Neighborhood Environments and Obesity: Exploring Links to Body Mass and Physical Activity

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Abstract

We assess potential mechanisms through which the social and built environments may be linked to obesity, both directly and indirectly through their affects on physical activity, using data from Chicago neighborhoods. Preliminary findings reveal that neighborhood factors appear to play important roles in predicting both exercise and walking, net of a wide array of individual-level characteristics. People exercise less in neighborhoods in which residents perceive higher levels of crime and disorder, but walk more in such neighborhoods. People walk less in neighborhoods where there is more collective fear of crime. The presence of recreational facilities and/or waterfront in a neighborhood appears to encourage exercise. People who live in more "yuppie" neighborhoods (places with people who have higher levels of education and people in professional managerial jobs, and marked by the absence of children) tend to exercise more, and they tend to walk more in areas with higher population density.

Extended Abstract

It has become an increasingly popular view in the field of public health that physical and social features of the residential environment can affect health either directly (e.g., through contaminants in the air or water supply) or indirectly, by influencing behaviors related to health (e.g., physical activity, food intake substance use, utilization of medical care) and/or psychosocial dispositions (e.g., stress and social relationships that help cope with stress) that may be related to health through more complex causal chains (2002). An increasingly large body of observational studies, most of them conducted by social epidemiologists and sociologists, demonstrates that there is considerable variation in mortality and other health outcomes across local geographic areas (Diez Roux 2001; Morenoff and Lynch 2004) and that this variation is related to area socioeconomic status (e.g., poverty rates and other measures of disadvantage and affluence) and appears to be at least partly independent of personal measures of socioeconomic position..

All of this suggests that health is adversely affected by living in impoverished neighborhoods (Robert 1998). However, this research has been criticized on the grounds that people self-select into neighborhoods on the basis of characteristics that are not assessed directly in observational studies on health or that are assessed with considerable measurement error, and that neglecting these selection factors can lead to biased (and perhaps inflated) estimates of the causal effects of neighborhood residence on health (Kling, Liebman, and Katz 2005; Oakes 2004). Another important criticism is that most studies examining the link between residential environments and health have relied on measures of socioeconomic status (usually taken from the census) to explain area variation in health, but they have not identified specific causal

mechanisms, especially those relating to features of the physical or social environment that can be manipulated through interventions.

In this paper we consider the question of how residential environments might affect health outcomes related to obesity by examining data from a recent study of adult health in Chicago neighborhoods. We focus on obesity because the rapid rise in obesity rates in the United States over the past two decades (Mokdad et al. 1998) cannot be explained solely in terms of biological/genetic factors (French, Story, and Jeffery 2001; Hill and Peters 1998) and because prior theory and research has identified specific features of residential environments that might be causally linked to physical activity and food intake, both proximal determinants of obesity. Obesity is also one of the few health outcomes for which there is experimental evidence of a connection to residential environments (U.S. Department of Housing & Urban Development 2003). Still, systematic evidence is lacking on the extent to which body mass and obesity vary across residential contexts, making the current study an important contribution to this literature.

Our aim is to assess some potential mechanisms through which the social and built environments may be linked to obesity, both directly and indirectly through their affects on physical activity. Our analysis focuses on the role of neighborhood crime and disorder – both perceptions and more objective assessments of crime and disorder in the neighborhood – as well as the presence of parks, playgrounds and other public open spaces, the pervasiveness of mixed commercial/residential land use, and the prominence of detached single-family homes in the neighborhood. Thus far we have focused our efforts on the analysis of exercise and walking as outcomes because we expect that these behaviors would be more immediately responsive to neighborhood conditions than would obesity per se, but we do intend to extend our analysis to obesity for the final conference paper.

Data and Measures

We analyze data from a new study designed explicitly to investigate the role of residential environments, in conjunction with individual and household factors, in affecting adult health: the Chicago Community Adult Health Study (CCAHS). In this study, face-to-face interviews were conducted and physical/biological measurements were made on a stratified, multistage, probability sample of 3105 adults, aged 18 and over and living in 343 neighborhood clusters (NCs) within the city of Chicago between May, 2001 and March, 2003. One individual per household was interviewed, and the response rate was 71.82%. The NCs were defined for a previous study (Sampson, Raudenbush, and Earls 1997) as aggregations of census tracts (the typical NC consists of two census tracts) with meaningful physical and social identities and boundaries.[1] All data in the ensuing analysis are weighted to take account of the different rates of selection as well as household size and differential coverage and nonresponse across NCs.[2]

The obesity-related outcomes that we analyze include direct measurements of body mass index (BMI) and waist size, and survey-based measures of exercise and walking. We measure exercise with a scale constructed from survey questions that asked respondents (1) whether they are currently confined to a bed or chair for most or all of the day because of their health, (2) how many days a week do they do light or moderate leisure activities other than walking or working around the house for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate, (3) when they do light/moderate leisure activities, do they

[1] The neighborhood data in CCAHS were collected in collaboration with the Project on Human Development in Chicago Neighborhoods (PHDCN) and they included a second wave of the PHDCN Community Survey and Systematic Social Observation.

