

# Neighborhood-Based Differences in Physical Activity: An Environment Scale Evaluation

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We have observed growing disappointment among researchers with the inability of individually oriented models to adequately explain the high population prevalence of physical inactivity.<sup>1</sup> The inability of individually focused interventions to create long-term change or population shifts in physical activity also is disappointing.<sup>2,3</sup> However, interest in the potential of multilevel ecological models to facilitate a better understanding of physical-environment effects on behavior has increased.<sup>4,5</sup> The small but growing health literature on this subject documents relations between numerous environmental variables and physical activity but provides few definitive explanations.<sup>6,7</sup> Further investigation of the environmental correlates of physical activity is needed and could lead to improved interventions.

The negative effects of low-density, automobile-dependent, segregated-use patterns of land and transport system development are attracting public health attention.<sup>8</sup> Transportation studies indicate that people living in “traditional” neighborhoods—characterized by higher residential density, a mixture of land uses (residential and commercial), and gridlike street patterns with short block lengths—engage in more walking and cycling trips for transport than do people living in sprawling neighborhoods.<sup>9</sup> Transportation research currently provides the best evidence that environmental factors can contribute to low levels of lifestyle physical activity,<sup>10</sup> because many Americans live in environments that can be characterized as low in “walkability.”<sup>11</sup>

From a physical activity and health perspective, transportation studies have numerous shortcomings: the contribution of community design to overall physical activity is unknown, only a small number of environmental variables have been studied, and reliable and valid measures of environmental variables are not available.<sup>9</sup> Our study builds on the strengths of transportation research to

**Objectives.** This study evaluated a neighborhood environment survey and compared the physical activity and weight status of the residents in 2 neighborhoods.

**Methods.** On 2 occasions, 107 adults from neighborhoods with differing “walkability” were selected to complete a survey on their neighborhood environment. Physical activity was assessed by self-report and by accelerometer; height and weight were assessed by self-report.

**Results.** Neighborhood environment characteristics had moderate to high test–retest reliabilities. Residents of high-walkability neighborhoods reported higher residential density, land use mix, street connectivity, aesthetics, and safety. They had more than 70 more minutes of physical activity and had lower obesity prevalence (adjusted for individual demographics) than did residents of low-walkability neighborhoods.

**Conclusions.** The reliability and validity of self-reported neighborhood environment subscales were supported. Neighborhood environment was associated with physical activity and overweight prevalence. (*Am J Public Health.* 2003;93:1552–1558)

fill important knowledge gaps. We evaluated self-report measures of neighborhood environment variables hypothesized to be important contributors to physical activity.<sup>7,12,13</sup> On the basis of transportation research and to a model of environmental influences on physical activity,<sup>9,14</sup> self-report measures of neighborhood environmental constructs were developed and assessed for reliability and construct validity. We also compared physical activity and weight status among adult residents living in neighborhoods characterized as having high or low “walkability,” which is defined by residential density, mixed land use, and street connectivity.<sup>9</sup>

## METHODS

### Participants

We recruited residents from 2 neighborhoods defined as nonadjacent 1990 census tracts in San Diego, California. The high-walkability neighborhood had a mixture of single-family and multiple-family residences, which is consistent with higher residential density, whereas the low-walkability neighborhood had predominantly single-family homes. The high-walkability neighborhood had a concentration of nonresidential land uses (restaurants, grocery or convenience

stores, and other small retail stores) along the main corridor of the neighborhood, whereas the low-walkability neighborhood was mostly residential and had only a small commercial area on the neighborhood periphery. The high-walkability neighborhood had a mostly gridlike street pattern, with short block lengths and few cul-de-sacs, which is indicative of greater street connectivity. The low-walkability neighborhood had longer block lengths, a mixture of gridlike and curvilinear street patterns, and more cul-de-sacs. According to the 1990 census, the neighborhoods had similar census tract–level median income (high-walkability neighborhood, \$40 170; low-walkability neighborhood, \$46 647) and median resident age (high-walkability neighborhood, 39.9 years; low-walkability neighborhood, 36.5 years).

