

*Building the Evidence—U.S. Approaches*

# Neighborhood Environment, Access to Places for Activity, and Leisure-time Physical Activity in a Diverse North Carolina Population

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## Abstract

**Purpose.** To examine associations between perceived neighborhood characteristics, access to places for activity, and leisure-time physical activity.

**Design.** Cross-sectional telephone survey.

**Setting.** Cabarrus, Henderson, Pitt, Robeson, Surry, and Wake counties in North Carolina.

**Subjects.** Population-based sample of 1796 adults at least 18 years of age residing in the six counties.

**Measures.** The 133-item questionnaire assessed self-reported leisure-time physical activity and perceptions of neighborhood characteristics (sidewalks, trails, heavy traffic, streetlights, unattended dogs, and safety from crime) and general access to places for physical activity.

**Results.** Trails, streetlights, and access to places were positively associated with engaging in any leisure activity: unadjusted odds ratio (OR) (95% confidence interval [CI]); 1.62 (1.09–2.41), 1.57 (1.14–2.17), and 2.94 (1.91–4.52), respectively. Trails and access to places were positively associated with engaging in the recommended amount of leisure activity: 1.49 (1.00–2.22), and 2.28 (1.30–4.00), respectively). In multivariable logistic regression modeling including environmental factors and demographics, access to places was associated with any activity (2.23 [1.44–3.44]) and recommended activity (2.15 [1.23–3.77]), and trails were associated with recommended activity (1.51 [1.00–2.28]).

**Conclusion.** Certain neighborhood characteristics, particularly trails, and access to places for physical activity may be associated with leisure activity levels. In this study, perceived neighborhood environmental factors and access to places for physical activity were strongly associated with race, education, and income. (*Am J Health Promot* 2003;18[1]:58–69.)

**Key Words:** Exercise, Environment, Ethnic Groups, Socioeconomic Factors, Prevention Research

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## INTRODUCTION

Physical activity has been shown to improve health and reduce the risk of developing many chronic diseases, including cardiovascular disease, diabetes, and some forms of cancer, three of the leading causes of death in the United States.<sup>1</sup> Physical inactivity among U.S. adults has also been implicated in the ongoing national epidemic of obesity.<sup>2</sup> A handful of publications have attempted to estimate the annual number of deaths in the United States attributable to physical inactivity and obesity. Hahn et al<sup>3</sup> estimated that more than 250,000 deaths are due to physical inactivity alone, whereas McGinnis and Foege<sup>4</sup> estimated that more than 300,000 deaths are due to the combined effect of physical inactivity and unhealthy diet. A more recent publication reported that more than 280,000 deaths in the United States each year are attributable to overweight and obesity.<sup>5</sup>

In an effort to address this major public health concern, the Surgeon General's Report on Physical Activity and Health was issued in 1996 and recommended that all Americans accumulate at least 30 minutes of moderate-intensity physical activity on most, if not all, days of the week.<sup>1</sup> More recently, Healthy People 2010 has included physical activity as one of the 10 leading health indicators for the nation, in part because of its broad public health impact.<sup>6</sup> Despite this, few Americans are regularly physically active. Nearly 30% are inactive, and only 25% engage in the

recommended amount of physical activity.<sup>7</sup> Leisure-time physical activity levels have not improved in the United States over the past decade.<sup>7</sup>

Major public health reports issued over the last few years have increasingly advocated environmental change interventions as part of comprehensive public health programs to promote physical activity.<sup>1,8,9</sup> Recently, the Task Force on Community Preventive Services has strongly recommended policy and environmental efforts that create or enhance access to places for physical activity (combined with informational outreach activities) as an intervention to increase physical activity in communities.<sup>10</sup> Accordingly, public health programs are increasingly focusing efforts on creating policy and environmental change to complement individual behavior change interventions and provide social and physical environments that are more supportive of healthy behaviors. Examples of these interventions include creating or increasing access to trails, parks, sidewalks, safe roads for walking and bicycling, or indoor or outdoor recreation facilities.

Despite the growing interest in implementing environmental change interventions to promote physical activity, there is still limited evidence to indicate which specific environmental factors influence physical activity behaviors and which environmental changes are most likely to have an impact on public health.<sup>11</sup> To examine the association between specific neighborhood characteristics, access to places for physical activity, and leisure-time physical activity, we conducted a telephone survey of adults residing in six diverse North Carolina (NC) counties. The presence of neighborhood sidewalks, trails, heavy traffic, streetlights, and unattended dogs; neighborhood safety from crime; and general access to places for physical activity were assessed and their associations with two measures of leisure-time physical activity were examined.

## METHODS

### Design

The NC Six-county Cardiovascular Health (CVH) survey was a cross-sectional

random-digit dial telephone survey of adults at least 18 years of age residing in six NC counties. The telephone interviews were conducted for all counties simultaneously from June to November 2000 using a computer-assisted telephone interview (CATI) system. The variables of interest included demographics; participation in leisure-time physical activity; general access to places for physical activity; and neighborhood characteristics (sidewalks, trails, streetlights, unattended dogs, and safety from crime).

### Sample

**Study Population.** Noninstitutionalized adult (age 18 or older) residents of Cabarrus, Henderson, Pitt, Robeson, Surry, and Wake counties, NC, formed the study population. Henderson and Surry counties are in the western mountain region of NC, Cabarrus and Wake are in the central piedmont region, and Pitt and Robeson are in the eastern coastal plain region. The populations of these counties are quite diverse in terms of age (range county median age, 30.4–42.7 years)<sup>12</sup>; income (range county median annual family income, \$36,900–\$71,300)<sup>13</sup>; education (range county percentage high school graduates, 57.05%–85.36%; percentage college graduates, 9.38%–35.28%)<sup>13</sup>; population density (range county population density, 134.2–809.7 persons per square mile)<sup>13</sup>; and race (range percentage county population White, 32.8%–92.5%; percentage Black, 3.1%–33.6%).<sup>12</sup> The population of one of the counties is 38% American Indian.<sup>12</sup> Each of these counties is the Lead CVH County for one of six NC CVH Program implementation regions; these Lead CVH Counties are funded by the NC CVH Program to implement interventions that will improve cardiovascular health in their counties and regions. The NC CVH Program is funded by the Centers for Disease Control and Prevention and focuses on creating environmental and policy change to prevent heart disease and stroke.

