NEIGHBORHOOD ENVIRONMENT AND HEALTH BEHAVIOR IN LOS ANGELES AREA

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1. INTRODUCTION

Obesity has become a major health concern in the U.S. It is a major contributor of many medical conditions such as heart disease, Type 2 diabetes, hypertension, stroke, and certain cancers (WHO, 2000). U.S. data shows that 35.7 percent of U.S. adults were obese in 2009-2010 (Ogden et al, 2012). In Los Angeles County, with approximately 9 million residents, the proportion of obesity among adults has increased from 13.6% in 1997 to 23.6% in 2011 (LADPH, 2012). The large amount and drastic growth of the obese population may lead to serious problems for public health due to increasing medical expense. The prevalence of obesity has caused serious financial concerns to the U.S. In 2006, medical costs related to obesity in the U.S. were about $147 billion, which is almost double to $74 billion in 1998 (Finkelstein et al, 2009).

There is a recent growing interest in integrating transportation and land use planning policies to solve the issue of obesity. U.S. Centers for Disease Control and Prevention (CDC) acknowledges that transportation policies can have positive impacts on reducing obesity (CDC, 2012). Because lack of physical activities is an important reason for being obese, CDC has recommended two transportation policies: “Promote Active Transportation” and “Expand Public Transportation.” These two policies encourage people to walk and bike more, thus reducing their weight and enhancing their health condition. CDC also recommended a land use policy called “Encourage Healthy Community Design” that encourages transit-oriented development (TOD). The main concept of TOD is that residential neighborhoods with higher densities, mixed use of land, better street connectivity, or closeness to transit services will encourage residents to walk or bike for accessing their daily activities, and therefore residents living in this type of community can reduce their weight.

Active transportation and public health is also becoming a major policy focus for regional planning agencies in California. The Southern California Association of Governments (SCAG), a metropolitan planning organization for six counties in Southern California, is responsible for developing a long-range regional transportation plan (RTP) and sustainable community strategies (SCS) to solve regional issues such as traffic congestion, air pollution, and greenhouse gas emissions. The integrated land use and active transportation strategies are included in the long-range plan to alleviate public health issues for the region.

The purpose of this research is to analyze how neighborhood environmental characteristics, including both land use and built environment, are associated with the likelihood of being obese. Through this analysis, we sought to understand how land use and built environment factors can contribute to the enhancement of public health in the SCAG region. We tested a binary logistic regression model to examine data from 7,200 adult respondents in the 2007 Los Angeles County Health Survey (LACHS).

This paper has five sections. The next section describes relevant literature on built environment, physical activity and obesity. Section 3 describes research approach, methodology, and data sources. Section 4 summarizes model results. Section 5 summarizes conclusions and further analysis.

2. REVIEW OF PAST RESEARCH AND ANALYSIS

Previous research indicated that the prevalence of obesity declines with increasing income and education, and is more common for non-whites than whites. Obesity rate is different by race, ethnicity, and gender. Flegal et al (2012) estimated the prevalence of adult obesity based on a sample of U.S. adults (n=5,826) from the 2009-2010 National Health and Nutrition

Examination Survey (NHANES). They found that non-Hispanic blacks have the highest rates of obesity (49.5%) compared with Hispanics (39.1%) and non-Hispanic whites (34.3%) nationwide. In Los Angeles County (LACPH, 2011), Latinos (29.4%) and African Americans (29.2%) have higher obesity rates than other racial groups. Based on the analysis of NHANES data from 1999-2008, the obesity rate for males has shown a significant linear growth trend over the 12 year period (Flegal et al, 2012).

Researchers have attempted to explain how land use characteristics and the built environment of residential neighborhoods are associated with the tendency of residents to engage in physical activity. Some studies analyzed descriptive statistics (Saelens et al (2003), Brownson et al (2009), and Rahman et al (2011)), showing that land use or built environment characteristics are associated with the level of physical activity engagement. Those studies did not analyze direct relationships, due to lack of available data.