Potential participants were identified through a Haines & Company, Inc (North Canton, Ohio) reverse directory that sorts households alphabetically by street address rather than by last name. For streets that extended beyond census tract boundaries, only those residents with street addresses within the identified census tract were eligible to participate. Residences with telephone numbers were randomly selected from within the neighborhoods.

The residents were mailed an introductory letter and a study consent form. They were then contacted by telephone, with up to 6 calls attempted, to assess study interest and eligibility. Eligibility criteria included (1) still living within the identified neighborhoods, (2) being 18 to 65 years old, (3) not having a disability that precluded walking, and (4) being able to complete written surveys in English. Sample size requirements were based on estimated differences (observed in transportation research) in walking rates between high- and low-walkability neighborhoods.<sup>9</sup> After we adopted a more conservative effect size (effective size statistic [ $d$ ] = .65) than that derived from the transportation literature ( $d$  = 1.0),<sup>9</sup> we determined that 46 participants from each neighborhood were needed to detect a moderate to large effect size with more than 80% power.<sup>15</sup> Recruitment continued until approximately 50 individuals from each neighborhood had completed the survey and had provided objective physical-activity data.

Contact by mail and telephone was attempted with 600 individuals in the high-walkability neighborhood and with 707 individuals in the low-walkability neighborhood; 30.5% and 26.3%, respectively, could not be reached by telephone. Among the telephone contacts in the high- and low-walkability neighborhoods, respectively, 41.2% and 53.6% refused participation, 39.1% and 31.5% were not eligible, and 19.7% and 15.0% agreed to participate. Age was the primary reason for ineligibility in both neighborhoods. Among the individuals who agreed to participate, 81.7% ( $n$  = 67) in the high-walkability neighborhood and 82.0% ( $n$  = 64) in the low-walkability neighborhood returned signed consent forms.

Nine participants dropped out after consenting to participate ( $n$  = 4 in the high-walkability neighborhood,  $n$  = 5 in the low-walkability neighborhood), and 12 participants were unable to complete the survey either because they did not wear the activity monitor long enough or because the activity monitor malfunctioned ( $n$  = 7 in the high-walkability neighborhood,  $n$  = 5 in the low-walkability neighborhood); no significant demographic differences between those who did and did not complete the survey). One

**TABLE 1—Participant Demographics by Neighborhood**

	High-Walkability Neighborhood (n = 54)	Low-Walkability Neighborhood (n = 53)	P Value
Female, %	51.9	54.7	NS
Age, mean (SD), y	44.9 (11.6)	50.8 (10.7)	.008
Ethnicity, %			
White	79.6	83.0	NS
Hispanic/Latino	13.0	5.7	NS
Asian/Pacific Islander	3.7	5.7	NS
Black	0	1.9	NS
Multiple ethnicities	3.7	3.7	NS
Completed college/university, %	63.0	41.5	.026

Note. NS = not significant,  $P$  > .05.

hundred ten participants provided objective physical activity data and completed surveys. Among these participants, 3 ( $n$  = 2 in the high-walkability neighborhood,  $n$  = 1 in the low-walkability neighborhood) were removed from analyses because they were outliers on objective physical activity measures (>3 standard deviations above the mean), which resulted in a sample of 107 participants ( $n$  = 54 in the high-walkability neighborhood,  $n$  = 53 in the low-walkability neighborhood). Results of tests of statistical differences between the neighborhoods were the same regardless of whether the outliers were included in analyses. Participant demographic characteristics are shown in Table 1.

### Procedures

Participant contact was solely by telephone and mail. When research staff received a signed written consent form, the participant was mailed a uniaxial accelerometer/activity monitor (CSA Model 7164; Computer Sciences Applications Inc, Shalimar, Fla). Participants were instructed to attach the activity monitor to an adjustable belt and to wear it firmly around the waist, positioned just above the right hip. The activity monitor was to be worn for 7 consecutive days during waking hours when the participant was not engaged in water-related activities such as swimming and showering.