[2] The weighted sample matches the 2000 Census population estimates for the city of Chicago in terms of age, race/ethnicity and sex. The weights also take into account different rates of subsampling for final intensive interview completion efforts.

generally do them for 20 minutes or more, (4) how many days a week do they do vigorous activities for at least 10 minutes that cause heavy sweating or large increases in breathing or heart rate, and (5) each time they do vigorous activities, do they generally do them for 20 minutes or more? The scale was coded as follows:

- 0 = Never: Individuals who said they (a) never engage in light-moderate leisure activities, (b) never engage in vigorous activity, or (b) were confined to a bed or chair.
- 1 = Light: Individuals who engage in (a) light-moderate physical activity once a week or less regardless of duration, (b) light-moderate physical activity 2-3 times per week for less than 20 minutes, or (c) vigorous activity once per week or less for less than 20 minutes.
- 2 = Light-moderate: Individuals who engage in (a) light-moderate activity 2-3 times per week for more than 20 minutes, (b) light-moderate activity 4 or more times per week for less than 20 minutes, or (c) vigorous activity once per week or less for more than 20 minutes.
- 3 = Moderate-heavy: Individuals who engage in (a) light-moderate activity 4 or more times per week for more than 20 minutes, or (b) vigorous activity 2-3 times per week regardless of duration.
- 4 = Heavy: Individuals who engage in vigorous activity 4 or more times per week regardless of duration.

Our measure of walking is based on the following survey question: “On the average over the past year, how many days a week do you walk continuously for 20 minutes or more, either to get somewhere or just for exercise or pleasure?” (1) Never, (2) Less than once a week, (3) Once a week, (4) 2-3 times a week, (5) 4-5 times a week, (6) Almost every day.

Our analysis focuses on the role of neighborhood-level measures of crime/disorder and land use, as well as individuals' perceptions of crime. Our key independent variables include the following:

- Official Chicago police reports of arrest for homicide, robbery, and burglary from the years 2000-2003
- Measures of perceived crime and disorder including (1) respondent perceptions of crime and disorder in the neighborhood, (2) violent victimization, and (3) perceptions of safety in the neighborhood (i.e., fear of crime). We use both individual-level and aggregate neighborhood-level measures of perceived crime in our analysis, and for the latter we have data not only from the CCAHS (conducted mainly in 2002) but also the 1995 Project on Human Development in Chicago Neighborhoods (PHDCN) Community Survey, thus diminishing our reliance on the same data source for the measurement of both the dependent variable (exercise and walking) and neighborhood-level independent variables (perceptions of crime and disorder).
- Direct observations of disorder in neighborhoods collected via systematic social observation
- Land use measures, also collected via systematic social observation, including (1) the prevalence of face blocks in the neighborhood with a mix of commercial and residential land use, (2) the presence of recreational facilities and/or waterfront, and (3) the predominance of detached single-family homes.[3]

[3] We have recently acquired additional data on land use and commercial activity in neighborhoods from InfoUSA, a market research database, and from business licenses in the City of Chicago. We intend to incorporate these measures into our final analysis, which will also enable us to consider the link between the local food environment and obesity.

- Census-based measures of neighborhood sociodemographic characteristics. Specifically, we use a measure of population density and the following three indices derived from a principal components analysis of 18 census variables:
  (1) Affluence/mobility/young adults-no children: This component is characterized by positive loadings of the percentage of people with 16 or more years of education, the percent in professional or managerial occupations, and the percent of people age 30-39; and a negative loading of the percent of people age 17 and under.
  (2) Disadvantage: This component is characterized by positive loadings for the percentage of people with incomes of $10,000 or less, the percentage of families in poverty, the percentage of families on public assistance, the percentage of unemployed in the civilian labor force, the percentage of families that are female-headed; and negative loadings on the percentage of people with incomes of $50,000 or more and the percentage of homes that are owner-occupied.
  (3) Hispanic/immigrant/non-black: This component is characterized by positive loadings of the percentage of people who are Hispanic and the percent immigrant, and a negative loading for the percent non-Hispanic black.

