

# Environmental and Policy Determinants of Physical Activity in the United States

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Physical activity is an important public health issue that has received increasing attention in recent years.<sup>1,2</sup> The goal of increasing physical activity in the United States is one of 10 “leading indicator” areas described in *Healthy People 2010*.<sup>3</sup> Despite the known health benefits of physical activity, approximately one quarter of the American population remain completely inactive, and leisure-time inactivity is up to 3-fold more common in lower income than higher-income populations.<sup>2</sup>

To help in achieving public health goals related to physical activity, environmental and policy strategies are aimed at changing the physical and sociopolitical environments.<sup>4</sup> Environmental and policy approaches may be especially indicated as a complement to more frequently used individual behavior and lifestyle modification strategies, because they can benefit all people exposed to the environment rather than focusing on changing the behavior of one person at a time.<sup>4–6</sup> Strategies often include providing access to facilities and programs not currently available and supporting social environments that favor activity. Examples of environmental and policy approaches designed to increase physical activity include walking and bicycle trails, funding for public facilities, zoning and land use facilitating activity in neighborhoods, mall walking programs, building construction encouraging activity, policies and incentives promoting physical activity during the workday, and policies requiring comprehensive school health programs.<sup>5–8</sup>

Although such environmental and policy interventions to promote physical activity are being promoted widely,<sup>9,10</sup> there are sparse data on the patterns and effects of these approaches on a population-wide basis.<sup>2,5,6</sup> For example, in a recent review, Sallis et al.<sup>6</sup> identified only 7 published English-language studies focusing on the use of environmental and policy interventions in promoting physical activity. In particular, physical environments are the least studied type of influence

**Objectives.** This study examined (1) descriptive patterns in perceived environmental and policy determinants of physical activity and (2) associations between these factors and behavior.

**Methods.** A cross-sectional study was conducted from 1999 to 2000 among US adults; individuals at lower income levels were oversampled.

**Results.** Availability of areas for physical activity was generally higher among men than among women. The 4 most commonly reported personal barriers were lack of time, feeling too tired, obtaining enough exercise at one's job, and no motivation to exercise. Neighborhood characteristics, including the presence of sidewalks, enjoyable scenery, heavy traffic, and hills, were positively associated with physical activity. There was a high level of support for health policy-related measures. Up to one third of individuals who had used environmental supports reported an increase in physical activity.

**Conclusions.** An array of environmental and policy determinants, particularly those related to the physical environment, are associated with physical activity and should be taken into account in the design of interventions. (*Am J Public Health.* 2001;91:1995–2003)

on physical activity.<sup>11</sup> In addition, existing determinants studies are frequently restricted to a narrow population (e.g., older women, university students, or clinic patients<sup>12,13</sup>), limiting generalizability. Variations in environmental and policy determinants may help to explain some of the well-documented variations in physical activity behavior across socioeconomic strata.

In an attempt to add to the information base on environmental and policy determinants of physical activity, we recently conducted a survey among US adults (i.e., the US Physical Activity Study) that included an oversampling of lower income individuals. The main purposes were 2-fold: (1) to determine descriptive patterns in perceived environmental and policy determinants of physical activity and (2) to examine the associations between these factors and physical activity behavior.

## METHODS

### Sampling

Data were collected via telephone survey, and a modified version of the sampling plan of the Behavioral Risk Factor Surveillance System (BRFSS) was used in data collection.

These survey methods have been described in detail elsewhere<sup>14–16</sup> and are discussed only briefly here. The cross-sectional risk factor survey used a random-digit dialing technique to collect data.

As a means of obtaining a representative sample of lower income individuals, zip code areas in which 32% or more of residents were below the federal poverty level were oversampled. Once zip codes were selected, the area code–exchange combinations that were at least 70% within the zip code–defined area were determined and used as the final sample frame for this stratum. All area code–exchange combinations below the 70% criterion were eliminated from the sample frame.

The random-digit-dialed sample that was used for this project can be best characterized as a single-stage equal probability selection sample of all residential telephone numbers (including listed, unlisted, and unpublished numbers) in the defined sampling frame. The system involved a database consisting of all residential telephone exchanges, working bank information, and various geographic variables such as state, county, and zip code. In addition, the database provided working bank information at the 2-digit level; each of

the 100 banks (i.e., first 2 digits of the 4-digit suffix) in an exchange is defined as “working” if it contains 1 or more listed households with telephones. On a national basis, this definition covers an estimated 96.4% of all residential telephone numbers and 99.96% of listed residential numbers.

