were selected into a subpopulation and the effects of treatment Levels 1 and 2 were estimated within this subpopulation.

A logistic regression model was used to estimate the conditional probability to be in treatment Level 2, with the value of $T=1$. People in treatment Level 1 were assigned with $T=0$. The estimated conditional probability was the estimated propensity score.

$$e(x) = \Pr(T = 1 \mid X_I = x_I) = \frac{\exp(\alpha + \beta X)}{1 + \exp(\alpha + \beta X)}$$

Covariates X used in this model include personal and household characteristics, and the other five built-environment measures.

The propensity score for population weights was used.^{18–20} The estimated treatment effects adjusted for all pre-treatment variables are as follows:

$$E(Y_1) = E\left[\frac{Y \cdot T}{e(x)}\right]; E(Y_0) = E\left[\frac{Y \cdot (1 - T)}{(1 - e(x))}\right]$$

Adjusted for all pre-treatment variables, $E(Y_1)$ is the average outcome of the treatment ($T=1$) for the population, and $E(Y_0)$ is the average outcome of the control ($T=0$) for the population. Therefore the weight for each observation was the inverse of the probability of receiving the treatment actually received.

Each built-environment measure examined has more than two treatment levels. Although propensity score was originally applied to the case where treatment takes only two levels,¹⁸ Imbens²⁰ extended propensity-score methodology to multiple levels of treatments. However, this study compared only adjacent treatment levels because it was not possible to balance all covariates across wide ranges of a certain measure.

RESULTS

The percentage of people having at least one walking trip during a travel day, varied with different neighborhood characteristics without covariate adjustment (Table 2). Walking correlates with the number of businesses in a neighborhood, housing density, fraction of four-way intersections, and parking pressure. As median housing age increased, people tended to walk less, except that people in the neighborhoods built between 1940 and 1949 walked a little more than those in older neighborhoods. There was a very low probability of walking for blocks less than 400 feet but this group had only 12 observations. When block lengths are greater than 400 feet, block length was correlated with fewer walking trips.

Table 3 shows the results of the propensity-score method to examine the effects of each built-environment measure, controlling for individual and household characteristics, and the other five built-environment measures.

After covariate adjustment for adjacent levels of built-environment measures, the effects of a single built-environment measure on the average probability to walk during a travel day were moderated. For median housing age and parking pressure, all pairs of differences were not significant. Moving from block lengths less than 600 feet to 600–804 feet increased the probability of walking (OR= 1.26, 95% CI= 1.04–1.52). This result seems to be inconsistent with the Scorecard's claim that shorter the block length stimulates walking. However, sample size considerations prevented investigating the actual Scorecard's categories. Within block lengths of over 804 feet, there were no significant effects on walking. Moving from two different business types in the neighborhood to three types significantly improved the probability of walking (OR= 1.15, 95% CI=1.001–1.320). The same effect was found when comparing four with three different business types (OR=1.24, 95% CI=1.11–1.39). Additional increases in business diversity were not associated with a significant increase in walking. Living in a neighborhood with housing density >14 units per acre significantly increased the probability of walking compared to housing density of 11–14 units per acre (OR=2.05, 95% CI= 1.46–2.89). But with a housing density of 11–14 units/acre compared to 7–11 units/acre, the probability to walk was lower (OR=0.80, 95% CI=0.64–1.00). Finally, the percentage of four-way intersections appeared to be an important factor for people living in areas where the street network is not entirely a grid system. The difference between the areas with the lowest percentage of four-way intersections (0–24%) and those with 25%–49% was a 36% increase in walking (OR=1.36, 95% CI=1.18–1.58). For residents living in areas where 25%–74% of intersections are four-way intersections, the probability to walk was higher at the level of 50%–74% compared to the level of 25%–49% (OR=1.38, 95% CI= 1.09–1.75). Furthermore,

neighborhoods with 75%–99.9% of four-way intersections promote walking compared to the level of 50%–74% (OR=1.20, 95% CI= 1.02–1.41). But there was no significant effect on walking at the level of 100% four-way intersections, compared to 75%–99.9%. As a whole, the studied measures showed only a modest impact on walking. The fraction of four-way intersections, housing density and business diversity appear to be more important than block lengths (long side), parking pressure and median housing age.