**Sampling.** A randomly generated sample of 9000 residential household

phone numbers, estimated to yield approximately 300 interviews per county, were obtained from a market research company. Based on the white-page listings and a screener question related to county of residence, households known to be outside of the six counties were eliminated from the sample. One adult was randomly chosen to be interviewed from each household. The Behavioral Risk Factor Surveillance System (BRFSS) calling protocol was used; up to 15 call attempts were made for each sampled phone number, distributed across weekday, weeknight, and weekend attempts.<sup>14</sup>

**Response.** The response rate, as calculated by the method used for the BRFSS,<sup>15</sup> was 57% overall, with a range of 51% to 65% across the six counties. This response rate reflects both the amount of cooperation among the eligible respondents contacted and the efficiency of the telephone sampling, and was similar to the 2000 NC BRFSS response rate of 59% and the 2000 BRFSS median of 49% across all states.<sup>15</sup> Equivalent numbers of completed interviews were obtained in each county: 302 in Cabarrus, 307 in Henderson, 303 in Pitt, 321 in Robeson, 305 in Surry, and 341 in Wake.

### Measures

The entire NC Six-County CVH Survey was much broader than physical activity (including questions on diet, tobacco use, and other health behaviors), had a total of 133 questions, and took about 20 minutes to complete. The complete survey instrument is available at <http://www.startwithyourheart.com/resources/sixcountycvh/6cntyoc.htm>.

**Leisure-time Physical Activity.** Leisure-time physical activity during the past month was assessed through the BRFSS Exercise Module, which consists of 10 questions and has been described in detail elsewhere.<sup>7</sup> This instrument captures the type, duration, intensity, and frequency of the two leisure-time physical activities most commonly performed during the past month. Two measures of physical activity were created: (1) any ac-

tivity, and (2) recommended activity. "Any activity" was defined as engaging in any leisure-time physical activity during the past month, regardless of the number, type, frequency, duration, or intensity of activities. "Recommended activity" was defined as engaging in moderate-intensity leisure-time physical activity for at least 30 minutes per session on 5 or more days of the week, or engaging in vigorous-intensity leisure-time physical activity for at least 20 minutes per session on 3 or more days of the week.<sup>7</sup> Several studies have assessed the reliability of the BRFSS exercise module and have reported generally acceptable reliability for any activity ( $\kappa$  range, .50–.77) across ethnic groups.<sup>16–18</sup> A study among U.S. women age 40 and older reported lower reliability for recommended activity ( $\kappa$  range, .26–.30) and lower reliability of this measure among black women compared with other ethnic groups.<sup>19</sup> No published studies have assessed the validity of the BRFSS exercise module itself; the instrument is similar (in that it attempts to capture frequency, duration, and intensity of leisure-time physical activities) to the Minnesota Leisure Time Physical Activity Questionnaire and the Harvard Alumni Physical Activity Questionnaire, both of which have been found to have acceptable validity.<sup>20</sup>

**Place of Leisure-time Physical Activity.** Respondents who reported engaging in any leisure-time physical activity during the past month were also asked, "Where do you usually take part in this activity?" for each of the types of activity reported. Because up to two types of activity could be reported, this one question was asked either zero (if the respondent did not report any leisure-time physical activity), one, or two times for a given respondent, corresponding to the number of activities reported by the respondent. Responses to this open-ended question were grouped into the following categories: streets or roads (including sidewalks); home (indoors or in yard); private recreational facility, club, or gym; workplace recreational facility or gym; public park; other public recreational

facility; school facility or grounds; greenway or other walking/jogging/biking trail; golf course; shopping mall; facility or grounds at place of worship; or some other place. This measure was not an indicator of access to these facilities; it was only an indicator of places usually used for activity among those who were active. Reliability and validity of this measure have not been assessed.

**Neighborhood Characteristics.** Using questions developed by Sallis et al.,<sup>21</sup> respondents were asked whether their neighborhood had sidewalks, heavy traffic, streetlights, and unattended dogs; using the same format, a question was added on the presence of trails. Respondents were asked, "Please indicate which of the following apply to your neighborhood. Do you have sidewalks? Do you have walking, jogging, or biking trails? Do you have heavy traffic? Do you have streetlights? Do you have unattended dogs?" with response options of "yes" or "no" for each of the five items. One published study examined the reliability of these same sidewalk, heavy traffic, streetlight, and unattended dog questions and found at least substantial agreement for each (item,  $\kappa$ : sidewalks, .84; heavy traffic, .64; streetlights, .72; unattended dogs, .60).<sup>19</sup> A recently published study examining reliability of similar questions also found substantial agreement (item,  $\rho$ : sidewalks, .74; traffic, .69; street lighting, .73; unattended dogs, .69).<sup>22</sup> This study also attempted to assess validity by comparing the perceptions of these neighborhood items with objective measures, and found fair agreement for the sidewalks question ( $\kappa$ , .37); slight agreement for the street lighting question ( $\kappa$ , .19); and poor agreement for the unattended dogs ( $\kappa$ ,  $-.02$ ) and traffic ( $\kappa$ , .02) questions.<sup>22</sup> The authors, however, acknowledged that difficulties in obtaining objective measures for unattended dogs and traffic might have impaired the study's ability to fairly assess validity of those questions. No reports have been published on the reliability or validity of the neighborhood trails item to our knowledge.

