Walking for Transportation or Leisure: What Difference Does the Neighborhood Make?

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BACKGROUND: Patients are often advised to initiate a physical activity program by walking for transportation or leisure. This study explored whether neighborhood factors beyond the individual might affect compliance.

OBJECTIVE: We examined the associations between total walking and neighborhood factors in a multiethnic population-based sample in California and the roles race/ethnicity plays in these associations.

DESIGN: Cross-sectional study

PARTICIPANTS: Individual-level data were obtained from the 2003 California Health Interview Survey. Participants' census tracts were linked to Census 2000 data to capture neighborhood SES.

MEASUREMENTS AND MAIN RESULTS: The dependent variable was self-reported walking at recommended levels. Neighborhood SES was measured by a scale of 4 Census-based variables (alpha=0.83). Social cohesion was measured by a scale tapping the extent of perceived social connectedness, trust, and solidarity among neighbors (alpha=0.70). Neighborhood access to a park, playground, or open space was measured by a single item. Safety was measured by a scale of three items (alpha=0.66). We performed a series of multiple logit models with robust variance estimates while taking complex survey design into account. Neighborhood social cohesion (odds ratio [OR]=1.09, 95% CI=1.04, 1.14) and access to a park, playground, or open space (OR=1.26, 95% CI=1.16, 1.36) were significant environmental correlates of walking at recommended levels, independent of individual socio-demographics. Subgroup analysis showed that neighborhood effects were different by race/ethnicity.

CONCLUSIONS: Neighborhood physical and social environmental factors are significantly associated with walking at recommended levels. Being aware of the ways that the environment could affect a patient's compliance with PA recommendations may help physicians tailor recommendations to circumstances.

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INTRODUCTION

Regular physical activity (PA) reduces the risk of many chronic diseases (e.g., cardiovascular conditions, diabetes, and cancer), promotes mental well-being, and improves overall quality of life.[1] Increasing PA is a national health priority in the United States.[2] However, only about 25% of Americans engage in the recommended amount of PA.[3]

Few interventions have been effective at increasing PA level long term.[4,5] Patients and the public are often advised to initiate a PA program by walking because it is perceived to be relatively accessible.[6,7] The Surgeon General's Call to Action to Prevent and Decrease Overweight and Obesity endorsed walking as the "first step" in increasing PA: "You don't need special skills or training to be physically active. Walking is a great way to be active".[8] The American Heart Association's Task Force on Risk Reduction similarly recommended that an exercise program starts with walking: "Walking is the recommended mode of activity unless the individual can attend supervised classes where other activities can be provided."[9] In population-based health surveys, walking is the most commonly reported PA.[10]

Prior research has shown that most people walk in their neighborhood, and that perceived neighborhood "walkability" is significantly associated with a higher level of PA.[6,11–13] Evidence also suggests that neighborhood environment influences individual PA and may thus hold the promise of facilitating long-term increase in PA.[14–19] However, the literature is not consistent on which aspects of the neighborhood environment affect PA. Some studies report that neighborhood sociodemographic factors have little independent effect on PA after controlling for individual characteristics.[20,21] Evidence for contextual effects of the built environment, defined by the Centers for Disease Control and Prevention as human-formed, developed, or structured areas,[22] is stronger than evidence for the effects of the neighborhood social environment, which has been studied less often.[23,24]

Few studies have simultaneously assessed both physical and social dimensions of neighborhood environment and their associations with walking.[16] It is also unclear if the neighborhood-walking associations vary by racial/ethnic group[25] and if neighborhood factors contribute to racial/ethnic disparities in

PA.[26] There is some evidence that the individual and environmental factors associated with PA do differ across racial/ethnic groups of U.S. women.[27] In this study, we examine the association between neighborhood and walking in a large population-based, multi-ethnic sample. We also examine whether these factors account for racial/ethnic differences in walking, and if these factors operate differently across racial/ethnic groups. Our data are derived from California, a state with significant racial/ethnic diversity, and also one where season and weather are relatively less likely to be key determinants of outdoor activity.

METHODS

Data

We used cross-sectional data from the 2003 California Health Interview Survey (CHIS). CHIS is a population-based telephone survey of civilian households, selected through random digit dialing. CHIS is designed to provide population-based estimates for California's overall population and its major racial/ethnic groups. For the CHIS adult sample, the adult interview response rate was 60%,[28] comparable to telephone surveys carried out by the National Center for Health Statistics. The final CHIS 2003 estimates are consistent with the 2003 California Department of Finance Population Projections.[28] The sample for this analysis was restricted to adults, 18 years and older.