Four to 5 days after sending the activity monitors, research staff sent participants a survey and encouraged them to complete them and mail them back with the activity

monitors. Approximately 1 week after receiving the completed first survey, research staff sent a second survey. When all measures were completed, participants were compensated \$20.

### Measures

**Activity Monitor.** The CSA activity monitor provided an objective measure of physical activity. It collected minute-by-minute activity counts that were collapsed into minutes spent across the 7 days in intensity levels of light, moderate, hard, and very hard activity based on cutpoints derived from previous research.<sup>16</sup> Hard-activity and very-hard-activity minutes were combined to create an estimate of vigorous physical activity. CSA-derived information correlates highly with heart rate and with other movement and energy-expenditure estimates.<sup>17</sup> It provides a valid estimate of physical activity even in nonlaboratory settings,<sup>18</sup> particularly in the case of moderate-intensity physical activities such as walking.<sup>19</sup>

**Surveys.** A new survey was developed to assess neighborhood environment characteristics hypothesized to be related to physical activity. The first 2 authors and a community group composed of transportation, environmental protection, and urban planning professionals created the survey, which was based on empirical literature from transportation planning and urban planning.<sup>9</sup> It assessed several environmental characteristics: (1) residential density; (2) proximity to, and ease of access to, non-residential land uses, such as restaurants

and retail stores (land use mix–diversity and land use mix–access); (3) street connectivity; (4) walking/cycling facilities, such as sidewalks and pedestrian/bike trails; (5) aesthetics; (6) traffic safety; and (7) crime safety. With the exception of the residential density and land use mix–diversity subscales, items were scaled from 1 (strongly disagree) to 4 (strongly agree), with higher scores indicating a more favorable value of the environmental characteristic. Residential density items asked about the frequency of various types of neighborhood residences, from single-family detached homes to 13-story or higher apartments/condominiums, with a response range of 1 (none) to 5 (all). Residential density items were weighted relative to the average density of single-family detached residences (e.g., 7- to 12-story apartments and condominiums were considered to be 50 times more person-dense than single-family residences), and weighted values were summed to create a residential density subscale

score. Land use mix–diversity was assessed by the walking proximity from home to various types of stores and facilities, with responses ranging from 1- to 5-minute walking distance (coded as 5) to  $\geq 30$ -minute walking distance (coded as 1). Higher scores on land use mix–diversity indicated closer average proximity. With the exception of the residential density subscale, all subscale scores were calculated as the mean across the subscale items. Sample items from the Neighborhood Environment Walkability Scale (NEWS) are shown in Table 2.

In addition to the NEWS, the first survey contained a validated and reliable self-report walking assessment that asked about the number of minutes spent during the past week walking to or from work or school, during breaks or lunch at work or school, as part of errands done outside the household, for exercise, and to/from transit stops.<sup>20</sup> Total self-reported walking was the sum of time across walking purposes. Leisure time physical activity was assessed with the

Godin–Shephard Leisure Time Exercise Questionnaire.<sup>21</sup> The first survey also included demographic questions, including questions about age, gender, ethnicity, height, weight, and level of education. Body mass index (BMI) was calculated as  $\text{kg}/\text{m}^2$ ; overweight was defined as  $\text{BMI} > 25$ . Level of education was dichotomized as completing college and higher or not completing college and lower. The second survey contained only the perceived-environment subscales that were part of the first survey.

### Data Analytic Plan

The data were evaluated for normality and for potential outliers. Three individuals with extremely high accelerometer values were eliminated from the analyses. In addition, 1 individual with an extreme score on self-reported walking for errands ( $> 6$  standard deviations above the mean) was removed from the self-reported walking analyses but was retained in other analyses. Self-reported walking scores had high positive kurtosis and positive skewness; thus, logarithmic transformations were used in analyses, with median values presented as measures of central tendency. Accelerometer and perceived-environment data were neither highly skewed nor kurtotic; these data were not transformed. Mean values are presented.