Neighborhood safety from crime

was assessed through one question, "How safe from crime would you consider your neighborhood to be?" with the response options of "extremely safe," "quite safe," "slightly safe," and "not at all safe."<sup>23</sup> This measure was collapsed into two categories, "extremely or quite safe" and "slightly or not at all safe," for the logistic regression analysis. This question has been used on the BRFSS, but only recently has reliability and validity information been available. Two recent studies have examined reliability of the measure. One, conducted among diverse groups of women across the United States, found at least moderate reliability (intraclass correlation coefficient range: .49–.89) across seven of the eight race/ethnicity-site groups of women; in one group of women (Chicago Latinas), the reliability was fair (intraclass correlation coefficient, .20).<sup>24</sup> The other study also reported moderate reliability of this measure ( $\rho$ , .58) among adults in a southeastern U.S. county.<sup>22</sup> This study also assessed validity of the question by comparing responses to neighborhood crime data and reported fair agreement ( $\kappa$ , .22) between the two measures.<sup>22</sup>

**General Access to Places for Physical Activity.** Access to places for physical activity was assessed through a two-part question, which was developed by Brownson et al,<sup>25</sup> "Do you have access to places to be physically active?" Respondents who replied "yes" were asked "Are these places indoor, outdoor, or both?" The response options were "yes, both indoor and outdoor"; "yes, indoor only"; "yes, outdoor only"; and "no." This measure was collapsed into two categories, "yes" (both indoor and outdoor, indoor only, and outdoor only) and "no" for the logistic regression analysis. A recent study assessed reliability of this measure (as collapsed into a dichotomous yes/no variable) among diverse groups of women across the United States and found at least moderate reliability (intraclass correlation coefficient range, .48–.92) across seven of the eight race/ethnicity site groups of women; in one group of women



(African-Americans in Maryland), the reliability was fair (intraclass correlation coefficient, .34).<sup>24</sup> There have been no published reports of the validity of this measure to our knowledge. Although the neighborhood characteristics questions attempt to assess the suitability of the neighborhood environment for physical activity, this measure is an attempt to more globally assess access to suitable outdoor or indoor places for physical activity. These places may be anywhere (a workplace, community center or park, school, etc.), not just in the neighborhood of residence.

**Demographics.** Information on age (in years); race; sex; annual household income (categorized as <\$20,000, \$20,000–49,999, and \$50,000+); and education (categorized as less than high school, high school, some college, and college graduate) was collected using the 2001 BRFSS demographics module. Respondents were allowed to report more than one race group. Respondents who reported more than one race group ( $n = 19$ ) were asked “Which one of these groups would you say best represents your race?” and that response was used as the race group for this analysis.

### Statistical Analyses

Eighty-three respondents were excluded because of missing data on variables needed to calculate recommended physical activity, leaving data on 1796 respondents available for this analysis. Data were weighted to account for nonresponse and to reflect the adult population of the six counties in terms of age, race, and sex distribution. SAS 8.1<sup>26</sup> and SAS-callable SUDAAN 8.0<sup>27</sup> were used for all analyses. The  $\chi^2$  test was used to assess potential associations between environmental factors, demographics, and leisure activity. Unconditional logistic regression, with any activity and recommended activity as the dependent variables, was used to calculate the unadjusted ORs and their 95% CIs for each environmental and demographic variable. Separate multivariable logistic regression models were formed for the two outcomes any activity and recommended activity.

All environmental variables were placed in the model along with sex, age (as a continuous variable), race, and education to create a “full model.” The “final models” were generated using the stepwise backward elimination approach, with a  $p$ -value greater than or equal to .10 required for removal. Multivariable models were limited to the 1701 participants with complete data on all the environmental variables, sex, age, race, and education; those who reported a race other than White, Black, or American Indian were excluded for the multivariable models because there were too few ( $n = 34$ ) to allow meaningful conclusions about these groups.

### RESULTS

Table 1 shows that nearly three quarters of the population had engaged in any leisure-time physical activity during the past month, and one quarter had engaged in the recommended level of physical activity. Physical activity patterns varied by certain sociodemographic characteristics and environmental factors (Table 1). American Indian respondents were significantly less likely to engage in any activity compared with White respondents and slightly less likely (not statistically significant) to engage in any activity compared with Black respondents. Both American Indian and Black respondents were significantly less likely to engage in recommended activity than Whites. The percentage reporting any activity increased with increasing education level and with increasing annual household income. The percentage engaging in recommended activity was generally higher in higher education groups and increased with increasing annual household income. Age and sex were not significantly associated with any activity or recommended activity. Those who reported access to both indoor and outdoor places for physical activity were more likely to engage in any activity and in recommended activity than those who reported no access to places for activity. Having neighborhood trails and streetlights were both positively associated with engaging in any activity.

Those with neighborhood trails were also slightly more likely to engage in recommended activity. Those with neighborhood sidewalks were slightly more likely ( $p < .10$ ) to engage in any activity than those without sidewalks. Although the percentage engaging in both any activity and recommended activity appeared to increase with increasing neighborhood safety, this was not statistically significant.

Table 2 is a simple frequency of the places usually used for physical activity among those who reported any type of leisure-time physical activity during the past month ( $N = 1214$ ; respondents who did not report activity were not asked about location of activity). The most commonly reported place for activity was on streets or roads (41.7%), closely followed by the respondent's home (37.6%). Other commonly used places included private gyms (10.5%), workplace facilities (9.6%), and public parks (8.6%).