This study has been approved by the Institutional Review Boards (IRB)s at the University of Utah and the University of Chicago.

Dependent Variable

CHIS asked respondents about the frequency and total duration of walking for transport and leisure in the past 1 week. Based on national PA recommendations,[3] we constructed the dependent variable for this study as a dichotomous variable indicating "walking at recommended levels". It was defined as 5 or more sessions of walking (for transportation or leisure) in the previous week totaling at least 150 minutes.

Independent Variables

Neighborhood variables. The four main independent variables were neighborhood socioeconomic status (SES), social cohesion, physical environment, and safety. Neighborhood-level SES was constructed from Census data including concentrated affluence, concentrated poverty, percent college educated residents, and percent home ownership; coefficient of alpha was 0.83. Higher scores indicated higher neighborhood SES. The remaining three neighborhood variables reflect respondents' perceptions of their neighborhood. A scale of social cohesion was constructed from 5 items measuring the respondent's level of agreement (on a 4-point scale) with the following statements: 1) "People in my neighborhood are willing to help each other"; 2) "People in this neighborhood generally do not get along with each other"; 3) "People in this neighborhood can be trusted"; 4) "People in this neighborhood do not share the same values"; and 5) "Most people in this neighborhood know each other." The coefficient of alpha was 0.70, with higher scores indicating higher levels of social cohesion in the neighborhood. Physical environment was tapped by a single item asking whether the neighborhood had a park, playground, or open space within walking distance of home. A scale of neighborhood safety was constructed from 3 items measuring the respondents' level of agreement (on a 4-point scale) with the following statements: 1) "Many people in this neighborhood are afraid to go out at night"; 2) "The park or playground closest to where I live is safe during the day"; 3) "The park or playground closest to where I live is safe at night." The coefficient of alpha was 0.66; with higher scores indicating higher levels of perceived safety. For neighborhoods that have no parks or playgrounds nearby, this scale is missing. Missing values were imputed using the five social cohesion items and an item indicating whether the respondent's house had ever been broken into (this item did not fit well with the 3 items used to construct the safety scale). The imputation did not change the results on neighborhood safety. Principal component factor analysis with orthogonal rotation was used to construct measures of neighborhood SES, social cohesion, and safety.

Sociodemographic variables. Demographic variables included race/ethnicity, marital status (married vs unmarried), sex, age (18–29, 30–39, 40–49, 50–64, 65+), SES, and immigration status.

Individuals were classified by self-report as non-Hispanic White, Hispanic, Black/African American, Asian, or Other. The Other category includes American Indians, Native Hawaiians, Pacific Islanders, those who indicated "other race" or multiple races (although the tables include the "Other" race group, they will not be discussed in detail because of heterogeneity).

Individual-level SES was measured by poverty income ratio (PIR), education, and employment status (employed vs unemployed). PIR is a ratio where the numerator is household income and the denominator is the appropriate federal poverty level (FPL) given the family's size and composition. Poverty thresholds are revised each year by the Census Bureau. Thus, a PIR less than 100% indicates that the household is living below the poverty threshold. PIR was categorized as: "0–99% of FPL," "100–199% FPL," "200–299% FPL" and "300% FPL and above." Education was categorized as: "less than high school," "high school graduate," "some college," and "college graduate." Education and PIR were each entered as single ordinal variables in the regression models.

Percent of life years in the United States was employed as an indicator of immigrant status and acculturation.

Because social and environmental factors may affect body mass index (BMI), we also adjusted for BMI (weight[kg]/height [m^2]) in the analysis. BMI was categorized as underweight (BMI <18.5), normal weight (BMI=18.5–24.99), overweight (BMI=25–24.99), and obese (BMI≥30).