One-way model single-measure intraclass correlations were used to evaluate the test–retest reliability of the NEWS subscales. One participant did not return the second survey and was not included in the reliability analyses. Differences between residents of the 2 neighborhoods on demographics, perceived neighborhood environment (from Survey 1), physical activity, and BMI were examined with 1-way analysis of variance (ANOVA) for continuous variables and with  $\chi^2$  tests for dichotomous variables. In addition to our examining the amount of self-reported walking time by purpose, dichotomized values of walking by purpose (e.g., walking for exercise vs not walking for exercise) were analyzed for neighborhood differences. We used analysis of covariance (ANCOVA) tests for continuous outcomes and logistic regression for dichotomous outcomes in analyzing neighborhood differences when adjusting for resident age

**TABLE 2—Subscales and Sample Items From the Neighborhood Environment Walkability Scale**

Subscale	Sample Items
Residential density	How common are detached single-family residences in your immediate neighborhood? How common are apartments or condos 1–3 stories in your immediate neighborhood?
Land use mix–diversity	About how long would it take to get from your home to the <i>nearest</i> businesses or facilities if you <i>walked</i> to them? • Convenience/small grocery store • Post office • Video store • Non-fast food restaurant
Land use mix–access	I can do most of my shopping at local stores. Parking is difficult in local shopping areas.
Street connectivity	The streets in my neighborhood do not have many, or any, cul-de-sacs. The distance between intersections in my neighborhood is usually short.
Walking/cycling facilities	The sidewalks in my neighborhood are well maintained. There is a grass/dirt strip that separates the streets from sidewalks in my neighborhood.
Aesthetics	There are many attractive natural sights in my neighborhood (such as landscaping, views). There are attractive buildings/homes in my neighborhood.
Pedestrian/automobile traffic safety	The speed of traffic on most nearby streets is usually slow (30 mph or less). There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.
Crime safety	There is a high crime rate in my neighborhood. My neighborhood streets are well lit at night.

Note: The complete Neighborhood Environment Walkability Scale (NEWS) and scoring procedures are available at <http://www.drjamesallis.sdsu.edu/NEWS.pdf> and <http://www.drjamesallis.sdsu.edu/NEWSscoring.pdf>, respectively.

**TABLE 3—Test–Retest Reliability<sup>a</sup> and Mean (SD) Subscale Scores From the Neighborhood Environment Walkability Scale**

Neighborhood Environment Factor or Subscale	Test–Retest Reliability (n = 106)	Mean (SD) Subscale Score	
		High-Walkability Neighborhood (n = 54)	Low-Walkability Neighborhood (n = 53)
Residential density	.63	203.2 (19.2)*	194.4 (21.6)
Land use mix–diversity	.78	3.5 (0.6)*	2.8 (0.7)
Land use mix–access	.79	3.2 (0.3)*	2.8 (0.5)
Street connectivity	.63	3.2 (0.5)*	2.9 (0.5)
Walking/cycling facilities	.58	3.0 (0.3)	3.2 (0.4)**
Aesthetics	.79	3.0 (0.5)*	2.8 (0.5)
Pedestrian/traffic safety	.77	3.1 (0.5)*	2.7 (0.5)
Crime safety	.80	3.1 (0.4)	3.1 (0.5)

Note. Subscale scores ranged from 1 to 4 (with the exceptions of land use mix–diversity [possible range: 1–5] and residential density [possible weighted score range: 177–473]), with higher scores indicating a more favorable value of the environmental characteristic

<sup>a</sup>Intraclass correlation, *R*.

\*high walkability > low walkability, *P* < .03; \*\*low walkability > high walkability, *P* = .003.

and education level. Analyses were conducted in SPSS 10.0 (SPSS Inc, Chicago, Ill), and all tests were 2-tailed.