Figure 1 shows the adjusted walking outcomes for each group of individuals in adjacent levels of a certain built-environment measure. For each measure, aside from the two groups in the lowest level and the highest level, other groups each had two adjusted means, as those in Table 3. Generally, the paired differences were small. Across the whole range of levels, there were both positive and negative trends. Walking was positively related to housing density, business density, fraction of four-way intersections, and parking pressure, and negatively related to short block length and median housing age.

The distributions of covariates in non-adjacent groups were very different. Therefore, reasonable comparisons can be made only in adjacent groups. Covariates balances for each comparison using weighted chi-square test were found to be acceptable. The only exception was a strong imbalance between the groups with housing density Level 1 and Level 2, partly because the lowest density category comprises a large (61.9% of total sample) and diverse group. However, the difference in average walking probability between Level 1 and Level 2 is small and insignificant after covariate adjustment.

DISCUSSION

This is one of the first attempts to empirically test whether the New Urbanism Smart Scorecard criteria will promote walkable communities. Among the four measures in the Scorecard that were assumed to be related to walking, it was found that three are associated with walking: the percentage of four-way intersections, business diversity, and housing density but only at the highest levels. The effect of block length could not be assessed because the block lengths in the sample were very different from those in the Scorecard. Using a different block-length categorization, it appeared that neighborhoods with a block length of 600–804 feet increase the probability of walking, compared to those with block length less than 600 feet. This contradicts the Scorecard's claim that shorter block lengths are better. Among block-length categories there were no significant effects on the probability to walk. The other built-environment measures: parking pressure and median housing age, did have a significant effect on walking after covariate adjustment.

Adjustment for covariates had a remarkably large effect which showed that each measure of this research is strongly correlated with neighborhood's conduciveness for walking but that neither of them appears to be the main cause of this conduciveness.

The effects of business diversity and the percentage of four-way intersections on walking are consistent with the Smart Scorecard criteria. The higher the fraction of four-way intersections, the more likely people would walk on a travel day. In neighborhoods with two or three types of businesses, increasing business diversity will improve considerably the probability of walking. But when there are already four or more types of businesses, increasing the types of businesses does not further increase walking. Finally, the effects of housing density on walking are mixed. Neighborhoods with housing density greater than or equal to 14 units/acre promote walking, compared to those with housing density less than 14 units/acre. However, when housing density is 11–14 units/acre, the probability to walk was lower than when housing density is 7–11 units/acre.

Each of the six built-environment measures examined appeared to have only a limited effect on walking. Therefore, in order to have a large effect on walking through the built environment, there appears to be a need to change more than one characteristic of the built environment.

The effect of some of the Scorecard criteria examined were not as hypothesized. This may be due to observing strong correlations between design characteristics and walking without sufficiently considering the effects of other variables. For example, short block length does not appear to stimulate walking after adjusting for covariates but the unadjusted analysis shows a strong correlation. Apparently short block lengths tend to be found in neighborhoods with other characteristics that affect walking but short block length as such does not appear to stimulate walking.

These results have some limitations. This investigation focused on six measures, although there may be others that could be more influential. Relying on national-scale data sets tends to make measurement less accurate than when using data collection developed specifically for the research questions, for example: In the linked dataset, the individual and household information was the data from the year 1995 to 1996, while the neighborhood data were obtained from the U.S. census year 2000. It is likely that neighborhood characteristics have changed somewhat from year 1995–1996 to year 2000, a few may even have undergone a complete redevelopment that changed all measures of this research. The data sets used could not be validated for this study. Another lack of precision is due to self-report of walking trips, which recall bias seems apparent from the fact that during cold weather more walking trips are reported. However, considering the results from table 2, clearly the signal to noise ratio is still quite favorable.

The Scorecard selects several areas in which the trend is consistent with increased walking, but the fine details are not precise. Its recommendations should be considered as a guideline, and not as a guaranteed recipe for promoting walking. Walking is likely to be influenced by both physical and social environmental features. The analysis was limited strictly to physical aspects of the environment. It is likely that social aspects play an integral role, and that other omitted variables such as crime or traffic influence the decision to walk. Further studies can expand the repertoire of variables to be examined to test specific features that create walkable communities.