Statistical Methods

All estimates and analyses were weighted using replicate weights, provided by CHIS, to adjust for non-response and the complex survey design. We performed a series of logistic regression models with robust standard errors, where the outcome was walking at recommended levels. Model 1 included all individual-level variables except percent of life in the US and served as the baseline model. In model 2, we added percent of life in the US to test the idea that acculturation mediates the association between race/ethnicity and PA, especially for Asians and Hispanics. Then, we

added each of the 4 neighborhood variables, one by one, to examine the effects of different aspects of neighborhood environment and explore what specific dimensions of neighborhood environment contributes to the race/ethnicity effects on PA. Next, we tested a full model including all 4 neighborhood variables and individual controls to see if the observed neighborhood effects were independent of each other. Lastly, we tested interaction effects between the key neighborhood factors and race/ethnicity and refit the full model for each group. For the Asian group, we further tested whether using separate Asian subgroups (i.e., Chinese, Japanese, Korean, Filipino, South Asian, Vietnamese, and Other Asian) revealed subgroup differences in the neighborhood effects (data not shown). Because there were little significant interactions between Asian subgroups, we used the aggregate race category in the analyses presented. We did not employ random effects models in this research because 3 of our 4 neighborhood variables were based on individual survey responses and therefore were not group-level variables. All neighborhood variables were standardized when entered in the models.

RESULTS

The sample included 41,545 adult respondents. Table 1 presents individual and neighborhood characteristics of the CHIS 2003 sample by race/ethnicity. Twenty-two percent of all subjects reported walking at recommended levels. This prevalence is close to the 25% national estimate.[3] In this sample, Blacks had the lowest rate of walking at recommended levels, but racial/ethnic differences were small.

Fifty-five percent of all participants were overweight or obese, also comparable to national estimates.[2] Blacks and Hispanics had the highest proportions of overweight and obese, whereas Asians were much less likely to be overweight or obese and more likely to be underweight.

Sociodemographic variables varied substantially by race/ethnicity (Table 1). Whites and Asians were more likely to be married and had higher SES than other groups. Asian respondents had spent an average of 52% of life in the United States, whereas Whites and Blacks had spent almost all of their life in the US.

Whites and Asians had comparable SES. Neighborhood SES was much lower for other groups. Levels of perceived social cohesion and perceived safety were the highest among Whites. Perceived safety was the lowest for Hispanics, followed by Blacks. The likelihood of having a nearby park, playground, or open space was also the highest for Whites, although group differences were small.

Table 2 presents our main analytical results. After adjusting for individual factors, compared to Whites, Blacks were significantly less likely to report walking at recommended levels; Hispanics had significantly higher odds of reporting walking at recommended levels; and Asians were not much different. After adding percent of life in the US to the baseline model, Asians became significantly less likely to report walking at recommended levels, and the Hispanic ethnicity effect became insignificant (Table 2, Model 2).

Neighborhood SES was not a significant correlate of walking at recommended levels. Whereas safety was a positive correlate when none of the other neighborhood variables were examined (Model 6), it was no longer significant in the full model (Model 7). Neighborhood social cohesion (OR=1.09; 95% CI=1.04, 1.14) and access to a park, playground, or open space (OR=1.26; 95% CI=1.16, 1.36) were both significantly associated with walking at recommended levels, after adjusting for individual sociodemographic factors and neighborhood SES and safety. Neighborhood factors did not seem to mediate racial/ethnic differences in walking at recommended levels. The magnitude of the race/ethnicity coefficients did not change when we added neighborhood factors to the regression models (Table 2, Models 3–7).

Table 3 presents the full model (Table 2, Model 7) stratified by 5 major racial/ethnic groups in the United States. All models were adjusted for age, gender, race/ethnicity, BMI, PIR, education, marital status, employment status, and percent of life in the United States. We focus on the point estimates, as the confidence intervals and significance also reflect differences in the sample sizes. Neighborhood SES was negatively correlated with walking at recommended levels among Blacks but had no effect on Whites, Hispanics or Asians. Social cohesion was positively associated with walking at recommended levels among Whites and Hispanics. Access to a park, playground, or open space was positively correlated with walking at recommended levels among all groups, except for Asians. Neighborhood safety was not significantly associated with walking at recommended levels in any subgroup analysis. Formal interaction tests further showed that neighborhood environment seemed to have stronger impacts on Whites than for minorities.

DISCUSSION

Using a multi-ethnic, population-based sample from California, we found that a neighborhood's social and built environment was significantly associated with walking at recommended levels, independent of individual sociodemographics. Surprisingly, we did not find that neighborhood SES and safety were important determinants in the full sample. Among the 4 neighborhood factors examined, both social cohesion and access to a park, playground, or open space were positively associated with walking at recommended levels. The promoting effect of access to facilities and destinations on PA has been confirmed elsewhere,[29–31] supporting the importance of the built environment for PA.[32,33] In this study, we found that the social environment, which was measured as perceived social cohesion, was also important.