Environmental factors were associated with many of the sociodemographic characteristics (Table 3). Men were more likely than women to report having access to places for physical activity (either indoor, outdoor, or both), less likely to report heavy traffic, and somewhat less likely to report unattended dogs. The percentage reporting access to places for physical activity declined with age, as did the percentage reporting sidewalks. American Indian respondents were less likely to report having sidewalks, streetlights, and access to places for physical activity, and more likely to report unattended dogs compared with Whites and Blacks. Black respondents were more likely to report sidewalks and streetlights than Whites. American Indian and Black respondents were also more likely than Whites to report that their neighborhood was slightly or not at all safe. Access to places for physical activity, sidewalks, trails, and streetlights generally increased with increasing education, and the percentage reporting unattended dogs was lowest in the highest education group. Access to physical activity places and trails increased with increasing income; in the highest in-

Table 1

Population Distributions of Any Activity and Recommended Activity by Selected Sociodemographic and Environmental Factors, North Carolina Six-County Adults†

Sociodemographic and Environmental Factors	Population		Any Activity			Recommended Activity		
	n	%	n	%	SE	n	%	SE
Total	1796	100.0	1214	72.0	1.64	428	25.6	1.61
Sex								
Female	1116	52.1	734	70.3	2.15	256	24.0	1.92
Male	680	47.9	480	74.0	2.50	172	27.2	2.63
Age group (years)								
18–29	330	23.3	250	74.2	4.09	67	23.6	4.00
30–44	542	33.2	368	74.1	2.62	113	23.3	2.72
45–64	564	28.5	386	71.7	2.83	139	25.2	2.67
65+	360	15.0	210	64.8	4.03	109	34.4	3.88
Race group				***			****	
White	1363	74.0	948	73.3	1.85	366	29.1	1.92
Black	274	17.8	174	70.4	4.38	38	16.3	3.60
American Indian	119	4.1	63	51.3	5.83	18	14.0	4.48
Other	34	4.1	27	80.0	9.17	5	13.7	6.77
Education level				****			**	
Less than high school	282	10.3	138	50.7	4.50	49	20.4	4.58
High school or GED	538	26.8	314	62.6	3.57	106	20.2	2.80
Some college	433	23.2	317	77.2	3.12	120	31.7	3.68
College graduate	536	39.6	442	81.2	2.48	153	27.2	2.60
Annual household income				****			****	
<\$20,000	348	15.8	183	59.8	4.24	59	16.7	2.74
\$20,000–49,999	678	40.4	470	69.2	2.89	161	25.9	2.67
\$50,000+	466	43.9	376	82.5	2.38	139	30.9	3.12
Sidewalks				*				
No	1300	60.6	862	69.5	1.99	302	24.4	1.78
Yes	495	39.4	351	75.9	2.82	125	27.4	3.03
Trails				**			*	
No	1426	74.8	946	70.3	1.94	330	23.8	1.75
Yes	361	25.2	265	77.8	3.00	97	31.3	3.71
Heavy traffic								
No	1064	61.4	739	71.7	2.21	263	23.9	2.01
Yes	729	38.6	472	72.5	2.39	164	28.1	2.66
Streetlights				****				
No	676	26.8	426	64.7	2.73	153	24.7	2.44
Yes	1115	73.2	784	74.7	2.00	273	25.9	2.02
Unattended dogs								
No	1096	68.5	750	73.9	1.93	271	26.8	2.08
Yes	688	31.5	457	67.9	3.05	154	23.0	2.41
Safety of neighborhood								
Not at all safe	39	1.5	22	64.0	10.36	6	15.3	7.64
Slightly safe	220	10.8	130	69.9	4.45	36	21.7	5.61
Quite safe	1056	61.1	714	70.6	2.22	255	26.4	2.11
Extremely safe	463	26.6	339	76.6	3.01	129	26.1	2.89
Access to places for physical activity				****			****	
No	281	11.5	139	48.9	4.68	38	13.6	3.13
Yes, outdoor only	286	15.5	186	66.4	4.75	69	23.0	3.85
Yes, indoor only	79	4.2	49	71.1	7.64	19	33.5	8.14
Yes, both indoor and outdoor	1141	68.7	838	77.2	1.85	302	27.7	2.04

† All percents were weighted. Percent may not add to 100 because of rounding. Sample sizes may not add to 1796 because of missing data for some factors. n = sample size; SE = standard error.

\*  $p < 0.10$ .

\*\*  $p < 0.05$ .

\*\*\*  $p < 0.01$ .

\*\*\*\*  $p < 0.005$ .

\*\*\*\*\*  $p < 0.001$ .

**Table 2**

**Reported Places Used for Physical Activity Among the 1214 Participants Who Reported Engaging in Leisure-time Physical Activity During the Previous Month, North Carolina Six-County Adults\***

Place of Leisure-time Physical Activity	n	%	SE
Street or roads (including sidewalks)	468	41.7	2.13
Home (indoors or in yard)	508	37.6	2.04
Private recreational facility, club, or gym	106	10.5	1.40
Workplace recreational facility or gym	98	9.6	1.49
Public park	97	8.6	1.34
Other public recreational facility	54	3.8	0.69
School facility or grounds	39	2.8	0.75
Greenway or other walking/jogging/biking trail	30	2.7	0.72
Golf course	15	1.4	0.51
Shopping mall	24	1.1	0.28
Facility or grounds at place of worship	8	0.9	0.46
Some other place	74	6.0	1.00

\* Percents do not add to 100 since respondents could list up to two places of activity. n = total number; SE = standard error. Respondents who did not report engaging in leisure-time physical activity during the previous month were not asked about place of leisure-time physical activity.

come group, the percentage reporting heavy traffic was lowest, and the percentage reporting streetlights was highest. The percentage reporting their neighborhood was slightly or not at all safe declined both with increasing education and increasing income.

After adjusting for age, sex, race, education, and all environmental factors, the presence of sidewalks, trails, and streetlights (which were associated with any activity before adjusting for other factors) were no longer associated with any activity. Only access to places for physical activity and education remained in the final model, with ORs similar to those in the full model (Table 4). There was no evidence of confounding by any variables removed from the final model; the beta coefficients and ORs for all factors remained essentially the same with removal of each variable (data not shown). Adding income to the full model (N = 1430) resulted in little change in the model (data not shown). The OR (95% CI) for those with an annual household income of \$20,000 to \$49,999 (with income <\$20,000 as the reference group) was 1.29 (.80, 2.09), and for those with an income of \$50,000+ was 1.77 (1.02, 3.06), after adjusting for all other variables in the full model.