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References

1. DHHS. Physical Activity and Health: A Report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996.
2. Hakim A, Petrovitch H, Burchfiel C. Effects of Walking on Mortality among Nonsmoking Retired Men. *The New England journal of medicine* 1998;338(2):94–9. [PubMed: 9420340]
3. Hawthorn, W. Why Ontarians Walk, Why Ontarians Don't Walk More: A Study Into the Walking Habits of Ontarians. Toronto: Energy Probe Research Foundation; 1989.
4. Carnegie MA, Bauman A, Marshall AL, Mohsin M, Westley-Wise V, Booth ML. Perceptions of the physical environment, stage of change for physical activity, and walking among Australian adults. *Res Q Exerc Sport* 2002;73(2):146–55. [PubMed: 12092889]
5. Craig CL, Brownson RC, Cragg SE, Dunn AL. Exploring the effect of the environment on physical activity: a study examining walking to work. *Am J Prev Med* 2002;23(2 Suppl):36–43. [PubMed: 12133736]
6. Humpel N, Owen N, Iverson D, Leslie E, Bauman A. Perceived environment attributes, residential location, and walking for particular purposes. *Am J Prev Med* 2004;26(2):119–25. [PubMed: 14751322]

7. Fleissig, W.; Jacobsen, V. Smart Scorecard for developing projects. 2002 [accessed: 2006]. http://www.cnu.org/cnu_reports/Scorecard_exp.pdf
8. Steuteville, R. The New Urbanism: An alternative to modern, automobile-oriented planning and development: New Urban News. 2004 [accessed: 2005]. <http://www.newurbannews.com/AboutNewUrbanism.html>
9. Congress for the New Urbanism. New Urbanism. 2005 [accessed: 2006]. <http://www.newurbanism.org/pages/416429/index.htm>
10. U.S. Environmental Protection Agency. EPA Smart Growth Strategy. 2004 [accessed: 2006]. <http://www.epa.gov/smartgrowth/pdf/EPASmartGrowthStrategy.pdf>
11. Holtzclaw, J. Using Residential Patterns and Transit to Decrease Auto Dependence and Costs. San Francisco: Natural Resources Defense Council; 1994.
12. Kockelman KM. Travel Behavior as a Function of Accessibility, Land Use Mixing and Land Use Balance: Evidence From the San Francisco Bay Area. *Transportation Research Record* 1997;(1607): 116–125.
13. Schimek P. Household Motor Vehicle Ownership and Use: How Much Does Residential Density Matter? *Transportation Research Record* 1996;(1552):120–125.
14. Population Division – U.S. Census Bureau. Metropolitan Areas and Components, 1999, with Fips Codes. 2002 [accessed: 2006]. <http://www.census.gov/population/estimates/metro-city/99mfips.txt>
15. ESRI and infoUSA. Business–Methodology. 2006 [accessed: 2006]. <http://www.esribis.com/data/busmethodology.html> and <http://www.infousa.com/>
16. National Climatic Data Center, Department of Commerce. United States Historical Climatology Network (USHCN). 2005 [accessed: 2006]. <http://www.ncdc.noaa.gov/oa/climate/research/ushcn/ushcn.html>
17. Executive Office of the President – Office of Management and Budget. Standard industrial classification manual, 1987. 1987 [accessed: 2006]. http://www.osha.gov/pls/imis/sic_manual.html
18. Rosenbaum P, Rubin D. The Central Role of Propensity Score in Observational Studies for Causal Effects. *Biometrika* 1983;70(1):41–55.
19. Rosenbaum P. Model–Based Direct Adjustment. *Journal of the American Statistical Association* 1987;82(398):387–394.
20. Imbens G. The role of the propensity score in estimating dose–response functions. *Biometrika* 2000;87(3):706–710.

Figure 1. Adjusted probability to walk during a travel day at different levels of built-environment measures. The vertical axis is the probability to walk. The horizontal axis is the level of built-environment measure. Error bars have lengths which are equal to 2 standard errors of the estimated means.