We also found that the pattern of neighborhood effects was not consistent across racial/ethnic groups. For Blacks, neighborhood SES appeared to be an environmental barrier, consistent with an Illinois study finding that neighborhood poverty was associated with more walking.[17] Additional analysis showed that increasing neighborhood SES was positively linked to more leisure walking (data not shown), but the inclusion of transportation walking offset this effect. These discrepancies in the size and direction of the association between neighborhood SES and walking suggest that both transportation and leisure walking should be examined to better understand environmental influences on PA. For Asians, neighborhood effects were generally weaker. To date, most active living research has not included Asians, hence data about the factors influencing PA among Asian Americans are limited.[34,35] More research is needed to explore determinants

Table 1. Sample Statistics* (Data from the 2003 California Health Interview Survey)

	Total	White	Black	Hispanic	Asian	Other
Sample size†	41,545	26,139	2,653	7,083	3,856	1,814
Total walking for at least 150 minutes 5 times per week (yes)	22%	21%	19%	23%	22%	24%
BMI height/weight						
Underweight (0, 18.49)	2%	2%	1%	1%	6%	1%
Normal (18.5, 24.99)	42%	44%	33%	33%	62%	38%
Overweight (25.0, 29.99)	35%	35%	35%	39%	26%	37%
Obese (30.0+)	20%	18%	30%	27%	7%	24%
Age (mean)	44	48	44	37	43	42
Male	49%	49%	46%	51%	47%	51%
Poverty income ratio %						
0–99% FPL Federal Poverty Level	15%	6%	17%	33%	15%	16%
100–99% FPL	19%	12%	20%	32%	17%	23%
200–299% FPL	14%	14%	16%	14%	13%	16%
300% FPL and above	52%	69%	47%	22%	55%	46%
Education						
Below high school	20%	8%	12%	51%	12%	19%
High school diploma	24%	23%	30%	24%	19%	30%
College educated, no degree	25%	29%	34%	16%	21%	30%
College degree or above	31%	40%	24%	8%	49%	21%
Married	55%	58%	37%	51%	62%	47%
Employed	64%	64%	61%	65%	63%	64%
Percent of life in the US (mean)	81	96	96	61	52	87
Components of the Neighborhood SES Scale mean						
Percent families with annual income ≥ $75,000	29%	34%	22%	20%	35%	27%
Percent individuals in poverty	13%	10%	18%	19%	11%	14%
Percent college educated residents	38%	44%	32%	25%	41%	36%
Percent home ownership	57%	62%	50%	49%	57%	57%
Components of the Neighborhood Social Cohesion Scale						
Neighborly helpfulness (yes)‡	86%	90%	80%	80%	87%	84%
People do not get along with each other (yes)§	16%	9%	14%	30%	17%	17%
Neighborly trust (yes)‖	83%	89%	76%	74%	84%	79%
People do not share the same values (yes)	41%	34%	45%	51%	51%	44%
People know each other (yes)#	68%	67%	68%	73%	60%	68%
Neighborhood Access to Park/Playground/Open Space (yes)	78%	80%	78%	77%	75%	79%
Components of the Neighborhood Safety Scale						
People are afraid to go out at night (yes) **	21%	14%	23%	34%	24%	22%
Neighborhood park or playground safe during the day (yes) ††	96%	98%	94%	93%	96%	96%
Neighborhood park of playground safe at night (yes) ††	65%	72%	58%	52%	66%	61%

*For categorical variables, the percent for each item (%) is presented. For age and percent of life in the US, means are presented.

†Except for the two neighborhood park or playground safety variables (see note †† below), all sample statistics were calculated based on sample sizes shown in this row.

‡ The item was based on the respondent's level of agreement with the statement "People in my neighborhood are willing to help each other." The item presented here was dichotomized into two levels: strongly agree/agree (yes) versus strongly disagree/disagree (no).

§The item was based on the respondent's level of agreement with the statement "People in this neighborhood generally do not get along with each other." The item presented here was dichotomized into two levels: strongly agree/agree (yes) versus strongly disagree/disagree (no).