Built environment factors, such as better transit services, are shown to have a negative association with higher levels of obesity. Rundle et al (2006) analyzed the relationship between the built environment and obesity in New York City. This research assumed that more residents would walk to transit if better transit service was provided in a neighborhood. The result concluded that mixed land use, density of bus stops, density of subway stops, and population density are significantly inversely associated with higher levels of obesity.

Using 10,878 adult respondents of a travel survey from the Atlanta region, Frank et al (2004) conducted a logistic regression test to analyze how socioeconomic characteristics, residential location, and travel patterns are linked to the probability of being obese. They found that individuals who travel longer walking distances, spend less time in a car, or reside in a mixed-use neighborhood, tend to have a lesser probability of being obese. The result seems

reasonable: more use in active transportation modes and less in a car increases physical activity engagement; thus people are less likely to be obese. However, Multicollinearity might be an issue in this analysis because land use mix may be correlated with other independent variables, such as longer walking distance or less time in a car.

The fundamental cause of obesity is an energy imbalance between calories consumed and calories expended. Globally, there has been an increase in consuming energy-dense foods that are high in fat, salt and sugars; and a decrease in physical activity (WHO, 2012). To analyze the level of obesity, both eating behavior and physical activity engagement should be considered.

3. RESEARCH APPROACH AND DATA ANALYSIS

This study focuses on the relationship among land use, built environment, physical activity, and obesity. The research undertakes two analytical approaches. One is to examine descriptive statistics of 2007 LACHS to analyze the proportion of obesity and the level of physical activity by socioeconomic status and neighborhood characteristics. The second approach is to test a model that examines whether land use and the built environment are associated with the probability of an individual being obese. A binary logistic regression model is used in the analysis. The model estimates the probability as a function of four groups of factors: individual socioeconomic characteristics, individual health behavior, neighborhood quality and safety, and neighborhood land use/built environment.

Data Source

The 2007 Los Angeles County Health Survey (LACHS) is used as the core data for this study. The LACHS is a population-based telephone survey of Los Angeles County households[1]. Households were selected by a random digit dial (RDD) sampling methodology. Within each selected household, one adult who is age 18 or older was randomly selected and interviewed via telephone (LADPH, 2008). A total of 7,200 adults in Los Angeles County were sampled. The survey data we used for this analysis includes individual socio-demographic characteristics, residential location by Census tract and zip code, and health behaviors. Socio-demographic variables include each individual's age, gender, race and ethnicity, household income, and education. Health behavior variables include each individual's body mass index (BMI[2]), individual's perceived neighborhood safety from crime, the frequency of an individual eating fast food, and the level of weekly physical activity.

To analyze the relationship between health outcomes and neighborhood environments, we applied variables at Census tract or zip code areas. Census tract was chosen because it was the smallest geographic boundary available in the survey. Census tract is also appropriate to represent neighborhood environment. For respondents without Census tract information (about 20%), we used zip code as neighborhood geography. We created residential neighborhood variables from SCAG's transportation, land use and socioeconomic database.

Household density and employment density were calculated based on SCAG's year 2008 socioeconomic database that was developed for SCAG's regional travel demand model input.

[1] Data information about 2007 Los Angeles County Health Survey can be found at http://www.publichealth.lacounty.gov/ha/hasurveyintro.htm

[2] BMI is calculated as weight in kilograms divided by height in meters squared. Obesity in adults was defined as BMI greater than or equal to 30 (NIH, 1998).

Level of transit service, bus stop density, and location of rail station are developed based on SCAG transit network and level of service database.

Model Formulation

The purpose of the research is to examine whether neighborhood land use and built environment factors are associated with the probability of being obese (BMI $\geq$ 30). A binary logistic regression model is used to determine the probability of being obese. The model estimates the probability as a function of four groups of factors: individual socioeconomic characteristics, individual health behaviors, neighborhood quality and safety from crime, and neighborhood land use and built environment. Socioeconomic characteristics are used as control variables.