We also control for an extensive battery of individual-level variables including age, sex, race/ethnicity, immigrant status, education, income, marital status, the presence of children in the household, car ownership, and functional limitations that could impede walking and exercise.

Initial Results

As an initial step in assessing the extent to which obesity-related outcomes vary across residential environments, we rely on the intra-cluster correlation (ICC), ρ, a commonly used

method for assessing contextual variation, which is defined as the fraction of variance in an outcome that lies between neighborhoods. Table 1 presents intra-cluster correlation coefficients for each outcome broken down by gender. We first consider the unadjusted ICCs, which we estimated via an unconditional random effects model in which persons vary around a neighborhood mean and neighborhoods vary around a grand mean. This model is written as follows:

$$Y_{ij} = \gamma_{00} + u_{0j} + r_{ij}$$

for person i in neighborhood j, with $r_{ij} \sim N(0, \sigma^2)$ and $u_{0j} \sim N(0, \tau_{00})$, and where $\rho = \tau_{00} / (\tau_{00} + \sigma^2)$. We estimated ρ on each outcome first for the full sample (3105 persons nested within 343 NCs), and then separately for women (1870 persons nested within 341 NCs) and men (1235 persons nested within 325 NCs), to take into account gender differences in the extent to which obesity-related outcomes vary across residential environments. For comparison, in educational and organizational research, ICCs tend to range between five and 20 percent (Hox 2002; Snijders and Bosker 1999), but for health outcomes, ICCs tend to be smaller (Morenoff 2003), rarely surpassing 10 percent. It is also important to keep in mind, as Duncan and Raudenbush (1999) demonstrate, that small ICCs can still translate into moderate or large sizes for the main effects of specific neighborhood-level attributes.

Table 1 shows that the unadjusted ICCs are relatively high for all of the obesity-related outcomes. In the analysis of the full sample, the ICCs for BMI, waist size, exercise, and walking are all over nine percent, indicating that there is substantial between-area variation in all of these outcomes. A second finding from Table 2 is that the ICCs tend to be larger for women than for men, especially in the case of BMI, waist size, and exercise. For example, 17.78 percent of the variance in unadjusted BMI among women lies between neighborhoods, but the comparable ICC

for men is only 7.42 percent, and this gender difference is even larger in the case of waist size. These results suggest that women's health may be more sensitive to factors in the residential environment than men's health. It is not clear from the extant literature why the proportion of neighborhood variance might be larger for women, but there is evidence from prior studies that socioeconomic disparities in obesity tend to be wider among women than among men (Sobal and Stunkard 1989). A variety of social and biological factors that vary by gender could contribute to the greater social patterning of BMI seen in women generally.

Since allocation of persons to neighborhoods is decidedly non-random, depending on household income, family size, ethnicity, and a host of other personal characteristics that are also correlates of health outcomes, ρ, unadjusted for these personal characteristics, represents the combined contribution of the causal effects of interest plus the variation in the outcomes associated with variation in the personal characteristics that select persons into neighborhoods. A better indicator of neighborhood variance can be obtained by estimating a two-level model in which neighborhood random effects are adjusted for person-level background characteristics.[1] The value of ρ defined on these adjusted random effects provides an unbiased estimate of the amount of within neighborhood clustering under linear model assumptions and under the strong assumption that all relevant covariates have been included in the model. Because both of these assumptions are potentially problematic, we interpret the adjusted ICCs as more refined descriptive indicators of neighborhood variance in obesity-related outcomes that persists after purging the effects of measured person-specific characteristics.

Table 1 shows that the ICCs for BMI and waist size decline after adjusting for person-level covariates, but that substantial neighborhood variance remains for both outcomes among women (the adjusted ICC for women is 8.98 for BMI and 9.56 for waist size). Interestingly,

exercise and walking are not affected by the adjustment for person-level correlates, which suggests that if residential environments do influence these behaviors, the causal mechanisms are probably not strongly related to the demographic and socioeconomic composition of local areas.

Thus far, our multivariate analysis has focused on exercise and walking. In Table 2, we present results of a multilevel analysis of exercise. In the first model, we consider the association between individual-level sociodemographic characteristics and exercise. We find that older people tend to exercise less than younger people, first-generation immigrants walk less than third and higher generations, people with lower levels of education excercise less than people with 16 or more years of education, and that exercise tends to be positively associated with income – that is to say people with higher incomes tend to exercise more.[2] In model 2 we introduce individual-level measures of marital status, presence of children, and functional limitations in an effort to explain the social disparities we observed in model 1. We find that people who are separated and never married tend to exercise more than people who are married and that people with more functional limitations exercise less. Including these variables in the model also reduces the association between age and exercise –after adjusting for functional limitations the drop off in exercise with age is no longer as severe – and that between education and exercise (in part because lower levels of functional limitations among people with higher levels of education accounts for some of this association). In model 3, we consider how individual-level perceptions of crime and disorder are related to walking. The results show that people who perceive more crime and disorder in the neighborhood are more likely to exercise. This counter-intuitive finding could arise due to the endogeneity of the perceived crime measures. First, people who exercise more – particularly runners – may be more aware of what is happening in their neighborhood,

and thus more likely to perceive crime. Also, people who are more physically active may also be more likely to engage in crime, all else being equal.