Both access to places for physical activity (1.66 [1.02, 2.70]) and education (less than high school [reference group]; high school or GED, 1.18 [.69, 2.02]; some college, 1.93 [1.10, 3.37]; college graduate, 2.45 [1.33, 4.51]) remained significantly associated with any activity after the inclusion of income in the full model.

Access to places for physical activity remained positively associated with recommended activity, and trails and heavy traffic were slightly associated, after adjusting for the other environmental variables, age, race, sex, and education in the full model (Table 5). Age was also slightly positively associated with recommended activity, and Black and American Indian race were negatively associated with recommended activity in the full logistic model. Trails, access to places for physical activity, age, and race all remained in the final model with ORs similar to those of the full model. There was no evidence of confounding by any variable removed from the model. Adding income (N = 1430) changed the full model only slightly. The OR (95% CI) for those with an annual household income of \$20,000 to \$49,999 (with income <\$20,000 as the reference group) was 1.99 (1.18, 3.37), and for those with an in-

come of \$50,000+ was 2.09 (1.10, 3.98), after adjusting for all other variables in the full model. Access to places for activity (2.06 [1.10, 3.84]); race (White [reference group]; Black, .49 [.27, .89]; American Indian, .51 [.22, 1.17]); and age (1.01 [1.00, 1.03]) remained significantly associated with recommended activity after adding income, and the OR for trails remained similar (1.50 [.92, 2.43]).

**DISCUSSION**

This study investigated whether neighborhood characteristics and access to places for physical activity were associated with leisure activity in a diverse population of adults living in six NC counties. Although neighborhood sidewalks, trails, and streetlights were positively associated with engaging in any leisure activity, these associations did not remain statistically significant after adjusting for socio-demographic and other environmental factors. Neighborhood trails were also positively associated with engaging in the recommended amount of activity, even after adjusting for socio-demographic and other environmental factors. General access to places for physical activity was consistently associated with both any activity and with recommended activity, even after adjustment for sociodemographic factors and neighborhood environmental characteristics. These findings suggest that neighborhood environmental characteristics, particularly trails, and general access to places for physical activity may play a role in leisure activity patterns.

The levels of leisure activity reported in this population were very similar to those reported among the U.S. population; 72% of NC six-county adults engaged in any leisure activity compared with 71% of U.S. adults, and 26% of NC six-county adults engaged in the recommended amount of activity compared with 25% of U.S. adults.<sup>7</sup> The proportion reporting the presence of neighborhood characteristics were similar to two other reports,<sup>25,28</sup> with two exceptions. Among six-county adults, only 39% reported sidewalks in their neighborhood, much lower than the

Table 3

Neighborhood Characteristics and Access to Places for Physical Activity by Selected Sociodemographic Factors, North Carolina Six-County Adults

Sociodemographic Factors	Sidewalks			Trails			Heavy Traffic			Streetlights		
	n	%	SE	n	%	SE	n	%	SE	n	%	SE
Sex												
Male	680	40.8	2.92	677	27.1	2.64	680	34.3	2.70	680	73.1	2.18
Female	1115	38.1	2.30	1110	23.4	2.00	1113	42.6	2.26	1111	73.4	1.75
Age group (years)		****			*							
18–29	330	54.6	4.21	330	23.9	3.68	330	35.1	4.12	329	76.7	3.16
30–44	542	41.0	3.18	538	31.3	3.09	541	36.1	3.00	539	75.4	2.44
45–64	564	31.7	3.10	561	21.8	2.70	564	40.3	3.07	564	70.9	2.45
65+	359	27.1	3.97	358	20.0	3.59	358	46.3	4.11	359	67.5	3.45
Race group		****			****						****	
White	1362	35.2	2.07	1355	23.8	1.86	1360	37.6	1.99	1358	71.5	1.64
Black	274	58.7	4.47	273	32.1	4.41	274	43.9	4.64	274	86.4	2.56
American Indian	119	19.3	5.85	119	21.8	5.46	119	41.2	5.74	119	39.1	5.97
Other	34	50.2	11.42	34	20.2	8.98	34	29.2	9.85	34	79.7	7.66
Education level		**			****						****	
<High school	282	28.9	4.79	278	16.0	3.15	282	48.8	4.54	282	61.8	4.02
High school or GED	537	34.8	3.75	535	21.2	2.83	536	38.4	3.45	536	67.1	3.02
Some college	433	45.0	3.82	432	20.3	3.28	432	38.0	3.58	433	76.1	2.55
College graduate	536	42.0	3.02	535	33.0	2.95	536	36.4	2.86	533	78.5	2.26
Annual household income					****				**		****	
<\$20,000	347	38.9	4.66	346	10.8	2.16	347	43.1	4.15	346	69.1	3.53
\$20,000–49,999	678	37.9	3.01	674	22.6	2.59	678	43.5	2.90	676	67.2	2.55
\$50,000+	466	39.7	3.31	466	33.4	3.24	466	31.1	3.03	466	78.7	2.27

† Access to either indoor only, outdoor only, or both indoor and outdoor places.

\*  $p < 0.10$ .

\*\*  $p < 0.05$ .

\*\*\*  $p < 0.01$ .

\*\*\*\*  $p < 0.005$ .

\*\*\*\*\*  $p < 0.001$ .