This database is updated on a quarterly basis. The sample frame consisted of the set of all area code–exchange combinations and their associated working banks that met the criteria listed earlier. The result was that every potential telephone number within the defined sample frame had a known and equal probability of selection. After the sample had been generated, we applied a systematic post-generation technique (GENESYS-ID) designed to purge a percentage (approximately 35%) of business and nonproductive numbers. In the course of the interviews, if contact could not be made after an initial call and 3 additional attempts, another number was selected from the primary sampling unit.

### Instrumentation and Data Collection

The survey instrument was developed through a combination of questions derived from the BRFSS, the National Health Interview Survey, and other recent surveys.<sup>7,14,15,17–21</sup> When valid and reliable scales were documented in the literature and available, every effort was made to use these scales intact. Psychometric properties of the questions and scales have been reported elsewhere.<sup>17,20,22,23</sup> In a few cases, adaptations were made from in-person to telephone administration (e.g., use of a yes–no question rather than a checklist). The final instrument contained 90 questions (including skip patterns); average administration time was 30 minutes.

Questions on perceived environmental and policy determinants took several forms and, unless otherwise noted, were asked of all respondents. These questions were grouped in broad categories, although there was considerable overlap between the categories. In regard to the physical environment, a “general access” question asked “Do you have access to places to exercise?” As a means of gaining information on “specific access” variables, individuals who engaged in some type of recreational activity were asked where they did so. Information on various neighborhood charac-

teristics was obtained via items asking respondents to indicate, through yes–no responses, whether their neighborhood had sidewalks, hills, and so forth.

Questions also focused on social factors and personal barriers. Responses to items related to friends and family (e.g., “If you had someone like a friend or family member to exercise with, chances are that you would exercise more”) were made on a 4-point scale ranging from *strongly agree* to *strongly disagree*. Respondents were asked about a series of personal barriers to being more physically active: “I am going to read you some things that interfere with or prevent you from exercising or being physically active. For each one, tell me how often it interferes or prevents you from exercising or being physically active.” For each barrier (e.g., “Others discourage me”), a 5-point scale ranging from *never* to *very often* was used.

Newly developed questions on physical activity behavior focused on moderate and vigorous physical activity in the domains of occupational physical activity, time spent in nonoccupational walking, moderate-intensity recreational activities, and vigorous-intensity recreational activities. These questions, designed to estimate compliance with new public health recommendations,<sup>1</sup> have been tested for reliability and validity.<sup>24</sup>

Interviews were completed between September 1999 and January 2000; 1818 individuals were interviewed (Table 1). Interviewers with previous experience conducted the interviews, and each underwent at least 16 hours of training. The response rate was calculated according to the method of the Council of American Survey Research Organizations and was based on the ratio of completed interviews to the sum of completed interviews, refusals, and a standard fraction of numbers that were working but either rang with no answer or were busy after multiple attempts.<sup>25</sup> The response rate was 61%.

### Analyses

Data on physical activity behavior were cleaned and edited according to standard quality control procedures.<sup>15</sup> This included imputation for a small percentage of values, particularly when reported duration of activ-

**TABLE 1—Sociodemographic Characteristics of Participants in the US Physical Activity Study, 1999–2000**

Characteristic	Sample, No. (%)	US Census, % <sup>a</sup>
<b>Sex</b>		
Female	1220 (67.1)	51.1
Male	598 (32.9)	48.9
<b>Age group, y</b>		
18–29	487 (26.8)	21.8
30–44	548 (30.1)	31.9
45–64	479 (26.3)	29.2
65+	295 (16.2)	17.1
Missing/unknown	9 (0.5)	...
<b>Race/ethnicity</b>		
White	971 (53.4)	82.4
Black	546 (30.0)	12.8
Other	295 (16.2)	4.8
Missing/unknown	6 (0.4)	...
<b>Household income, \$</b>		
<10 000	347 (19.1)	9.2
10 000 to <20 000	548 (20.8)	14.5
20 000 to <35 000	391 (21.5)	19.6
≥35 000	502 (27.6)	56.7
Missing/unknown	200 (11.0)	...
<b>Education</b>		
Less than high school	330 (18.2)	11.6
High school	547 (30.1)	31.9
Some college	521 (28.7)	21.4
College	419 (23.0)	35.1
Missing/unknown	1 (<0.1)	...