‖The item was based on the respondent's level of agreement with the statement "People in this neighborhood can be trusted." The item presented here was dichotomized into two levels: strongly agree/agree (yes) versus strongly disagree/disagree (no).

¶The item was based on the respondent's level of agreement with the statement "People in this neighborhood do not share the same values." The item was dichotomized into two levels: strongly agree/agree (yes) versus strongly disagree/disagree (no).

#The item was based on the respondent's level of agreement with the statement "Most people in this neighborhood know each other." The item presented here was dichotomized into two levels: strongly agree/agree (yes) versus strongly disagree/disagree (no).

**The item was based on the respondent's level of agreement with the statement "Many people in this neighborhood are afraid to go out at night." The item was dichotomized into two levels: strongly agree/agree (yes) versus strongly disagree/disagree (no).

††The two items were based on the respondent's level of agreement with the statement "The park or playground closest to where I live is safe during the day or at night." The items were dichotomized into two levels: strongly agree/agree (yes) versus strongly disagree/disagree (no). These two variables have significant yet legitimate missing values (22%).

of PA in this group. Overall, the racial/ethnic variation in the neighborhood–PA link suggests that community intervention programs may need to be individually tailored to meet the needs of each particular group.

Although the associations between walking at recommended levels and neighborhood factors varied by race/ethnicity, neighborhood factors did not explain the lower rates of walking at recommended levels among Blacks and Asians compared to non-Hispanic Whites. Cultural factors should be examined to better understand disparities in PA across ethnocultural groups.

The role of neighborhood safety is noteworthy. We found perceived safety was not an important correlate in the presence of social cohesion and access to open space. Prior evidence on the effect of perceived neighborhood safety on PA is mixed.[36–41] Different measures of safety and PA are possible sources of this inconsistency. More sophisticated measures of neighborhood safety should be used in future work to further evaluate the contribution of neighborhood safety in PA.

Many individual factors were significantly associated with walking at recommended levels. Older age and more education were positive factors, whereas marriage, higher BMI, higher

Table 2. Seven Logistic Regression Models Predicting Walking at Recommended Levels* (Data from the 2003 California Health Interview Survey)