Table 1
Smart scorecard measures and corresponding checklists

Measure	Checklist
Housing density: Average number of dwelling units/acre	
Average density is: 14 or more	Excellent
10–13	Preferred
7–9	Acceptable
4–6	Minimal
<4	Does not apply
Mixed land use: Provides a new type of development to an existing neighborhood (within 1 mile), such as employment, housing, retail, civic, educational, cultural, recreation, neighborhood serving retail/service	
4 additional use added to the neighborhood	Excellent
3	Preferred
2	Acceptable
1	Minimal
0	Does not apply
Street network is based on a grid system.	
100% of street network is a grid	Excellent
75–99.9 %grid	Preferred
50–74% grid	Acceptable
25–49 %grid	Minimal
<25% grid	Does not apply
Short block lengths (long-side)	
Less than 400 feet	Excellent
400 to 500 feet	Preferred
501 to 600 feet	Acceptable
Greater than 600 feet	Minimal

CI, confidence interval

Table 2

Neighborhood characteristics, proportion of subjects having at least one walking trip during a travel day, and average walking distance

Neighborhood characteristics	Percentage of subjects having at least one walking trip		
	No. [%] of people N =29,724	(95% CI)	Average walking distance (mile)
Number of different businesses			
0	6582 [22%]	7.70 [7.06–8.35]	0.136 [0.118–0.153]
1	4727 [16%]	8.89 [8.07–9.70]	0.140 [0.120–0.160]
2	5060 [17%]	10.42 [9.57–11.26]	0.156 [0.138–0.175]
3	4960 [17%]	15.54 [14.54–16.55]	0.237 [0.212–0.262]
4	3705 [12%]	24.43 [23.04–25.81]	0.365 [0.333–0.396]
5	2762 [9%]	31.64 [29.91–33.38]	0.510 [0.465–0.556]
6–7	1928 [6%]	45.64 [43.42–47.87]	0.833 [0.769–0.897]
Housing density (units/acre)			
0–4	18359 [62%]	8.66 [8.25–9.07]	0.139 [0.129–0.149]
4–7	3789 [13%]	15.02 [13.88–16.15]	0.201 [0.177–0.224]
7–11	1978 [7%]	21.79 [19.97–23.61]	0.294 [0.256–0.332]
11–14	1320 [4%]	21.67 [19.44–23.89]	0.304 [0.254–0.353]
>14	4278 [14%]	46.94 [45.44–48.43]	0.840 [0.795–0.885]
Median housing age (year)			
built 1939 or earlier	3431 [12%]	24.10 [22.67–25.54]	0.382 [0.346–0.418]
built 1940 to 1949	4848 [16%]	29.41 [28.13–30.70]	0.499 [0.464–0.534]
built 1950 to 1959	6351 [21%]	18.00 [17.05–18.94]	0.278 [0.256–0.300]
built 1960 to 1969	5996 [20%]	11.77 [10.96–12.59]	0.196 [0.176–0.217]
built 1970 to 1979	5608 [19%]	8.70 [7.96–9.44]	0.126 [0.111–0.142]
built 1980 to 2000	3490 [12%]	8.42 [7.50–9.35]	0.145 [0.123–0.167]
Parking pressure (person/foot)			
0–0.0077	2849 [10%]	5.90 [5.03–6.76]	0.120 [0.095–0.146]
0.0077–0.0135	4371 [15%]	7.37 [6.59–8.14]	0.113 [0.095–0.131]
0.0135–0.0224	7509 [25%]	9.80 [9.13–10.47]	0.147 [0.131–0.162]
0.0224–0.0363	7549 [25%]	15.21 [14.40–16.02]	0.215 [0.198–0.233]
0.0263–0.0599	4490 [15%]	27.10 [25.80–28.41]	0.442 [0.408–0.475]
0.0599–0.4713	2956 [10%]	43.74 [41.95–45.53]	0.792 [0.739–0.845]
Block length (long side) (feet)			
>600	1136 [4%]	29.93 [27.27–32.59]	0.476 [0.410–0.542]
600–804	5763 [19%]	30.37 [29.18–31.55]	0.476 [0.447–0.506]
804–1040	5761 [19%]	20.33 [19.29–21.37]	0.317 [0.291–0.343]
1040–1420	5689 [19%]	12.94 [12.07–13.81]	0.206 [0.185–0.228]
1420–2132	5711 [19%]	8.84 [8.11–9.58]	0.164 [0.144–0.183]
>2132	5664 [19%]	6.74 [6.09–7.40]	0.117 [0.101–0.134]
Fraction of 4-way intersections (%)			
<25	15231 [51%]	8.02 [7.59–8.45]	0.130 [0.119–0.140]
25–49	5272 [18%]	13.18 [12.27–14.10]	0.183 [0.163–0.203]
50–74	3432 [12%]	20.28 [18.93–21.63]	0.314 [0.281–0.346]
75–99.9	4790 [16%]	36.37 [35.00–37.73]	0.608 [0.571–0.646]
100	999 [3%]	52.95 [49.86–56.05]	0.957 [0.866–1.049]