<sup>a</sup>1999 estimated US census figures for persons 18 years or older.

ity was clearly out of range (e.g., reports of more than 8 hours per day of moderate or vigorous activity). Physical activity behavior was grouped into 1 of 3 categories: (1) moderate (5 times per week, 30 minutes per activity) or vigorous (3 times per week, 20 minutes per activity) activity (those who meet public health recommendations), (2) insufficient activity (those who do not meet the recommendation for moderate activity or vigorous activity), or (3) inactive (those reporting no moderate or vigorous activity). These algorithms were developed by the Centers for Disease Control and Prevention (CDC) for use in recent population-based

surveys (C. Macera; Physical Activity and Health Branch, CDC; written communication; August 2000).

Unadjusted and multivariate-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated to compare levels of physical activity by various sociodemographic and environmental policy categories. In developing logistic regression models based on multiple potential confounders, we added independent correlates to a model if they had been consistently shown to be significant predictors of physical activity in ours and other national studies.<sup>2,26</sup> The variables selected in the final modeling process included age, sex, race/ethnicity, household income, and education level. For logistic regression analyses, physical activity behavior was dichotomized (meeting public health recommendations vs insufficient activity and inactivity).

## RESULTS

The sociodemographic characteristics of the study population are shown in Table 1. The sample tended to underrepresent men, Whites, and higher income groups (in comparison with data from the US census). As intended from our sampling plan, approximately 40% of the study population had household incomes below \$20 000 per year.

### Patterns Among Environmental and Policy Determinants

Data related to the physical environment were examined by sex and income level (Table 2). Among general access variables, reported availability of places for physical activity was typically higher among men than among women. The largest difference by income group was that for access to both indoor and outdoor places to engage in physi-

cal activity. The relative differences between income groups (i.e., absolute difference in percentages divided by the larger percentage) for this category were 25% among women and 59% among men.

Regarding specific access variables, men again tended to report higher levels of availability of places and equipment for leisure-time activity for each category except shopping malls. Specific access variable patterns also differed by income group and sex. For example, among women, those with higher incomes generally reported greater access than those with lower incomes to areas or equipment such as walking or jogging trails, parks, and treadmills. In contrast, among men, those with lower incomes generally reported higher rates of access than those with higher incomes.

Regarding other neighborhood characteristics, the majority of respondents, regardless of

**TABLE 2—Characteristics of the Perceived Physical Environment Among Participants in the US Physical Activity Study, by Sex and Income Level, 1999–2000**