	1. Baseline Model	2. Acculturation	3. Neighborhood SES	4. Social Cohesion	5. Open Space	6. Safety	7. Full Model
White (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Black	0.86* [0.75, 0.98]	0.87* [0.77, 0.99]	0.87* [0.77, 0.99]	0.89 [0.78, 1.01]	0.87* [0.77, 0.99]	0.88 [0.77, 1.01]	0.88* [0.77, 1.00]
Hispanic	1.19*** [1.08, 1.31]	0.99 [0.89, 1.10]	0.99 [0.89, 1.10]	1.00 [0.90, 1.12]	0.99 [0.89, 1.10]	1.00 [0.90, 1.11]	0.99 [0.89, 1.10]
Asian	0.98 [0.87, 1.11]	0.75*** [0.66, 0.86]	0.75*** [0.66, 0.85]	0.77*** [0.67, 0.87]	0.76*** [0.67, 0.87]	0.76*** [0.66, 0.86]	0.77*** [0.68, 0.88]
Other	1.22* [1.03, 1.43]	1.17* [1.00, 1.37]	1.17* [1.00, 1.37]	1.18* [1.01, 1.39]	1.17* [1.00, 1.37]	1.18* [1.00, 1.38]	1.18* [1.00, 1.38]
Normal weight (Ref)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Underweight	0.91 [0.73, 1.14]	0.90 [0.72, 1.12]	0.90 [0.72, 1.12]	0.90 [0.72, 1.12]	0.90 [0.73, 1.12]	0.90 [0.72, 1.12]	0.91 [0.73, 1.13]
Overweight	0.80*** [0.74, 0.87]	0.81*** [0.75, 0.86]	0.81*** [0.75, 0.86]	0.81*** [0.75, 0.88]	0.81*** [0.75, 0.88]	0.81*** [0.75, 0.88]	0.81*** [0.75, 0.88]
Obese	0.68*** [0.62, 0.75]	0.70*** [0.63, 0.77]	0.70*** [0.63, 0.77]	0.70*** [0.64, 0.78]	0.70*** [0.63, 0.77]	0.70*** [0.63, 0.77]	0.70*** [0.63, 0.77]
Age†	1.06*** [1.04, 1.09]	1.07*** [1.04, 1.10]	1.07*** [1.04, 1.10]	1.06*** [1.03, 1.09]	1.07*** [1.05, 1.10]	1.07*** [1.04, 1.10]	1.07*** [1.04, 1.10]
Male gender	1.04 [0.97, 1.11]	1.03 [0.96, 1.10]	1.03 [0.96, 1.10]	1.04 [0.97, 1.12]	1.02 [0.96, 1.10]	1.03 [0.96, 1.10]	1.03 [0.96, 1.11]
Married	0.94 [0.87, 1.01]	0.89** [0.83, 0.96]	0.89** [0.83, 0.96]	0.87*** [0.82, 0.94]	0.89*** [0.83, 0.95]	0.89*** [0.83, 0.95]	0.88*** [0.82, 0.94]
Poverty Income Ratio %‡	0.92*** [0.88, 0.97]	0.96 [0.92, 1.01]	0.96 [0.92, 1.01]	0.95* [0.91, 0.99]	0.96 [0.92, 1.00]	0.96 [0.92, 1.00]	0.95* [0.91, 1.00]
Education §	1.07***[1.03, 1.11]	1.08***[1.04, 1.12]	1.08***[1.04, 1.12]	1.07***[1.03, 1.11]	1.07***[1.03, 1.11]	1.07***[1.03, 1.11]	1.07***[1.03, 1.11]
Employed	0.82***[0.76, 0.89]	0.81***[0.75, 0.88]	0.81***[0.75, 0.88]	0.81***[0.75, 0.88]	0.81***[0.75, 0.88]	0.81***[0.75, 0.88]	0.81***[0.74, 0.87]
Percent of life In the US ‖		0.90***[0.92, 0.95]	0.90***[0.92, 0.95]	0.90***[0.92, 0.95]	0.90***[0.92, 0.95]	0.90***[0.92, 0.95]	0.90***[0.92, 0.95]
Neighborhood SES ¶			1.00[0.96, 1.04]				0.98[0.94, 1.01]
Neighborhood social cohesion #				1.10***[1.06, 1.14]			1.09***[1.04, 1.14]
Neighborhood access to open space**					1.27***[1.17, 1.37]		1.26***[1.16, 1.36]
Neighborhood safety †						1.05**[1.01, 1.08]	1.01[0.97, 1.05]

*N=41,545 individuals. 95% confidence intervals of the odds ratios are presented in the parentheses. *p≤0.05; **p≤0.01; ***p≤0.001*

†Age is treated as a continuous variable in the models. It has five levels: 18–29 years, 30–39 years, 40–49 years, 50–64 years, 65+ years.

‡Poverty Income Ratio (%) is treated as a continuous variable in the models. It has four levels: "0–99% of FPL," "100–199% FPL," "200–299% FPL," and "300% FPL and above."

§Education is treated as a continuous variable in the models. It has four levels: below high school, high school diploma, college educated (no degree), and college degree or above.

‖Odds ratios presented in this row correspond to 20% increase in percent of life in the US.

¶Neighborhood SES is measured by a factor score of concentrated affluence, concentrated poverty, percent college educated residents, and percent home ownership. Higher scores indicate higher stock of socioeconomic resources in the neighborhood.

#Neighborhood social cohesion is measured by reported perceptions of the extent of social connectedness, trust, and solidarity among neighbors. Higher scores indicate higher levels of social cohesion in the neighborhood.

***Neighborhood access to open space, as a proxy for neighborhood physical environment, is tapped by a single item asking whether the neighborhood has a park, playground, or open space within walking distance of home (yes/no).*

††Neighborhood safety is measured by a factor score based on perceived safety of the neighborhood park or playground at day time, at night time, plus an item asking respondents' agreement to the statement "Most people in this neighborhood are afraid to go out at night." Higher scores indicate higher levels of perceived neighborhood safety.