## RESULTS

### Validity and Test–Retest Reliability of the NEWS

Table 3 shows that residents in the high-walkability neighborhood perceived their neighborhoods as having higher residential density, land use mix–diversity, land use mix–access, street connectivity, aesthetics, and pedestrian/automobile traffic safety than did residents of the low-walkability neighborhood (all *F* statistic [*F*]  $F_{1,105} > 9.69$ , *P* < .003). However, low-walkability neighborhood residents reported having more facilities for walking/cycling ( $F_{1,105} = 9.07$ , *P* = .003). There were no differences between neighborhoods in perceived crime safety ( $F_{1,105} = 0.002$ , *P* = .97). Perceived-environment findings were not altered substantially by the inclusion of participant age and education level as covariates.

The median amount of time between participants' returning the first and second surveys was 15 days. Intraclass correlations for the test–retest reliability of the NEWS subscales were all  $\geq .58$ , and the majority of test–retest values were  $\geq .75$  (all  $F_{1,105} > 3.78$ , *P* < .001).

### Physical Activity and Weight Status Differences

Table 4 shows that residents in the high-walkability neighborhood engaged in approximately 52 more minutes of moderate-intensity physical activity during the past 7 days than did residents of the low-walkability neighborhood ( $F_{1,105} = 6.02$ , *P* = .016). This difference was the primary contributor to greater overall objectively measured physical activity among high- versus low-walkability neighborhood residents ( $F_{1,105} = 6.80$ , *P* = .010). These significant neighborhood differences were maintained after adjustment for participant age and education level. In contrast, high- and low-walkability neighborhood residents did not significantly differ in amount of objectively measured vigorous-intensity physical activity.

High-walkability neighborhood residents reported spending more time walking for errands and during breaks at work or school than low-walkability neighborhood residents, but these differences did not remain statistically significant after adjustment for age and education. The difference among neighborhoods in total self-reported walking approached statistical significance ( $F_{1,104} = 2.88$ , *P* = .093), but the covariates attenuated this difference. Percentage of residents walking for errands was higher in the high-walkability neighborhood than in the low-walkability neighborhood (85.2% vs 59.6%;  $\chi^2 [1] =$

8.72, *P* = .003), as was the percentage of residents walking during breaks at work or school (50% vs 25%,  $\chi^2 [1] = 7.05$ , *P* = .008). However, after participant age and education level were entered into the logistic model, only walking for errands had a significant neighborhood term ( $\beta = 1.04$ , *SE* = .50, *P* = .01). No significant differences by neighborhood type were observed in self-reported frequency of engaging in mild, moderate, or strenuous physical activity during the past week either before or after adjustment for participant age and education level. The comparison of BMI between high- and low-walkability neighborhood approached statistical significance, with residents of low-walkability neighborhoods having a higher average BMI than residents of high-walkability neighborhoods (27.4 vs 25.3,  $F_{1,106} = 3.89$ , *P* = .051). This difference was attenuated somewhat by the inclusion of participant age and education level covariates (27.3 vs 25.4,  $F_{1,103} = 2.81$ , *P* = .097). A greater percentage of residents from the low-walkability neighborhood than from the high-walkability neighborhood met criteria for overweight (60.4% vs 35.2%;  $\chi^2 [1] = 6.81$ , *P* = .009). Neighborhood walkability remained significant in a logistic regression model of overweight prevalence after we entered participant age and education level ( $\beta = 0.86$ , *SE* = .42, *P* = .043).

## DISCUSSION

Our findings strongly supported the test–retest reliability and validity of a new self-report measure of neighborhood environment characteristics hypothesized to be related to lifestyle physical activity, particularly walking for transport. Most of the NEWS subscales had test–retest reliability above .75, which is a high level of consistency. Scales that assessed residential density, walking/cycling facilities, and street connectivity had lower, but still acceptable, reliability. Item difficulty could explain the lower reliability of the street connectivity subscale, because some judgments, such as street block length, were difficult. There also was little variability in some walking/cycling facilities and residential density items, including items that asked whether sidewalks (high frequency in both neighborhoods) and apart-