We begin to consider neighborhood characteristics in model 4, where we introduce neighborhood-level measures of crime and disorder, none of which are significantly related to exercise. As a block, these variables also fail to improve the fit of the model, as evidenced by the chi-square test of the deviance statistic. Land use measures, introduced in model 5, do improve the model fit and are related to exercise. Specifically, people who live in neighborhoods with recreational facilities and/or waterfront are more likely to exercise, while people who live in neighborhoods with more detached single-family homes are less likely to exercise. Moreover, after controlling for land use we find that people exercise less in neighborhoods where collective perceptions of crime and disorder are higher. This suppressor effect arises because neighborhood with higher levels of perceived crime tend to have other characteristics that promote exercise (e.g., mixed commercial and residential land use). In the final model, we find that people who live in neighborhoods populated by more affluent people and young adults tend to exercise more, and that controlling for neighborhood sociodmographic characteristics also explains the association between the predominance of detached single-family homes in a neighborhood and exercise.

In Table 3 we run the same set of models to predict walking. The key findings are as follows:

- There are fewer significant individual-level predictors of walking. In part, associations at the individual-level between individual-level sociodemographic characteristics and walking is more complicated than was the case with exercise. People of lower socioeconomic status tend to rely on walking as a basic means of getting around

- In model 3, we find that respondents who report being victimized by violent crime are less likely to walk. However, respondents who perceive more violence and disorder in their neighborhoods are more likely to walk. The latter finding is consistent with the results from the analysis of exercise, and likely reflects the endogeneity of perceived crime to both walking and exercise. For example, neighborhood crime could in part be capturing lower neighborhood socioeconomic status, and people in such neighborhoods may be more likely to walk as part of their commute to work or to go shopping because they lack cars. Also, people who walk more may be more aware of the crime around them.
- In model 4, we find that people walk more in neighborhoods where collective levels of perceived crime and disorder are higher but less in neighborhoods where collective fear of crime is higher. This finding suggests that although high-crime neighborhoods may be places where people walk more, fear of crime may still discourage people from walking.
- None of our measures of neighborhood land use are significantly related to walking (see model 4), but as a block of variables they do explain a significant amount of variation.
- People tend to walk more in more densely populated neighborhoods, but otherwise there are no significant associations between neighborhood sociodemographic characteristics and walking.

Tentative Conclusions:

The analysis we have completed so far has focused on the association between neighborhood environments and physical activity (with more work to come on obesity later). Keeping in mind the shortcomings of neighborhood effects research on observational data, particularly with cross-sectional data, we offer the following tentative conclusions:

- Neighborhood factors appear to play important roles in predicting both exercise and walking, net of a wide array of individual-level characteristics.
- Contextual measures of crime are significantly associated with both exercise and walking, but some qualifications are in order. People appear to exercise less in neighborhoods in which residents perceive higher levels of crime and disorder, but they tend to walk more in such neighborhoods. However, people tend to walk less in neighborhoods where there is more collective fear of crime. Individuals who perceive more crime and disorder actually exercise and walk more, a finding that we suspect is driven by the endogeneity of this measure. Also, people who have been victimized by violent crime tend to walk less.
- The presence of recreational facilities and/or waterfront in a neighborhood appears to encourage exercise.
- People also tend to exercise more in more "yuppie" neighborhoods (places with people who have higher levels of education and people in professional managerial jobs, and marked by the absence of children), and they tend to walk more in areas with higher population density.

We will include a more extensive discussion of these results in the final paper.