Table 3. Ethnic-Group Specific Logistic Regression Models Predicting Walking at Recommended Levels* (Data from the 2003 California Health Interview Survey)

	White	Black	Hispanic	Asian	Other
Neighborhood SES†	0.99[0.95, 1.03]	0.86*[0.75, 0.98]	0.96[0.88, 1.05]	1.04[0.93, 1.17]	0.81**[0.68, 0.95]
Neighborhood Social Cohesion ‡	1.06***[1.01, 1.12]	1.10[0.92, 1.33]	1.14*[1.02, 1.27]	1.11[0.97, 1.27]	1.07[0.90, 1.27]
Neighborhood Access to Open Space§	1.29***[1.15, 1.45]	1.64***[1.16, 2.32]	1.21*[1.02, 1.44]	1.03[0.81, 1.30]	1.14[0.80, 1.62]
Neighborhood Safety‖	1.02[0.97, 1.08]	1.14[0.91, 1.42]	0.98[0.90, 1.06]	0.94[0.82, 1.08]	0.96[0.81, 1.15]
Sample size	26,139	2,653	7,083	3,856	1,814

*95% confidence intervals of the odds ratios are presented in the parentheses. *$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$. The full model in Table 2 (Model 7) is refit for each of the 5 racial/ethnic groups. All models are adjusted for age, gender, race/ethnicity, BMI, PIR, education, marital status, employment status, and percent of life in the US. 95% confidence intervals of the odds ratios are presented in the parentheses.

†Neighborhood SES is measured by a factor score of concentrated affluence, concentrated poverty, percent college educated residents, and percent home ownership. Higher scores indicate higher stock of socioeconomic resources in the neighborhood.

‡Neighborhood social cohesion is measured by reported perceptions of the extent of social connectedness, trust, and solidarity among neighbors. Higher scores indicate higher levels of social cohesion in the neighborhood.

§Neighborhood access to open space, as a proxy for neighborhood physical environment, is tapped by a single item asking whether the neighborhood has a park, playground, or open space within walking distance of home (yes/no).

‖Neighborhood safety is measured by a factor score based on perceived safety of the neighborhood park or playground at day time, at night time, plus an item asking respondents' agreement to the statement "Most people in this neighborhood are afraid to go out at night." Higher scores indicate higher levels of perceived neighborhood safety.

income, employment, and greater percent of life in the United States were negative correlates. Some of these results are unexpected. Age has been negatively linked to leisure-time PA,[42,43] and a curvilinear relationship between age and PA has been reported for California residents when PA was measured by non-leisure walking and biking.[44] However, few studies have directly assessed how age is linked to total amount of walking. It is plausible that walking is a more important form of PA for older adults, both for leisure and as a means of transport.[45] Hence, activity-friendly environment may be particularly important for older people.

The longer a respondent has lived in the United States, the less likely he/she is to report walking at recommended levels. Stratified analyses showed that the magnitude of this effect was fairly consistent across racial/ethnic groups (data not presented). Moreover, controlling for acculturation, compared to whites, the Hispanic advantage disappeared and the Asian disadvantage became strengthened (see Model 1 to Model 2 in Table 2). These results suggest that acculturation may be a risk factor for physical inactivity among immigrants.

There is insufficient evidence about the effectiveness of routine PA counseling in the primary care setting. However, several professional health organizations and the US Department of Health and Human Services encourage PA counseling in the primary care setting,[46] and there is some evidence that a patient-centered assessment and counseling influences PA.[47] In light of this, our findings may have implications for primary care physicians who hope to increase PA levels among their patient. When discussing PA with patients and developing a patient-centered exercise plan, the physician may want to enquire about neighborhood factors and how these affect the patient's willingness or ability to walk for exercise.

This study has several limitations. First, cross-sectional data limit our ability to make causal inferences about the neighborhood environment and walking behavior. Even longitudinal observational data would not resolve the direction of causality because of the selection bias. Experimental studies are rarely used to examine neighborhood effects on PA, but they are not entirely impossible. For example, were policy experiments, such as the Gautreaux Assisted Housing Program in Chicago and the more recent Moving to Opportunity housing voucher programs in various American cities,[48–50] to incorporate behavioral outcomes, then we would have experimental or quasi-experimental data to more rigorously investigate whether there is a causal link between the environment and PA. Second, the study is based in California and these results are not necessarily generalizable to other places. Third, our measure of walking was based on self-report and was subject to response bias.

This study suggests that neighborhood environment is associated with walking at recommended levels, and that the strength of these associations varies across racial/ethnic groups. Neighborhood factors do not explain the lower rates of walking at recommended levels among Asians and Blacks in California. Interventions that address both neighborhood and individual-level factors may be more fruitful in increasing PA; however, tailoring interventions to the needs of individuals and groups is likely to be more effective, and more research is needed to understand if such interventions can address racial/ethnic disparities in PA.

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