**TABLE 4—Walking and Physical Activity by Neighborhood**

Outcome	Unadjusted		Adjusted for Participant Age and Education Level	
	High-Walkability Neighborhood (n = 54)	Low-Walkability Neighborhood (n = 53) <sup>a</sup>	High-Walkability Neighborhood (n = 54)	Low-Walkability Neighborhood (n = 53)
CSA-measured physical activity				
(mean [SD] total minutes during past 7 days)				
Moderate-intensity physical activity	188.7 (116.5)*	136.9 (101.2)	194.8**	130.7
Vigorous-intensity physical activity	18.1 (44.6)	6.7 (18.9)	15.7	9.1
Total physical activity	206.8 (138.1)*	143.6 (110.8)	210.5**	139.9
Self-reported walking for various purposes (median total minutes during past 7 days)				
To or from work or school	0.0	0.0	NA	NA
To or from bus/transit stop	0.0	0.0	NA	NA
For errands outside home	30.0*	15.0	NA	NA
During breaks at work or school	2.5**	0.0	NA	NA
For exercise	30.0	20.0	NA	NA
Total walking	137.5	65.0	NA	NA
Godin-Shephard Leisure Time Exercise Questionnaire (mean [SD] times per week)				
Mild	3.0 (3.3)	2.6 (3.0)	3.1	2.5
Moderate	2.3 (2.3)	2.5 (3.2)	2.3	2.6
Strenuous	1.3 (2.0)	0.7 (1.4)	1.1	0.9

Note. NA = not applicable for covariate analyses. CSA = Computer Sciences Applications Inc uniaxial accelerometer/activity monitor (Model 7164, Shalimar, Fla).

<sup>a</sup>n = 52 for self-reported walking outcomes.

\*high walkability > low walkability, all  $P < .05$ ; \*\*high walkability > low walkability, all  $P < .01$ ;

ment buildings of over 3 stories (low frequency in both neighborhoods) existed.

The high-walkability neighborhood had higher scores on 6 of the 8 perceived-environment subscales, including all 4 variables on which neighborhood selection was based: residential density, land use mix–diversity, land use mix–access, and street connectivity. Differences between neighborhoods were sometimes subtle because of geographic proximity and shared governance; thus, the ability of respondents to perceive differences provided strong support for the validity of subscale constructs.

Surprisingly, the low-walkability neighborhood residents reported greater numbers of walking/cycling facilities. The walking/cycling facilities subscale had the lowest reliability and was directed toward assessing sidewalks

(presence, separation from street) and accessibility of walking/cycling trails, factors that were not used for neighborhood selection. Crime safety also was not used in neighborhood selection and, not surprisingly, did not differ between neighborhoods. Neighborhood environment characteristics assessed are associated with walking and cycling trips for transport,<sup>9</sup> but the psychometrics of the measures of these constructs had not previously been systematically assessed in either the transportation or the health research.

Our study sought to provide a preliminary test of the oft-stated hypothesis that neighborhood walkability,<sup>8,13,22</sup> as defined by land use and community design, is related to physical activity and body weight. Although this study was based on a small sample, it was the first to objectively measure and document the as-

sociation between neighborhood design and physical activity. Our study extended the transportation research findings by suggesting that higher nonmotorized transport rates in high-walkability neighborhoods may contribute to significantly greater total physical activity.<sup>9</sup>

No observed difference was found between neighborhoods regarding self-reported walking for exercise, self-reported leisure time physical activity, or objectively measured vigorous physical activity. There was, however, a difference between neighborhoods regarding walking for errands. This difference is consistent with transportation research that finds no differences in walking for exercise but finds significant differences in walking for transport purposes between high- and low-walkability neighborhoods.<sup>23</sup> Other types of utilitarian walking in our study—to or from work or school and to or from transit—were infrequent in both neighborhoods, which is consistent with previous research.<sup>24</sup>

On the basis of accelerometer values, residents in the high-walkability neighborhood engaged in approximately 70 more minutes of moderate to vigorous physical activity per week than did the residents in the low-walkability neighborhood. Virtually all the difference in neighborhood-based physical activity was in moderate-intensity activity, which suggests that activities such as walking accounted for the total physical activity difference between neighborhoods. The average person in a high-walkability neighborhood may be meeting the physical activity guidelines of at least 30 minutes of physical activity per day on 2 or more days per week.<sup>25</sup> A 70-minute-per-week difference in physical activity translates to walking 3 miles more per week given an approximate 20-minute-per-mile pace. Over the course of a year, this amount of walking would yield about 15 000 kilocalories of energy expenditure for a 68-kilogram person, which, if not offset by caloric intake, could result in almost 1.8 kilograms of weight loss.