[1] To the extent that the predictors of health at the neighborhood level are correlated with person-level covariates, such an adjustment will produce a downward bias in the contribution of neighborhoods (Bingenheimer and Raudenbush 2004). This bias can be removed in a three-step procedure. First, we regress each outcome on a set of personal background characteristics including sex, age, race/ethnicity, immigrant generation, education, and income, with neighborhood fixed effects. This provides so-called "within-neighborhood" estimates of the effects of personal background characteristics that are purged of any correlation with neighborhood characteristics. Second, we adjust each outcome for individual background characteristics using the estimates of the coefficients from the fixed effects

model, as follows: $y_{ij}^{*} = y_{ij} - \hat{\beta}'_{w} X_{ij}$, where $\hat{\beta}'_{w}$ are the "within-neighborhood" coefficients for the vector of covariates, *X*, as estimated from the fixed-effects regression model described in the first step, and the y_{ij}^{*} are the adjusted values of each outcome. Third, we decompose the variance in each adjusted outcome by estimating an unconditional random effects model and calculating an adjusted ρ as the fraction of variation in the adjusted outcome that lies between neighborhoods.

[2] We have discovered that a non-trivial percentage of respondents who are currently coded as having incomes under $5,000 have been miscoded and actually make substantially more. We are in the process of cleaning this variable and when we are done we will also impute it. Our current results do not show a relationship between this income category and exercise, but this is likely to change after the variable is cleaned.

Table 1. Intra-cluster Correlation (Percentage of Variance Between Neighborhoods) for Obesity-Related Outcomes Before and After Adjusting for Individual-Level Covariates: CCAHS

	Unadjusted ICC			Adjusted ICC		
Outcome	Full Sample	Females	Males	Full Sample	Females	Males
BMI	10.06	17.78	7.42	6.32	8.98	5.78
Waist Size	11.33	19.54	4.96	5.82	9.56	3.89
Exercise	10.68	15.86	10.94	9.16	15.32	9.01
Walking	9.02	10.44	8.79	9.73	10.61	10.87

Table 2. Individual- and Neighborhood-Level Predictors of Exercise

	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef	SE		Coef	SE		Coef	SE		Coef	SE		Coef	SE		Coef	SE	
Female	-0.33	(0.06)	**	-0.28	(0.06)	**	-0.26	(0.06)	**	-0.26	(0.06)	**	-0.26	(0.06)	**	-0.26	(0.06)	**
Age (ref=age 18-29)																		
Age 30-39	-0.21	(0.08)	**	-0.11	(0.08)		-0.11	(0.08)		-0.11	(0.08)		-0.10	(0.08)		-0.08	(0.08)	
Age 40-49	-0.44	(0.09)	**	-0.25	(0.10)	*	-0.24	(0.10)	*	-0.23	(0.09)	*	-0.23	(0.09)	*	-0.21	(0.09)	*
Age 50-59	-0.61	(0.10)	**	-0.37	(0.11)	**	-0.36	(0.11)	**	-0.35	(0.11)	**	-0.34	(0.10)	**	-0.33	(0.10)	**
Age 60-69	-0.71	(0.11)	**	-0.43	(0.13)	**	-0.41	(0.13)	**	-0.40	(0.13)	**	-0.40	(0.13)	**	-0.37	(0.13)	**
Age 70+	-1.19	(0.12)	**	-0.82	(0.15)	**	-0.79	(0.15)	**	-0.78	(0.15)	**	-0.76	(0.15)	**	-0.74	(0.15)	**
Race/Ethnicity (ref=non-Hisp white)																		
Non-Hisp Black	0.00	(0.08)		0.02	(0.08)		0.01	(0.08)		0.07	(0.09)		0.17	(0.09)		0.27	(0.10)	**
Hispanic	0.19	(0.10)		0.21	(0.10)	*	0.21	(0.10)	*	0.25	(0.10)	*	0.26	(0.09)	**	0.30	(0.10)	**
Non-Hisp Other	0.22	(0.18)		0.18	(0.18)		0.18	(0.18)		0.19	(0.18)		0.17	(0.18)		0.16	(0.19)	
Immigrant status (ref=3rd+ generation)																		
1st Generation Immigrant	-0.34	(0.11)	**	-0.29	(0.11)	**	-0.25	(0.11)	*	-0.24	(0.11)	*	-0.25	(0.10)	*	-0.23	(0.10)	*
2nd Generation Immigrant	-0.16	(0.10)		-0.12	(0.10)		-0.12	(0.10)		-0.13	(0.10)		-0.13	(0.10)		-0.12	(0.10)	
Education (ref=16+ years)																		
<12 years of education	-0.31	(0.09)	**	-0.21	(0.10)	*	-0.21	(0.10)	*	-0.19	(0.10)		-0.14	(0.10)		-0.06	(0.10)	
12-15 years of education	-0.17	(0.07)	*	-0.11	(0.07)		-0.11	(0.07)		-0.11	(0.07)		-0.06	(0.07)		0.01	(0.07)	
Income (ref=$50,000+)																		
Income < $5,000	-0.17	(0.15)		-0.22	(0.14)		-0.23	(0.14)		-0.23	(0.14)		-0.19	(0.14)		-0.17	(0.14)	
Income $5,000-$9,900	-0.53	(0.14)	**	-0.49	(0.14)	**	-0.48	(0.14)	**	-0.47	(0.14)	**	-0.46	(0.14)	**	-0.46	(0.14)	**
Income $10,000-$29,999	-0.25	(0.09)	**	-0.28	(0.09)	**	-0.28	(0.09)	**	-0.28	(0.09)	**	-0.26	(0.09)	**	-0.24	(0.09)	**
Income $30,000-$49,999	-0.07	(0.09)		-0.13	(0.09)		-0.13	(0.09)		-0.12	(0.09)		-0.11	(0.09)		-0.10	(0.08)	
Missing data on income	-0.37	(0.10)	**	-0.40	(0.10)	**	-0.38	(0.10)	**	-0.39	(0.10)	**	-0.35	(0.09)	**	-0.31	(0.09)	**
Marital Status (ref=married)																		
Separated				0.51	(0.13)	**	0.52	(0.13)	**	0.53	(0.13)	**	0.54	(0.13)	**	0.56	(0.12)	**
Divorced				0.06	(0.10)		0.06	(0.10)		0.07	(0.10)		0.05	(0.10)		0.05	(0.10)	
Widowed				0.14	(0.13)		0.14	(0.13)		0.14	(0.13)		0.16	(0.13)		0.17	(0.12)	
Never Married				0.25	(0.08)	**	0.24	(0.08)	**	0.25	(0.08)	**	0.23	(0.08)	**	0.22	(0.08)	**
Presence of Children (ref=no children)																		
1 Child				-0.16	(0.09)		-0.18	(0.09)	*	-0.17	(0.09)	*	-0.14	(0.08)		-0.11	(0.08)	
2 Children				-0.13	(0.10)		-0.14	(0.09)		-0.14	(0.09)		-0.11	(0.09)		-0.09	(0.09)	
3 Children				-0.06	(0.13)		-0.08	(0.12)		-0.08	(0.12)		-0.07	(0.12)		-0.03	(0.12)	
4+ Children				0.02	(0.15)		0.00	(0.15)		0.01	(0.15)		0.04	(0.15)		0.07	(0.15)	