60% or more reported in a survey of U.S. adults<sup>25</sup> and more similar to the 44% reported in a survey of U.S. women age 40 or older.<sup>28</sup> Also, 73% of NC six-county adults reported streetlights, higher than the 55% reported among U.S. women<sup>28</sup> and more similar to the approximately 75% reported among U.S. adults.<sup>25</sup>

Several other reports have examined similar environmental factors and their association with leisure activity, with varying results. In 1997, Sallis et al.<sup>21</sup> found no correlation between the eight-item neighborhood features scale they developed and leisure activity; they did not report the association of leisure activity with individual items in the scale. Since then, several other researchers have used this scale and examined its components.<sup>25,28,29</sup> We examined four

of these items: sidewalks, heavy traffic, streetlights, and unattended dogs. We also added neighborhood trails in the same question format, and used the BRFSS neighborhood safety question,<sup>23</sup> which is a bit more detailed, in place of the high crime item. We did not attempt to create a scale because of the sometimes counterintuitive findings of previous reports. For example, both unattended dogs and heavy traffic, items expected to be negatively associated with physical activity, have each been found to be positively associated with physical activity in one study.<sup>25,28</sup>

In our study, those reporting neighborhood sidewalks were only slightly more likely to engage in any activity, and this association did not remain after adjusting for other factors; sidewalks were not associated

with recommended activity. The presence of sidewalks was not correlated with physical activity among either rural or urban U.S. women,<sup>28,29</sup> but was associated with recommended activity among a national sample of U.S. adults,<sup>25</sup> even after adjusting for sociodemographics. Other studies found no association between streetlights and physical activity<sup>25,28,29</sup>; the NC six-county adults reporting neighborhood streetlights were more likely to engage in any activity, but this association did not remain after adjusting for sociodemographic and other environmental factors.

We found no association between unattended dogs and leisure activity, and only a weak positive association between heavy traffic and recommended activity, after adjusting for other factors. King et al.<sup>28</sup> reported

**Table 3**  
**Extended**

Unattended Dogs			Slightly or Not at All Safe			Access to Places for Activity†		
n	%	SE	n	%	SE	n	%	SE
	*						****	
678	28.5	2.43	676	11.9	1.89	675	91.9	1.12
1106	34.2	2.18	1102	12.7	1.49	1112	85.4	1.65
							****	
328	30.8	3.91	329	19.0	3.80	330	93.8	1.55
541	31.3	2.83	540	11.0	1.55	539	91.6	1.37
561	31.3	2.69	559	10.1	1.66	561	87.1	1.94
354	33.4	4.17	350	9.0	2.02	357	75.7	3.88
	*			**			****	
1351	32.0	1.87	1349	10.6	1.21	1355	89.9	1.03
274	27.2	4.08	270	18.8	3.79	273	85.8	3.59
119	44.2	5.59	119	18.3	3.55	119	72.3	4.62
34	28.6	10.78	34	10.7	9.30	34	90.7	4.06
	**			****			****	
276	34.5	4.17	277	22.0	4.84	280	70.4	3.69
535	37.1	3.49	528	15.1	2.57	531	84.4	2.61
432	35.0	3.45	432	13.0	2.52	433	89.8	1.94
534	25.0	2.47	534	7.5	1.40	536	95.0	1.16
	*			****			****	
343	33.2	3.74	341	20.7	3.40	347	76.2	3.17
675	35.3	2.80	671	14.5	1.96	673	86.2	2.18
466	26.3	2.68	465	5.7	1.62	466	96.0	1.01

that unattended dogs were positively associated with activity among U.S. women, and Brownson et al.<sup>25</sup> found that heavy traffic was positively associated with activity among U.S. adults. These counterintuitive findings point out the complexity of assessing neighborhood environmental characteristics and their influence on physical activity. These findings may have been due to chance alone, to other unmeasured confounders (such as rural/urban residence), or to an effect of physical activity on peoples' perceptions of their environment. Those who are more physically active in their neighborhood may be more likely to notice heavy traffic or unattended dogs. Other studies have not found associations between heavy traffic or unattended dogs and activity.<sup>25,28,29</sup>

The original neighborhood features scale developed by Sallis et al.<sup>21</sup> did not include neighborhood trails, but three other studies have suggested a positive association between

trails and physical activity. Among adults in rural Missouri, regular walkers were more likely to use trails than those who did not walk regularly.<sup>31</sup> In another study, those living closer to a Boston-area rail-trail were more likely to have used it for activity during the previous 4 weeks than those who lived farther away.<sup>32</sup> Among lower income urban and suburban U.S. adults, having access to trails was found to be positively associated with meeting recommended levels of physical activity.<sup>30</sup> Our findings, that neighborhood trails were positively associated with any leisure activity (although not after adjusting for other factors) and with recommended activity (even after adjusting for other factors), are consistent with those previous findings. Only 2.7% of those who engaged in leisure-time physical activity during the past month reported that they usually used a trail for this activity, however. Having a trail in a neighborhood may be correlated with other factors not mea-

sured here that are associated with activity (such as a nearby park or other community facility). Future studies focusing on relationships between the presence and use of trails and physical activity levels, particularly prospective intervention studies examining activity before and after the creation of trails, would be helpful.

Lower levels of perceived neighborhood safety have previously been reported to be associated with lower levels of any leisure activity.<sup>23</sup> In contrast, we found no statistically significant association between neighborhood safety and leisure activity. The previous study, however, had a much larger sample size (N = 12,767)<sup>23</sup> than our study, which may be required given the small percentage of individuals reporting their neighborhood as "not at all safe" using this scale. Studies that have used the high crime item from the neighborhood features scale have not found a relationship between high crime and activity.<sup>25,28,29</sup>

Among the environmental factors, the general access to places for physical activity measure was most consistently related to leisure activity in this study. Those who reported access to places for physical activity (either indoor or outdoor) were nearly twice as likely to engage in any activity and were twice as likely to engage in recommended activity compared with those who reported no access after adjusting for all sociodemographic and neighborhood environmental measures. Access to places for physical activity has previously been reported to be associated with recommended activity among U.S. adults.<sup>25</sup> Unfortunately, this more general measure of access may not be specific enough to provide direction to public health practitioners on how best to intervene and increase access. This measure may appear to be more strongly associated with activity simply because it provides a more global indicator of whether or not an individual has access to suitable places for physical activity, whether in their neighborhood or not. Another possibility is that those who are physically active may be more likely to perceive that they have access to facilities for physical activity than those who are