The basic conceptual model is:

$$Y_i = f(SE_i, HB_i, NQ_i, LB_i) \qquad (3.1)$$

where Y_i = obesity level of individual *i*

SE_i = socioeconomic attributes of individual *i*

HB_i = health behavior of individual *i*

NQ_i = neighborhood quality of the residential location of individual *i*

LB_i = land use characteristics and built environment of the residential location of individual *i*

The probability is transformed to a logit form so that there is a linear relationship between independent variables and the dependent variable. The binary logit regression model has the following form:

$$\log it(p) = \log(\frac{p}{1-p}) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k$$

$$= \alpha + \sum_k \beta_k X_k \qquad (3.2)$$

where

p = probability of an individual is obese

X_k = independent variables

β_k = estimated coefficients

α = intercept

The probability can be modeled as:

$$p = \frac{\exp(\alpha + \sum_k \beta_k X_k)}{1 + \exp(\alpha + \sum_k \beta_k X_k)} = \frac{1}{1 + \exp(-\alpha - \sum_k \beta_k X_k)} \qquad (3.3)$$

The maximum likelihood estimation method is used to obtain model coefficients. The likelihood ratio tests the significance of the logistic model, and the Wald statistic shows the significance of each independent variable. If the coefficient of an independent variable is significant, the predicted probability will be higher for a higher coefficient value; or lower for a lower coefficient value.

Analysis of Obesity Data

Based on self-reported weight and height data from each survey individual, BMI is calculated as weight in kilograms divided by height in meters squared in the LACHS data. The LACHS categorizes BMI into four groups: Obese (BMI $\geq$ 30), Overweight (30 > BMI $\geq$ 25), Normal (25 > BMI $\geq$ 18.5), and Underweight (BMI < 18.5). According to the summary data of the 2007 LACHS (LADPH, 2007), 22% of adults in the health survey are obese, compared to 36% and 40% as overweight and normal, respectively.

Table 1 shows that the percent of obese adults by different demographic, economic, land use characteristics, and health behavior. The share of obese males and obese females is about the same. However, according to the data from LADPH (LADPH, 2007), males (44.1%) have a much higher share of being overweight compared to females (27.2%). Those who are ages 30 to 64 years, Hispanic or Black, lower household income, or lower education background have significantly higher share of obesity than those who are younger than 30 or older than 65, White or Asian, higher household income, or higher education background. The goodness-of-fit test of each category in Table 1 shows that the proportion of obesity is significantly different by socioeconomic status, such as gender, age, race and ethnicity, income, and education background.

It is valuable to understand whether people living in neighborhoods with high density or proximity to rail stations will be less likely to be obese due to better walkability and better access to transit services. However, the result is mixed. Data in Table 1 shows that the share of obesity is lower for those residing in a neighborhood with either high household density (18 units/acre or higher) or low household density (lower than 6 units/acre) than those living in middle density (6–18 units/acre). The lower proportion of obesity for those living in lower density neighborhoods may be related to their socioeconomic status, such as higher household income. The goodness-

of-fit tests show significant difference in obesity share between living an area with rail stations and without rail stations. However, the magnitude of the difference is not very large.

Overall median household income of a neighborhood is used as an indicator to represent the quality of a neighborhood. In general, a neighborhood with higher median income has more resources to maintain overall quality of its environment, such as better street design, sidewalk maintenance, bus stop benches, and street planting, which will encourage people to walk. As expected, the obesity share is lower with higher neighborhood median household income. This result may also explain why a low-density neighborhood has lower obesity share because income level is generally higher in a low-density neighborhood. For those survey respondents who feel that their neighborhood is safe, their proportion of obesity is lower than those who feel unsafe in their neighborhood.

Table 1 shows the proportion of obese adults by two types of health behavior: the frequency of eating fast food and the level of engaging in physical activity. People who eat fast food more frequently or have less physical activity tend to have a higher proportion of obesity than those who eat less fast food or exercise more. This result is reasonable.

Analysis of Physical Activity Data

Based on the amount of physical activity during a week, LACHS categorizes the level of physical activity into three groups: Active (meets guidelines), Some Activity (does not meet guidelines), and Minimal to No Activity. Table 2 shows the proportion of the three physical activity categories by socioeconomic status and neighborhood characteristics. According to the data summary from the LADPH website (LADPH, 2007), about 52% of adults were actively

engaged in physical activity and 38% were minimally active or did not engage in any physical activity.