	(1)		(2)		(3)		(4)		(5)		(6)	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Car Ownership (ref=no car)												
Owns 1 car			0.03	(0.08)	0.03	(0.08)	0.03	(0.08)	0.04	(0.07)	0.05	(0.07)
Owns 2 cars			-0.01	(0.09)	0.00	(0.09)	-0.02	(0.09)	0.02	(0.08)	0.04	(0.08)
Owns 3+ cars			-0.24	(0.16)	-0.23	(0.16)	-0.26	(0.16)	-0.21	(0.16)	-0.17	(0.15)
Functional Limitations			-0.25	(0.03) **	-0.25	(0.03) **	-0.26	(0.03) **	-0.25	(0.03) **	-0.25	(0.03) **
Subject's Perceptions of Crime												
Perceived Crime/Disorder					0.08	(0.04) *	0.12	(0.04) **	0.12	(0.04) **	0.13	(0.04) **
Victimization					0.05	(0.03)	0.06	(0.03)	0.06	(0.03)	0.06	(0.03)
Fear of Crime					-0.04	(0.03)	-0.03	(0.04)	-0.03	(0.04)	-0.03	(0.04)
Neighborhood Crime												
NC Viol Arrest							0.02	(0.05)	0.03	(0.05)	0.05	(0.05)
NC Perceived Crime/Disord							-0.11	(0.06)	-0.24	(0.06) **	-0.18	(0.06) **
NC Victimization							-0.03	(0.04)	0.00	(0.04)	0.01	(0.04)
NC Fear of Crime							-0.01	(0.05)	-0.01	(0.05)	0.02	(0.05)
Neighborhood Land Use												
Prop BF Detached Single Family Homes									-0.35	(0.13) **	0.08	(0.17)
Prop BF Mixed Comm-Resid Land Use									0.32	(0.18)	0.18	(0.18)
Prop BF Recreat Facilities/Waterfront									0.26	(0.07) **	0.20	(0.07) **
Neighborhood Sociodemographic												
Population Density[a]											-0.04	(0.07)
Affluence/mobility/young adult/few children											0.24	(0.04) **
Disadvantage											0.08	(0.07)
Hispanic/immigrant/non-black											0.04	(0.05)
Intercept	3.01	(0.10) **	2.68	(0.15) **	2.68	(0.15) **	2.63	(0.15) **	2.49	(0.15) **	2.31	(0.15) **
Variance Components												
Level 1	1.37		1.32		1.32		1.31		1.31		1.30	
%Reduction from unconditional model	(39.20%)		(41.38%)		(41.74%)		(41.82%)		(42.02%)		(42.21%)	
Level 2	0.12		0.10		0.10		0.10		0.07		0.06	
%Reduction from unconditional model	(48.22%)		(56.16%)		(54.21%)		(56.08%)		(67.83%)		(74.39%)	
Deviance	9962.8		9833.1		9820.0		9810.9		9766.7		9735.6	
Chi Square (df)	426.9	(18) **	129.7	(12) **	13.1	(3) **	9.1	(4)	44.2	(3) **	31.1	(4) **