**Table 4**

**Odds Ratios (OR) and 95% Confidence Intervals (CI) From Logistic Regression Models for Any Activity, North Carolina Six-County Adults**

Variable	Any Activity (N = 1701)		
	Unadjusted OR (95% CI)	Full Model† OR (95% CI)	Final Model‡ OR (95% CI)
Sidewalks			
No	1.00	1.00	—
Yes	1.42 (0.98, 2.05)*	0.99 (0.63, 1.56)	
Trails			
No	1.00	1.00	—
Yes	1.62 (1.09, 2.41)**	1.28 (0.84, 1.96)	
Heavy traffic			
No	1.00	1.00	—
Yes	1.11 (0.80, 1.55)	1.27 (0.89, 1.81)	
Streetlights			
No	1.00	1.00	—
Yes	1.57 (1.14, 2.17)***	1.21 (0.79, 1.83)	
Unattended dogs			
No	1.00	1.00	—
Yes	0.77 (0.54, 1.09)	0.96 (0.65, 1.42)	
Safety of neighborhood			
Slightly or not at all safe	1.00	1.00	—
Extremely or quite safe	1.24 (0.81, 1.91)	1.07 (0.68, 1.69)	
Access to places for physical activity			
No	1.00	1.00	1.00
Yes§	2.94 (1.91, 4.52)*****	1.94 (1.24, 3.04)***	2.23 (1.44, 3.44)*****
Sex			
Female	1.00	1.00	—
Male	1.33 (0.95, 1.86)*	1.29 (0.91, 1.84)	
Age (years)	0.99 (0.98, 1.00)	1.00 (0.99, 1.01)	—
Race group			
White	1.00	1.00	—
Black	0.81 (0.51, 1.28)	1.00 (0.60, 1.65)	
American Indian	0.37 (0.23, 0.62)*****	0.58 (0.32, 1.08)*	
Education level			
Less than high school	1.00	1.00	1.00
High school or GED	1.54 (0.96, 2.49)	1.38 (0.86, 2.22)	1.38 (0.86, 2.22)
Some college	3.05 (1.84, 5.06)*****	2.61 (1.57, 4.34)*****	2.64 (1.59, 4.39)*****
College graduate	4.09 (2.50, 6.67)*****	3.13 (1.82, 5.41)*****	3.35 (2.03, 5.52)*****

† The full model included the following variables: sidewalks, trails, heavy traffic, streetlights, unattended dogs, safety of neighborhood, access to places for physical activity, sex, age in years, race group, and education level.

‡ The final model included the following variables: access to places for physical activity and education level.

§ Access to either indoor only, outdoor only, or both indoor and outdoor places.

\*  $p < 0.10$ .

\*\*  $p < 0.05$ .

\*\*\*  $p < 0.01$ .

\*\*\*\*  $p < 0.005$ .

\*\*\*\*\*  $p < 0.001$ .

not active, even if they all in fact have the same level of access.

Among those who reported any activity, streets and roads (including

sidewalks) were most frequently reported as the place where that activity was done. This was consistent with a national survey reporting that

64.5% of those who reported any activity used neighborhood streets for that activity.<sup>25</sup> These findings illustrate the importance of streets as

**Table 5**

**Odds Ratios (OR) and 95% Confidence Intervals (CI) From Logistic Regression Models for Recommended Activity, North Carolina Six-County Adults**

Variable	Recommended Activity (N = 1701)		
	Unadjusted OR (95% CI)	Full Model† OR (95% CI)	Final Model‡ OR (95% CI)
Sidewalks			
No	1.00	1.00	—
Yes	1.21 (0.84, 1.74)	1.12 (0.74, 1.70)	
Trails			
No	1.00	1.00	1.00
Yes	1.49 (1.00, 2.22)**	1.46 (0.95, 2.25)*	1.51 (1.00, 2.28)**
Heavy traffic			
No	1.00	1.00	—
Yes	1.25 (0.88, 1.76)	1.35 (0.95, 1.93)*	
Streetlights			
No	1.00	1.00	—
Yes	1.06 (0.76, 1.48)	0.92 (0.63, 1.34)	
Unattended dogs			
No	1.00	1.00	—
Yes	0.77 (0.54, 1.09)	0.84 (0.59, 1.20)	
Safety of neighborhood			
Slightly or not at all safe	1.00	1.00	—
Extremely or quite safe	1.28 (0.69, 2.39)	1.13 (0.61, 2.09)	
Access to places for physical activity			
No	1.00	1.00	1.00
Yes§	2.28 (1.30, 4.00)****	2.10 (1.19, 3.69)**	2.15 (1.23, 3.77)***
Sex			
Female	1.00	1.00	—
Male	1.13 (0.81, 1.59)	1.12 (0.80, 1.59)	
Age (in years)	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)**	1.01 (1.00, 1.02)*
Race group			
White	1.00	1.00	1.00
Black	0.45 (0.26, 0.80)***	0.45 (0.26, 0.79)***	0.46 (0.27, 0.81)***
American Indian	0.39 (0.18, 0.82)**	0.45 (0.20, 0.98)**	0.45 (0.21, 0.96)**
Education level			
Less than high school	1.00	1.00	—
High school or GED	0.92 (0.48, 1.79)	0.90 (0.45, 1.82)	
Some college	1.68 (0.87, 3.23)	1.60 (0.77, 3.31)	
College graduate	1.42 (0.76, 2.63)	1.02 (0.51, 2.05)	

† The full model included the following variables: sidewalks, trails, heavy traffic, streetlights, unattended dogs, safety of neighborhood, access to places for physical activity, sex, age in years, race group, and education level.

‡ The final model included the following variables: trails, access to places for physical activity, age in years, and race group.

§ Access to either indoor only, outdoor only, or both indoor and outdoor places.

\*  $p < 0.10$ .

\*\*  $p < 0.05$ .

\*\*\*  $p < 0.01$ .