The data shows that adults who are male, younger, Hispanic or White, higher income, or higher education tend to engage in more physical activity than adults who are female, elderly, Black or Asian, lower income, or lower education. It is interesting that Hispanic adults tend to have higher proportions of physical activity, but also have higher proportions of being obese.

Regarding the relationship between neighborhood land use characteristics and physical activity, the difference between people living in an area with rail stations and without rail stations is very small though it is statistically significant. Household density also does not show clear patterns with the level of physical activity. Residents living in wealthier neighborhoods or those who feel safe in their neighborhood environment have higher levels of physical activity than those living in poorer neighborhoods or feel unsafe in their neighborhood environment.

4. MODEL ANALYSIS AND FINDING

It is expected that an individual living in a TOD type of community is more likely to travel by active transportation modes (walk or bike) to access local shops and services; and is therefore less likely to be obese due to more physical activity from walking and biking.

Variable Description

Table 3 shows the definitions and sources of the variables used in this part of the analysis. The dependent variable of the model is whether a person is obese or not. Four groups of variables are used as independent variables: individual socioeconomic characteristics, individual

health behaviors, neighborhood quality and safety from crime, and neighborhood land use and built environment.

Table 4 shows descriptive statistics of independent variables. Socioeconomic variables include age by three cohorts (30-49, 50-64, 65 or older), race and ethnicity (Hispanic, non-Hispanic Black), and education (college degree or higher). Household income is not included because of correlation with race and education. As explained above, socioeconomic characteristics have significant relationship with obesity. Therefore, socioeconomic variables are used as control variables in the model.

As described in the beginning of the paper, two major sources that cause obesity are related to health behavior: physical activity and eating habits. Physical activity, or exercise, such as walking or biking that consumes calories can reduce body weight. However, there are different levels of physical activity. According to the description in the LACHS questionnaire, vigorous exercise are activities that require hard physical effort and cause heavy sweating, and large increases in breathing and heart rate, for example, running or aerobics; moderate exercise are activities that cause light sweating, and slight increases in breathing and heart rate, for example, walking, yard work or physical labor at work (LADPH, 2008). Therefore, the increase in physical activity from active transportation or land use plans is probably considered as moderate exercise. The vigorous level of physical activity needs to be added as an independent variable to the model to have full representation of physical activity (both vigorous and moderate physical activity); otherwise, the model will miss an important element to explain obesity level. We used a “vigorous activity” variable based on health survey data. To reflect eating habits, a fast food variable is created if one eats meals and snacks at a fast-food restaurant at least once a week.

For neighborhood quality and safety variables, neighborhood median household income is calculated by SCAG's socioeconomic database. The neighborhood safety variable is directly from the health survey based on the respondent's perception of their neighborhood being safe from crime. We assume that the safety perception is directly related to real safety condition of the individual's neighborhood. Our following research will include crime rate data in the analysis.

Neighborhood land use and built environment variables include household density, having a rail station, bus stop density, and job density. As described earlier, those variables are applied to explain the level of active transportation use. As people are spending more time on walking or biking in order to access local shops, services, or transit stations, they are engaging in moderate-level physical activity, and will be less likely to be obese. Because many neighborhoods with rail stations inside also have higher residential density, an interaction variable is created to model the joint effect.

Model Results and Analysis

Table 5 presents the estimated results of the model. LACHS data used for the model test includes 5,245 adults in Los Angeles county. The reason for the difference from the original sample size of 7,200 is due to the absence of Census tract or zip code geography information in some survey respondents and missing data from the health survey. Respondents living in too large Census tract or zip code were also deleted because a large area may not represent the scale of a "neighborhood." Each variable is tested to assess whether the coefficient of each variable is significantly different from zero. The P-value associated with the coefficient test is given in the table.