**p <.01; *p <.05

[a] Coefficients and standard errors have been multiplied by 10000

Table 3. Individual- and Neighborhood-Level Predictors of Walking

	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef	SE		Coef	SE		Coef	SE		Coef	SE		Coef	SE		Coef	SE	
Female	-0.05	(0.07)		-0.01	(0.07)		0.03	(0.07)		0.03	(0.07)		0.03	(0.07)		0.04	(0.08)	
Age (ref=age 18-29)																		
Age 30-39	0.01	(0.11)		0.07	(0.11)		0.07	(0.11)		0.08	(0.11)		0.08	(0.11)		0.08	(0.11)	
Age 40-49	0.07	(0.11)		0.18	(0.12)		0.22	(0.12)		0.22	(0.12)		0.22	(0.12)		0.22	(0.12)	
Age 50-59	0.11	(0.13)		0.29	(0.14)	*	0.35	(0.14)	*	0.34	(0.14)	*	0.35	(0.14)	*	0.35	(0.14)	*
Age 60-69	-0.17	(0.14)		0.04	(0.16)		0.13	(0.16)		0.13	(0.16)		0.14	(0.16)		0.15	(0.16)	
Age 70+	-0.46	(0.16)	**	-0.16	(0.20)		-0.03	(0.20)		-0.03	(0.20)		-0.02	(0.20)		-0.01	(0.20)	
Race/Ethnicity (ref=non-Hisp white)																		
Non-Hisp Black	-0.18	(0.11)		-0.19	(0.11)		-0.24	(0.11)	*	-0.32	(0.13)	*	-0.28	(0.13)	*	-0.31	(0.15)	*
Hispanic	-0.08	(0.14)		-0.07	(0.14)		-0.08	(0.13)		-0.09	(0.14)		-0.08	(0.14)		-0.07	(0.14)	
Non-Hisp Other	-0.25	(0.26)		-0.28	(0.26)		-0.27	(0.27)		-0.28	(0.25)		-0.31	(0.25)		-0.30	(0.25)	
Immigrant status (ref=3rd+ generation)																		
1st Generation Immigrant	-0.07	(0.13)		-0.03	(0.13)		0.03	(0.13)		0.06	(0.13)		0.06	(0.13)		0.07	(0.13)	
2nd Generation Immigrant	0.13	(0.14)		0.16	(0.14)		0.18	(0.14)		0.20	(0.14)		0.20	(0.14)		0.21	(0.14)	
Education (ref=16+ years)																		
<12 years of education	0.21	(0.13)		0.27	(0.13)	*	0.23	(0.13)		0.22	(0.13)		0.24	(0.13)		0.27	(0.13)	*
12-15 years of education	0.12	(0.09)		0.18	(0.09)	*	0.16	(0.09)		0.16	(0.09)		0.19	(0.09)	*	0.21	(0.09)	*
Income (ref=$50,000+)																		
Income < $5,000	0.27	(0.17)		0.14	(0.18)		0.11	(0.18)		0.11	(0.18)		0.14	(0.18)		0.14	(0.18)	
Income $5,000-$9,900	0.01	(0.18)		-0.06	(0.18)		-0.08	(0.18)		-0.10	(0.18)		-0.09	(0.18)		-0.12	(0.18)	
Income $10,000-$29,999	0.26	(0.11)	*	0.17	(0.12)		0.13	(0.11)		0.12	(0.11)		0.13	(0.11)		0.12	(0.12)	
Income $30,000-$49,999	0.25	(0.12)	*	0.20	(0.12)		0.18	(0.11)		0.17	(0.11)		0.19	(0.11)		0.17	(0.11)	
Missing data on income	0.15	(0.12)		0.08	(0.11)		0.08	(0.11)		0.09	(0.11)		0.12	(0.11)		0.12	(0.12)	
Marital Status (ref=married)																		
Separated				0.37	(0.16)	*	0.35	(0.16)	*	0.34	(0.17)	*	0.35	(0.17)	*	0.35	(0.16)	*
Divorced				0.12	(0.12)		0.12	(0.12)		0.11	(0.12)		0.10	(0.12)		0.10	(0.12)	
Widowed				0.10	(0.19)		0.10	(0.18)		0.10	(0.18)		0.12	(0.18)		0.11	(0.18)	
Never Married				0.08	(0.11)		0.06	(0.11)		0.06	(0.11)		0.05	(0.11)		0.04	(0.11)	
Presence of Children (ref=no children)																		
1 Child				0.00	(0.11)		-0.01	(0.11)		0.00	(0.11)		0.01	(0.11)		0.02	(0.11)	
2 Children				-0.28	(0.14)	*	-0.30	(0.14)	*	-0.30	(0.14)	*	-0.28	(0.14)	*	-0.26	(0.14)	
3 Children				-0.03	(0.15)		-0.04	(0.15)		-0.03	(0.14)		-0.02	(0.14)		-0.01	(0.14)	
4+ Children				0.22	(0.17)		0.18	(0.17)		0.15	(0.17)		0.17	(0.17)		0.17	(0.17)	