\*\*\*\*  $p < 0.005$ .

\*\*\*\*\*  $p < 0.001$ .

physical activity “facilities,” and the importance of continuing to focus research and interventions on the characteristics of streetscapes that enhance both leisure and transportation activity.

The relationships between race, socioeconomic status, neighborhood environments, and physical activity are likely to be extremely complex and have so far not been clearly described. Physical activity levels in the United States are generally lower among those with less education and a lower income and among Blacks and Hispanics.<sup>1</sup> Socioeconomic status and race have also been reported by some studies to be associated with perceived neighborhood environment and access to places for physical activity.<sup>21,25,28</sup> Our findings, that neighborhood environmental factors and access to places for physical activity were associated with race, education, and income, with generally more favorable environments and greater access reported among Whites and those with more education and a higher income, are consistent with these previous reports.

What is not clear is how these factors—race, socioeconomic status, physical activity, and environmental factors—interrelate. Do socioeconomic status or race determine, to any extent, neighborhood environments and thereby influence physical activity? Socioeconomic status may dictate which neighborhoods are available to an individual to reside in, and what features, amenities, or barriers are present in those neighborhoods. Socioeconomic status may also determine mobility outside the neighborhood of residence and access to other facilities for physical activity. If this is the case, adjusting for race and socioeconomic status in multivariable models to examine the relationship between physical activity and the environment may actually be overadjustment; we may be adjusting out the very effect we are trying to measure. We have chosen to present both unadjusted and adjusted ORs to show the association between perceived environmental factors and physical activity both before and after adjusting for race, socioeconomic status, and other demographic factors. Studies

that examine these complex relationships between socioeconomic status, environment, and physical activity much more closely are needed to address these issues and guide future analyses. The findings of a recent study that did examine these interrelationships suggest that the association between environmental factors (access to certain places for physical activity) and physical activity may actually differ by income level and urban/rural residence.<sup>30</sup>

### Limitations

This study was subject to several limitations. Since it was a cross-sectional survey, causal relationships cannot be inferred. Second, as this was a phone survey, all data were self-reported. The BRFSS questions only assess leisure activity and do not capture other types of physical activity, such as transportation activity, that may be influenced by the neighborhood environment. Certain types of activity may be more strongly related to certain environmental factors than others; for instance, transportation activity may be more dependent than leisure activity upon the availability of sidewalks. In addition, neighborhood environments that promote walking and biking may potentially increase transportation activity, which could in turn potentially decrease leisure activity because individuals may see less need and have less time for leisure activity. Research into the relationship of environmental factors with different types of activity would begin to answer some of these questions.

Our survey assessed self-reported perceptions of the neighborhood environment and did not include objective measures of the environment. The validity of these perceived environmental measures is largely unknown. Few published studies have examined the correlation between any perceived and objective measures of the environment<sup>11</sup>; one study that did found a significant correlation between perceived and objectively measured distances to a rail trail.<sup>32</sup> A recently published study that compared perceptions of environments at the neighborhood and the larger community levels with objective environmental measures found generally

lower agreement between perceptions and objective measures at the community level compared with the neighborhood level.<sup>22</sup> This study reported that agreement was fair for neighborhood sidewalks and safety, slight for adequate street lighting and traffic, and poor for unattended dogs. The accuracy of some of the “objective” measures of the environment that have been used to validate perceptions has not been established, however, and some of the available objective measures, such as the number of dogs reported to Animal Control, may not provide a good estimate of the true environment. Further study of the validity and reliability of perceived and objective environmental measures would considerably advance the methods required for further research on the relationship between the environment and physical activity.

This survey was conducted among adults living in six NC counties, and so results may not be generalizable to all NC or U.S. adults. The prevalence of any activity and recommended activity in this NC population were strikingly similar to those reported in the general U.S. population, however.<sup>7</sup> Although our survey collected information on income, a large number of respondents refused to provide this information, impairing our ability to adequately assess the effect of income on environmental factors and leisure activity. Certain groups may be underrepresented in phone surveys, particularly those without household phones, who are typically of lower socioeconomic status. Finally, our survey collected information on a limited number of neighborhood characteristics; there may be other neighborhood characteristics associated with leisure activity that we did not assess.

### Conclusions

This population-based survey of a diverse population of NC adults found that perceptions of certain neighborhood characteristics, particularly the presence of trails, and general access to places for physical activity were positively associated with self-reported leisure-time physical activity. Neighborhood environmental

characteristics and access to places for physical activity were strongly associated with race, education, and income, with generally less favorable environments and less access reported among Blacks and American Indians and among those with less education and a lower income. Streets and roads (including sidewalks) were the most commonly reported places used

### SO WHAT? Implications for Health Promotion Practitioners and Researchers

This study seems to indicate that the perceived presence of neighborhood trails and general access to places for physical activity may be positively associated with leisure-time physical activity. Combined with other research, there seems to be preliminary support for the assertion that the presence of trails may increase physical activity levels, and moderate support for the assertion that increasing general access to places for physical activity may increase physical activity levels. If these assertions hold true, practitioners seeking to improve physical activity levels in communities should consider interventions that improve access to places for physical activity and that create multiuse trails. In addition, if these assertions hold true, researchers should focus future efforts on determining whether (and under what conditions) creation of multiuse trails increases physical activity levels, and determining which specific components of access to places for physical activity are most important in influencing physical activity levels.

for physical activity, illustrating the importance of streets as physical activity "facilities" and the importance of continuing to focus research and interventions on the characteristics of streetscapes that support physical activity. Further research on the complex relationships between community (and neighborhood) environmental factors and physical activity is needed to guide effective public

health interventions that will improve physical activity levels in the United States.

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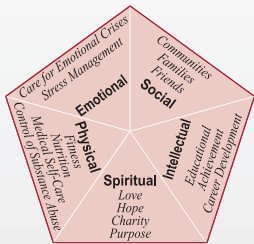
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