Overall, the model results are reasonable and the signs of all coefficients are expected. Model results show that an individual is more likely to be obese if he or she is between 30 and 64 years old, Hispanic or Black, and has not obtained a college degree. Results also show that an individual is less likely to be obese if he/she is younger than 30, White or Asian/Pacific Islander, and with a college or higher degree. Regarding model results to the neighborhood quality and health behavior, an individual living in a wealthier or self-perceived safer neighborhood, eating less frequently at a fast-food restaurant, or engaging in vigorous physical activity is less likely to be obese than those living in a poorer or unsafe neighborhood, eating more fast-food, or not engaging in physical activity. Finally, all land use and built environment variables are reasonable and significant. An individual living in higher household density, job density, bus stop density, and near a rail station is less likely to be obese than living in lower household or job density, bus stop density, and no rail stations.

5. DISCUSSION AND CONCLUSION

This study has shown a significant association between neighborhood land use/built environment characteristics and the level of obesity based on the 2007 Los Angeles County Health Survey, and SCAG land use and transportation database. It shows that living in a neighborhood with higher residential density and employment density, rail service, and higher bus stop density are associated with a lesser likelihood to be obese. This result shows that people in a well-designed TOD type of neighborhood tend to use active transportation modes to access their daily activities and reach transit services. Increased use of active transportation modes gives people an opportunity to engage in a moderate-level of exercise, so as to reduce their weight and enhance their health condition.

This paper contributes an approach to analyze or estimate the health impact of integrated land use-transportation plans for regional planning agencies. The model estimated in the paper can be used to estimate the number of change in the obese population as a result of different land use policies, built environment improvements, and future demographic change.

The model framework of this research also provides a reasonable approach to estimate future health impact. Though future implementation of land use and transportation policies will continue to have significant impact on physical activity and obesity, the health survey data has shown that socioeconomic characteristics also have a significant relationship with health behaviors. What will happen if there is a drastic change in socioeconomic characteristics of the future population? Future demographic characteristics will be changed significantly because of the increasing aging population and, to some regions like Southern California, the rapid growth of the Hispanic population. SCAG has analyzed potential impact of future growth in the Hispanic population and the elderly population on regional transportation and greenhouse gas emissions (Hu et al., 2012a, 2012b). Research results show that the magnitudes of those impacts from future demographic change are obvious and significant. Since travel behavior, residential location choice, and health behavior vary by different demographic groups, dramatic changes in future demographic composition may have significant impact on the overall use of active transportation and public health.

Although the analysis and model produce reasonable results, further analysis, testing and improvement are needed. First, this analysis focuses on adults. An analysis on children obesity is needed because obesity during childhood may be continued to adulthood. Second, Census tract or zip code is a rough representation of neighborhood geography. Further GIS analysis is needed to avoid extreme geographic shape or size in our sample. Third, to estimate future impacts on

different land use scenarios and change in future demographic composition, we plan to use the model result to conduct a simulation test by using SCAG's synthetic population database that was developed by an activity-based model. Fourth, a gentrification effect or self-selection should be considered. Fifth, though there is no longitudinal data to track individual's behavior and health situation over time, an analysis to include the new 2011 health survey will be helpful for understanding the change in land use and health behavior over time. Finally, we will collect and analyze health survey data from other counties of the SCAG region.

References

Booth, K. M. Booth, M. M. Pinkston, and W. S. Carlos Poston, 2005, Obesity and the Built Environment, *Journal of the American Dietetic Association* 105(5):110-117.

Brownson, R. C., C. M. Hoehner, K. Day, A. Forsyth, and J. F Sallis, 2009, Measuring the Built Environment for Physical Activity, *State of the Science* 36: 99-123.

Centers for Disease Control and Prevention (CDC). 2012. CDC Transportation Recommendations. http://www.cdc.gov/transportation/default.htm

Cynthia L. Ogden, Margaret D. Carroll, Brian K. Kit, and Katherine M. Flegal, 2012, Prevalence of Obesity in the United States, 2009–2010. *NCHS Data Brief* No. 82.

Frank, L. D., M. A. Andresen, and T. L. Schmid, 2004, Obesity relationships with community design, physical activity, and time spent in cars, *American Journal of Preventive Medicine* 27 (2): 87-96.