Consistent with the physical activity differences, there was a significant difference between neighborhoods in overweight prevalence (i.e., >25 kg/m<sup>2</sup>), with 60% of low-walkability neighborhood residents being overweight, but (similar to alarming US prev-

alence estimates<sup>26,27</sup>) only 35% of high walkability neighborhood residents being overweight. Our findings provide preliminary support for the hypothesis that macroenvironmental factors and trends in neighborhood design are contributing to the obesity epidemic.<sup>28,29</sup>

Physical activity levels within the general population may not improve until neighborhoods are made more walkable. Although changing the form of urban areas and guiding neighborhood design decisions are not areas of expertise for most public health professionals, partnerships with diverse disciplines can provide the data and the advocacy needed to make neighborhoods more conducive to physical activity.<sup>7</sup> The extraordinary promise of changing urban form could effect entire community populations on a relatively permanent basis by consistently helping residents reach elusive physical activity goals that are not achieved by individually oriented behavior-change interventions.<sup>2,30</sup>

The NEWS subscales were defined a priori on the basis of previous findings, a conceptual model, and specific hypotheses rather than empirically by factor analyses. Future research needs to evaluate more neighborhood environment variables and the relation between objective measures of environment and perceived environment measures to identify parsimonious, yet accurate, assessments of neighborhood environments. Census tracts have been used previously to define neighborhoods,<sup>31,32</sup> but the defined area of an individual's environment for physical activity is unknown, as is whether individuals are influenced by the environmental characteristics of entire neighborhoods or by the specific areas around residences.<sup>32</sup>

Random selection was used to recruit participants within the neighborhoods in our study, but the low recruitment rate and the demographic differences between the neighborhoods may limit generalizability. The cross-sectional design does not allow us to determine whether neighborhood design caused physical activity differences or whether individuals self-select into neighborhoods according to physical activity opportunities, including walkability. Assessment of residential choice and psychosocial correlates of physical activity need to be included in future physical

activity environmental research.<sup>33</sup> Our study was conceived as a pilot investigation, and the restriction to small samples in 2 neighborhoods in 1 city means that neighborhood comparisons of physical activity and BMI should be considered preliminary. Measurement of neighborhood food environments also could significantly augment the understanding of the relation between environment and weight status.<sup>31</sup> Our results indicate a need for larger and more definitive studies of hypotheses regarding the effects of neighborhood design on physical activity, BMI, and other health variables. ■

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### Contributors

B. E. Saelens conceptualized and designed the study, organized and supervised data collection and management, completed data analyses, and led the writing of the article. J. F. Sallis conceptualized and designed the study, supervised data collection, and contributed to the writing. J. B. Black and D. Chen were involved in data collection and management, data analysis, and data interpretation. All authors edited drafts of the article.

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### Human Participant Protection

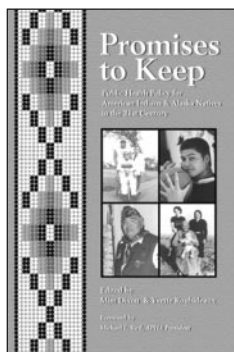
This study was approved by the committee for protection of human subjects of San Diego State University. Participants provided written consent.

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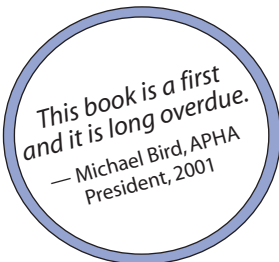
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