	(1)			(2)			(3)			(4)			(5)			(6)		
	Coef	SE		Coef	SE		Coef	SE		Coef	SE		Coef	SE		Coef	SE	
Car Ownership (ref=no car)																		
Owns 1 car				-0.12	(0.10)		-0.10	(0.10)		-0.08	(0.10)		-0.07	(0.10)		-0.06	(0.10)	
Owns 2 cars				-0.23	(0.12)		-0.19	(0.12)		-0.17	(0.12)		-0.14	(0.12)		-0.12	(0.12)	
Owns 3+ cars				-0.52	(0.20)	**	-0.48	(0.20)	*	-0.46	(0.20)	*	-0.43	(0.20)	*	-0.41	(0.20)	*
Functional Limitations				-0.36	(0.06)	**	-0.35	(0.06)	**	-0.35	(0.06)	**	-0.35	(0.06)	**	-0.35	(0.06)	**
Subject's Perceptions of Crime																		
Perceived Crime/Disorder							0.24	(0.05)	**	0.18	(0.06)	**	0.18	(0.06)	**	0.18	(0.06)	**
Victimization							-0.10	(0.04)	*	-0.10	(0.04)	*	-0.10	(0.04)	*	-0.10	(0.04)	*
Fear of Crime							-0.08	(0.04)		-0.05	(0.05)		-0.05	(0.05)		-0.05	(0.05)	
Neighborhood Crime																		
NC Viol Arrest										0.05	(0.06)		0.05	(0.06)		0.07	(0.07)	
NC Perceived Crime/Disord										0.24	(0.08)	**	0.17	(0.09)		0.11	(0.10)	
NC Victimization										-0.01	(0.06)		0.02	(0.06)		0.03	(0.06)	
NC Fear of Crime										-0.20	(0.07)	**	-0.20	(0.07)	**	-0.20	(0.07)	**
Neighborhood Land Use																		
Prop BF Detached Single Family Homes													-0.29	(0.19)		0.10	(0.25)	
Prop BF Mixed Comm-Resid Land Use													-0.09	(0.25)		-0.06	(0.25)	
Prop BF Recreat Facilities/Waterfront													0.14	(0.10)		0.11	(0.10)	
Neighborhood Sociodemographic																		
Population Density[a]																0.24	(0.10)	*
Affluence/mobility/young adult/few children																0.07	(0.07)	
Disadvantage																0.14	(0.09)	
Hispanic/immigrant/non-black																-0.05	(0.08)	
Intercept	4.25	(0.13)	**	4.16	(0.18)	**	4.16	(0.18)	**	4.19	(0.19)	**	4.12	(0.19)	**	4.10	(0.20)	**
Variance Components																		
Level 1	2.23			2.17			2.15			2.14			2.15			2.15		
%Reduction from unconditional model	(1.34%)			(4.07%)			(4.83%)			(5.06%)			(4.99%)			(4.96%)		
Level 2	0.22			0.20			0.18			0.16			0.15			0.13		
%Reduction from unconditional model	(1.42%)			(9.82%)			(19.58%)			(27.44%)			(33.61%)			(40.04%)		
Deviance	11038.2			10946.2			10908.5			10888.9			10880.9			10870.6		
Chi Square (df)	40.4	(18)	**	92.0	(12)	**	37.7	(3)	**	19.5	(4)	**	8.0	(3)	*	10.4	(4)	*

**p <.01; *p <.05

[a] Coefficients and standard errors have been multiplied by 10000