Finkelstein, EA, Trogdon, JG, Cohen, JW, and Dietz, W. Annual medical spending attributable to obesity: Payer- and service-specific estimates. *Health Affairs* 2009; 28(5): w822-w831.

Hu, HH, Choi, S. and F. Wen. "Travel Behavior of Hispanic Immigrants of Southern California - Scenario Analysis of Future Immigrants Growth from a Parcel-Based Sketch Planning Model", presented at the 4th Transportation Research Board Conference on Innovations in Travel Modeling, Tampa, Florida, April 30 - May 2, 2012

Hu, HH, Choi, S. and F. Wen. "Aging Population and Greenhouse Gas (GHG) Emissions in the Southern California Region", paper presented at Eastern Regional Organization for Planning and Human Settlements (EAROPH) 2012 World Congress, Daegu, Republic of Korea, October 17-19, 2012.

Katherine M. Flegal, Margaret D. Carroll,Brian K. Kit,Cynthia L. Ogden. 2012. Prevalence of Obesity and Trends in the Distribution of Body Mass Index Among US Adults, 1999-2010. *The Journal of the American Medical Association*. 2012;307(5):491-497.

Los Angeles County Department of Public Health (LADPH), 2007, 2007 LA County Health Survey- Topics &
Data, http://www.publichealth.lacounty.gov/ha/LACHSDataTopics2007_rev.htm.

Los Angeles County Department of Public Health (LADPH), 2008, 2007 Los Angeles County Public Health Survey – Summary of Survey Methodology.

Los Angeles County Department of Public Health (LADPH), 2011, Obesity & Related Mortality in Los Angeles County.

Los Angeles County Department of Public Health (LADPH), 2012, Trends in Obesity: Adult Obesity Continues to Rise.

National Institutes of Health (NIH). Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—The evidence report. *Obes Res* 6(Suppl 2): 51S–209S. 1998.

Rahman, T., R. A. Cushing, and R. J. Jackson, 2011, *Contributions o*f Built Environment to Childhood Obesity, *Mount Sinai School of Medicine* 78: 49-57.

Rundle, A. D, A. V. Diez Roux, L. M. Freeman, D. Miller, K. M. Neckerman, and C. C. Weiss, 2007, The Urban Built Environment and Obesity in New York City: A Multilevel analysis, *Amerian Journal of Health Promotion* 21 (4): 326-334.

Saelens, B. E., J. F. Sallis, and L. D. Frank, 2003, Environmental Collelates of Walking and Cycling: Findings from the Transportation, Urban Design, and Planning Literatures, *The Society of Behavioral Medicine* 25 (2): 80-91.

World Health Organization (WHO), 2000, Obesity: preventing and managing the global epidemic. Report of a WHO Consultation, *WHO Technical Report Series* 894: Geneva.

World Health Organization (WHO), 2012, Obesity and Overweight, *Fact Sheet*, N*311

Table 1 Percent and Estimated Number of Obese Adults

Demographic & Economic Characteristics	Percent	Number
Gender		
Male	22.6%	773,000
Female	21.8%	705,000
Chi-Square (X^2)		***701****
Age Group		
18-24	18.2%	136,000
25-29	20.7%	146,000
30-39	22.8%	314,000
40-49	24.0%	337,000
50-59	27.3%	275,000
60-64	25.2%	111,000
65 or Over	16.2%	158,000
Chi-Square (X^2)		***48,581****
Race/Ethnicity		
Hispanic	29.4%	764,000
Non-Hispanic White	17.6%	422,000
Non-Hispanic Black	29.2%	183,000
Non-Hispanic Asian	8.9%	82,000
Chi-Square (X^2)		***220,055****
Household income		
< $30,000	25.7%	551,000
$30,000 - $75,000	22.6%	414,000
> $75,000	17.4%	263,000
Chi-Square (X^2)		***35,638****
Education		
Less than high school	29.5%	370,000
High School	26.2%	325,000
Some College	25.2%	426,000
College or Higher	14.4%	350,000
Chi-Square (X^2)		***147,408****