Environmental Characteristic	Women, % (95% CI)			Men, % (95% CI)		
	Total	Lower Income <sup>a</sup>	Higher Income <sup>b</sup>	Total	Lower Income <sup>a</sup>	Higher Income <sup>b</sup>
<b>General access variables</b>						
Places to exercise	78.8 (76.4, 81.2)	69.3 (65.3, 73.3)	87.7 (85.0, 90.4)	87.3 (84.5, 90.1)	81.6 (76.3, 86.9)	90.8 (87.7, 93.9)
Indoor or outdoor	56.8 (53.8, 59.8)	48.3 (44.0, 52.6)	64.7 (60.7, 68.7)	64.3 (60.3, 68.3)	27.8 (21.1, 34.5)	68.3 (63.3, 73.3)
Indoor only	15.6 (1.7, 29.5)	13.9 (10.9, 16.9)	17.1 (14.0, 20.2)	13.2 (10.4, 16.0)	13.1 (8.5, 17.7)	13.3 (9.7, 16.9)
Outdoor only	6.5 (5.0, 8.0)	7.1 (4.9, 9.3)	5.9 (3.9, 7.9)	9.7 (7.2, 12.2)	10.7 (6.5, 14.9)	9.2 (6.1, 12.3)
<b>Specific access variables<sup>c</sup></b>						
Walking/jogging trail	24.6 (21.8, 27.4)	21.2 (17.2, 25.2)	27.5 (23.6, 31.4)	25.0 (21.1, 28.9)	28.6 (21.8, 35.4)	23.0 (18.2, 27.8)
Neighborhood streets	64.5 (61.4, 67.6)	63.5 (58.8, 68.2)	65.4 (61.2, 69.6)	68.2 (64.0, 72.4)	76.8 (70.4, 83.2)	63.3 (57.8, 68.8)
Park	28.2 (25.3, 31.1)	25.3 (21.1, 29.5)	30.5 (26.4, 34.6)	33.5 (29.2, 37.8)	38.7 (31.3, 46.1)	30.7 (25.5, 35.9)
Shopping mall	41.2 (38.0, 44.4)	43.1 (38.3, 47.9)	39.7 (35.4, 44.0)	31.0 (26.8, 35.2)	36.9 (29.6, 44.2)	27.7 (22.6, 32.8)
Indoor gym	19.5 (16.9, 22.1)	16.1 (12.5, 19.7)	22.4 (18.7, 26.1)	26.1 (22.1, 30.1)	27.4 (20.7, 34.1)	25.3 (20.4, 30.2)
Treadmill	24.3 (21.5, 27.1)	18.7 (14.9, 22.5)	28.9 (24.9, 32.9)	25.9 (21.9, 29.9)	20.8 (14.7, 26.9)	28.7 (23.6, 33.8)
<b>Neighborhood characteristics</b>						
Sidewalks present	61.2 (58.3, 64.1)	62.4 (58.2, 66.6)	60.2 (56.1, 64.3)	64.8 (60.8, 68.8)	67.1 (60.7, 73.5)	63.3 (58.2, 68.4)
Enjoyable scenery	76.4 (73.9, 78.9)	70.3 (66.4, 74.2)	82.1 (78.9, 85.3)	82.2 (79.0, 85.4)	79.6 (74.1, 85.1)	83.7 (79.8, 87.6)
Heavy traffic	44.1 (41.1, 47.1)	50.6 (46.3, 54.9)	38.1 (34.1, 42.1)	42.6 (38.4, 46.8)	48.8 (42.0, 55.6)	38.9 (33.7, 44.1)
Hills	40.1 (37.2, 43.0)	36.1 (31.9, 40.3)	43.8 (39.7, 47.9)	46.8 (42.6, 51.0)	43.0 (36.3, 49.7)	49.1 (43.8, 54.4)
Streetslights	74.1 (71.5, 76.7)	75.3 (71.6, 79.0)	73.0 (69.3, 76.7)	75.0 (71.4, 78.6)	78.7 (73.1, 84.3)	72.8 (68.1, 77.5)
Unattended dogs	44.5 (41.5, 47.5)	48.6 (44.3, 52.9)	40.6 (36.5, 44.7)	35.8 (31.8, 39.8)	38.2 (31.6, 44.8)	34.3 (29.2, 39.4)
Foul air from cars/factories	18.1 (15.8, 20.4)	21.6 (18.1, 25.1)	14.8 (11.8, 17.8)	23.1 (19.6, 26.6)	27.1 (21.0, 33.2)	20.7 (16.4, 25.0)

Note. CI = confidence interval.

<sup>a</sup>Less than \$20 000 annually.

<sup>b</sup>\$20 000 and higher annually.

<sup>c</sup>Information on specific access variables was collected only for respondents reporting some type of physical activity.

**TABLE 3—Perceived Social Factors and Personal Barriers Among Participants in the US Physical Activity Study, by Sex and Income Level, 1999–2000**