CI, confidence interval

Table 3Adjusted^a and unadjusted effects of built-environment measures on walking

	Odds ratio to walk (relative to previous level) (95% CI)	
	Adjusted	Unadjusted
Number of different businesses		
0		
1	1.08 [0.88–1.34]	1.17 [1.00–1.36]
2	0.92 [0.76–1.12]	1.19 [1.02–1.39]
3	1.14 [0.96–1.35]	1.58 [1.39–1.81]
4	1.24 [1.07–1.44]	1.76 [1.57–1.97]
5	1.01 [0.87–1.18]	1.43 [1.29–1.59]
6–7	0.97 [0.80–1.17]	1.81 [1.65–1.99]
Housing density (units/acre)		
0–4		
4–7	1.19 [0.85–1.66]	1.86 [1.67–2.08]
7–11	1.06 [0.79–1.41]	1.58 [1.37–1.82]
11–14	0.80 [0.60–1.06]	0.99 [0.84–1.18]
>14	2.03 [1.36–3.03]	3.20 [2.78–3.68]
Median housing age (year)		
Built 1939 or earlier		
Built 1940 to 1949	0.89 [0.77–1.04]	1.31 [1.19–1.44]
built 1950 to 1959	0.93 [0.81–1.07]	0.53 [0.48–0.58]
built 1960 to 1969	0.97 [0.83–1.14]	0.61 [0.54–0.68]
built 1970 to 1979	0.95 [0.77–1.17]	0.71 [0.62–0.82]
built 1980 to 2000	1.39 [0.92–2.10]	0.97 [0.81–1.15]
Parking pressure (person/foot)		
0–0.0077		
0.0077–0.0135	0.99 [0.73–1.35]	1.27 [1.01–1.59]
0.0135–0.0224	0.86 [0.66–1.11]	1.37 [1.17–1.59]
0.0224–0.0363	0.97 [0.79–1.19]	1.65 [1.48–1.84]
0.0263–0.0599	0.87 [0.69–1.11]	2.07 [1.89–2.27]
0.0599–0.4713	1.35 [1.10–1.64]	2.09 [1.93–2.27]
Block length (long side) (feet)		
>600		
600–804	1.26 [0.98–1.62]	1.02 [0.90–1.16]
804–1040	0.95 [0.84–1.07]	0.59 [0.54–0.64]
1040–1420	1.04 [0.88–1.22]	0.58 [0.52–0.65]
1420–2132	1.03 [0.85–1.26]	0.65 [0.57–0.75]
>2132	1.03 [0.84–1.27]	0.75 [0.64–0.87]
Fraction of 4-way intersections (%)		
<25		
25–49	1.35 [1.13–1.60]	1.74 [1.56–1.94]
50–74	1.40 [1.09–1.78]	1.68 [1.48–1.89]
75–99.9	1.20 [0.99–1.44]	2.25 [2.04–2.47]
100	0.98 [0.66–1.46]	1.97 [1.80–2.15]

^a Adjusted by weighting the observations to make the distribution of following covariates equal over both comparison groups: education; job status; age; gender; household size; Hispanic ethnicity; race; CMSA; household life cycle; month, precipitation, and average temperature on the reported travel day; and the other five built environment measures. CI, confidence interval