Land Use & Built Environment Characteristics	Percent	Number
Has Rail Station		
Rail	22.3%	**
No Rail	23.6%	**
Chi-Square (X^2)		***824****
Residential Density (household units/residential acre)		
< 6	18.5%	**
6-12	24.3%	**
12-18	27.5%	**
18-30	18.6%	**
> 30 units/acre	19.6%	**
Chi-Square (X^2)		***36,910****
Neighborhood Median Household Income		
< $25,000	30.4%	**
$25,000 - $50,000	25.8%	**
$50,000 - $75,000	18.4%	**
$75,000 - $100,000	15.1%	**
> $100,000	10.8%	**
Chi-Square (X^2)		***71,519****
Perception of Neighborhood Safety		
Safe	20.0%	**
Unsafe	32.4%	**
Chi-Square (X^2)		***83,913****

Health Behavior

East Fast Food per Week		
Never	14.8%	144,000
<1 / month	16.8%	207,000
< 1 / week	22.4%	391,000
1-3 / week	25.9%	569,000
4+ times / week	32.9%	159,000
Chi-Square (X^2)		***103,344****

Physical Activity		
Minimal/No Activity	25.6%	716,000
Some Activity	22.4%	155,000
Active	20.0%	600,000
Chi-Square (X^2)		***25,947****

** All goodness-of-fit statistic (X^2) results are higher than chi-square critical value (Pr > ChiSq: <0.0001)*

*** Data not shown because geographic information to some survey respondents is not available..*

Table 2 Percent and Estimated Number of Active Adults (18+ years old)

Demographic & Economic Characteristics	Percent	Number
Gender		
Male	57.9%	2,097,000
Female	48.7%	1,854,000
Chi-Square Value		***62,875****
Age Group		
18-24	64.9%	553,000
25-29	57.8%	483,000
30-39	57.5%	917,000
40-49	53.8%	832,000
50-59	48.9%	530,000
60-64	47.6%	229,000
65 or Over	39.3%	408,000
Chi-Square		***161,164****
Race/Ethnicity		
Hispanic	53.1%	1,655,000
Non-Hispanic White	56.9%	1,443,000
Non-Hispanic Black	54.2%	363,000
Non-Hispanic Asian	41.4%	409,000
Chi-Square Value		***76,073****
Household income		
< $30,000	46.9%	1,174,000
$30,000 - $75,000	56.1%	1,084,000
> $75,000	63.8%	1,585,000
Chi-Square Value		***114,342****
Education		
Less than high school	45.7%	736,000
High School	51.7%	703,000
Some College	55.8%	1,000,000
College or Higher	57.0%	1,467,000
Chi-Square Value		***59,200****

Land Use & Built Environment Characteristics	Percent	Number
Has Rail Station		
Rail	54.4%	***
No Rail	54.5%	***
Chi-Square Value		***8.7****
Residential Density (household units/residential acre)		
< 6	56.9%	***
6-12	52.0%	***
12-18	56.5%	***
18-30	54.6%	***
> 30 units/acre	55.8%	***
Chi-Square (X^2)		***11,272****
Neighborhood Median Household Income		
< $25,000	53.7%	***
$25,000 - $50,000	53.3%	***
$50,000 - $75,000	54.3%	***
$75,000 - $100,000	63.5%	***
> $100,000	63.6%	***
Chi-Square Value		***19,331****
Perception of Neighborhood Safety		
Safe	54.0%	***
Unsafe	50.5%	***
Chi-Square (X^2)		***14,052****

** Goodness-of-fit statistic (X^2) results are higher than chi-square critical value (Pr > ChiSq: <0.0001)*

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**** Data not shown because geographic information to some survey respondents is not available..*

Table 3 Description of Variables

Dimension	Variable	Description	Source
Dependent variables			
Health Outcome			
	Level of obesity	Obese (BMI $\geq$ 30) (1); Otherwise (0)	LACHS
Independent variables			
Socioeconomic			
Age	- AGE3049	Between 30-49 (1); Otherwise (0)	LACHS
	- AGE5064	Between 50-64 (1); Otherwise (0)	LACHS
	- AGE6599	65+ (1); Otherwise (0)	LACHS
Race/Ethnicity			
	- HISP	Hispanic (1); Otherwise (0)	LACHS
	- BLACK	African America (1); Otherwise (0)	LACHS
Education			
	- HighEdu	4-yr college graduate or higher degree (1); Otherwise (0)	LACHS
Neighborhood Quality & Safety	- INC10K	Neighborhood median household income (in $10,000)	SCAG SED
	- SAFETY	Feel neighborhood is safe from crime (1); Otherwise (0)	LACHS
Individual Health Behavior			
	- FASTFOOD	Eat fast food at least once per week (1); Otherwise (0)	LACHS
	- VigPA	Engage in vigorous physical activity (1); otherwise (0)	LACHS
Neighborhood Land Use & Built Environment	- HHden	Neighborhood household density (# households/res acre)	SCAG SED
	- JOBden	Neighborhood job density (# households/acre)	SCAG SED
	- RAIL	Neighborhood has at least one rail station	Network
	- HQbus	Density of high quality bus stop (# bus stops with headway < 20 mins on peak time/acre)	Network
	- RailxDen	Interactive variable = Rail x Hhden	Network

Table 4 Descriptive Statistics

Variable	Description	Mean	Std. Dev.	Min.	Max.
AGE3049	Age 30-49	0.36	0.48	0.00	1.00
AGE5064	Age 50-64	0.29	0.45	0.00	1.00
AGE6599	Age 65 or older	0.23	0.42	0.00	1.00
HISP	Hispanic	0.37	0.48	0.00	1.00
BLACK	African American	0.09	0.29	0.00	1.00
HighEdu	4-yr college graduate or higher degree	0.37	0.48	0.00	1.00
INC10K	Neighborhood average household income (in $10,000)	4.94	2.15	1.49	16.11
SAFETY	Feel neighborhood is safe from crime	0.83	0.37	0.00	1.00
FASTFOOD	Eat fast food at least once per week	0.37	0.48	0.00	1.00
VigPA	Engage vigorous physical activity	0.34	0.48	0.00	1.00
HHden	Neighborhood household density	13.57	17.28	0.60	265.14
JOBden	Neighborhood job density	6.00	9.39	0.01	134.90
RAIL	Neighborhood has at least one rail station	0.20	0.40	0.00	1.00
HQbus	Density of high quality bus stop (# bus stops with headway <_20 mins on peak time/acre)	0.70	0.46	0.00	1.00
RailxDen	Interactive Variable = Rail x Hhden	3.77	16.15	0.00	265.14

Table 5 Model Result

Variable	Description	Estimate	Wald Chi-Sq	Pr > ChiSq	Standardized Estimate
Intercept		-0.65	9.23	0.00	
AGE3049	Age 30-49	0.50	18.65	<.0001	0.13
AGE5064	Age 50-64	0.82	43.32	<.0001	0.20
AGE6599	Age 65 or older	0.25	3.22	0.07	0.06
HISP	Hispanic	0.37	18.45	<.0001	0.10
BLACK	African American	0.61	26.49	<.0001	0.10
HighEdu	4-yr college graduate or higher degree	-0.45	29.60	<.0001	-0.12
INC10K	Neighborhood average household income	-0.11	22.55	<.0001	-0.14
SAFETY	Feel neighborhood is safe from crime	-0.30	12.13	0.00	-0.06
FASTFOOD	Eat fast food at least once per week	0.37	27.96	<.0001	0.10
VigPA	Engage vigorous physical activity	-0.35	20.87	<.0001	-0.09
HHden	Neighborhood household density	-0.01	5.68	0.02	-0.12
JOBden	Neighborhood job density	-0.01	3.24	0.07	-0.07
RAIL	Neighborhood has at least one rail station	-0.38	10.40	0.00	-0.08
HQbus	Density of high quality bus stop (# bus stops with headway <_20 mins on peak time/acre)	-0.15	3.08	0.08	-0.04
RailxDen	Interactive Variable = Rail x Hhden	0.02	11.10	0.00	0.16

Likelihood Ratio: Chi-Sq=365.45; Pr > ChiSq <.0001

Estimation based on N = 5245

c statistic = 0.677