Characteristic	Women, % (95% CI)			Men, % (95% CI)		
	Total	Lower Income <sup>a</sup>	Higher Income <sup>b</sup>	Total	Lower Income <sup>a</sup>	Higher Income <sup>b</sup>
<b>Scocial factors</b>						
Many people exercising	40.4 (37.5, 43.3)	35.8 (31.7, 39.9)	44.6 (40.4, 48.8)	49.7 (45.5, 53.9)	43.5 (36.7, 50.3)	53.6 (48.3, 58.9)
High crime	21.9 (19.4, 24.4)	27.5 (23.6, 31.4)	16.6 (13.5, 19.7)	19.0 (15.7, 22.3)	25.2 (19.3, 31.1)	15.1 (11.3, 18.9)
Exercise with family/friend <sup>c</sup>	81.1 (78.8, 83.4)	79.9 (76.4, 83.4)	82.1 (78.9, 85.3)	74.9 (71.2, 78.6)	73.7 (67.7, 79.7)	75.6 (71.0, 80.2)
Friends encourage <sup>c</sup>	61.0 (58.1, 63.9)	61.2 (57.0, 65.4)	60.8 (56.7, 64.9)	64.3 (60.3, 68.3)	62.0 (55.4, 68.6)	65.8 (60.7, 70.9)
One friend to exercise <sup>c</sup>	72.0 (69.3, 74.7)	69.7 (65.0, 73.7)	74.1 (70.5, 77.7)	71.2 (67.4, 75.0)	68.3 (61.9, 74.7)	72.9 (68.1, 77.7)
Relatives encourage exercise <sup>c</sup>	66.4 (63.6, 69.2)	62.2 (58.0, 66.4)	70.4 (66.6, 74.2)	64.1 (60.1, 68.1)	62.1 (55.4, 68.8)	65.3 (60.2, 70.4)
One relative to exercise <sup>c</sup>	64.7 (61.8, 67.6)	63.9 (59.8, 68.0)	65.4 (61.4, 69.4)	63.1 (59.0, 67.2)	63.9 (57.3, 70.5)	62.6 (57.4, 67.8)
<b>Personal barriers<sup>d</sup></b>						
Others discourage me	3.7 (2.6, 4.8)	4.3 (2.5, 6.1)	3.1 (1.7, 4.5)	5.7 (3.7, 7.7)	9.7 (5.7, 13.7)	3.3 (1.4, 5.2)
Self-conscious	12.4 (10.4, 14.4)	13.2 (10.3, 16.1)	11.6 (8.9, 14.3)	10.9 (8.3, 13.5)	11.2 (6.9, 15.5)	10.7 (7.4, 14.0)
Afraid of injury	7.6 (6.0, 9.2)	9.7 (7.1, 12.3)	5.6 (3.7, 7.5)	6.1 (4.1, 8.1)	9.2 (5.3, 13.1)	4.1 (2.0, 6.2)
Do not have time	23.3 (20.8, 25.8)	19.7 (16.3, 23.1)	26.5 (22.8, 30.2)	21.0 (17.6, 24.4)	17.5 (12.3, 22.7)	23.1 (18.6, 27.6)
Too tired	19.9 (17.5, 22.3)	16.7 (13.5, 19.9)	22.9 (19.4, 26.4)	14.7 (11.7, 17.7)	15.5 (10.6, 20.4)	14.2 (10.5, 17.9)
No safe place	8.1 (6.5, 9.7)	10.3 (7.7, 12.9)	6.1 (4.1, 8.1)	5.0 (3.2, 6.8)	3.3 (0.9, 5.7)	5.9 (3.4, 8.4)
No child care	5.7 (4.3, 6.1)	6.3 (4.2, 8.4)	5.2 (3.3, 7.1)	3.3 (1.8, 4.8)	4.9 (1.9, 7.9)	2.4 (0.8, 4.0)
Bad weather	8.1 (6.5, 9.7)	10.3 (8.0, 12.6)	6.1 (3.8, 8.4)	6.1 (4.1, 8.1)	6.8 (3.4, 10.2)	5.6 (3.1, 8.1)
Not in good health	10.5 (8.7, 12.3)	13.2 (10.3, 16.1)	7.9 (5.7, 10.1)	8.5 (6.2, 10.8)	12.7 (8.1, 17.3)	5.9 (3.4, 8.4)
No energy	11.7 (9.8, 13.6)	11.3 (8.6, 14.0)	12.1 (9.4, 14.8)	9.9 (7.4, 12.4)	13.1 (8.5, 17.7)	8.0 (5.1, 10.9)
Get exercise at job	22.1 (19.6, 24.6)	22.0 (18.4, 25.6)	22.2 (18.7, 25.7)	28.9 (25.1, 32.7)	26.1 (20.1, 32.1)	30.1 (25.2, 35.0)
No motivation	14.2 (12.1, 16.3)	12.9 (10.0, 15.8)	15.5 (12.5, 18.5)	14.3 (11.4, 17.2)	14.1 (9.3, 18.9)	14.5 (10.7, 18.3)
Do not like exercise	12.7 (10.7, 14.7)	10.5 (7.8, 13.2)	14.8 (11.8, 17.8)	11.0 (8.4, 13.6)	10.2 (6.1, 14.3)	11.5 (8.1, 14.9)

Note. CI = confidence interval.

<sup>a</sup>Less than \$20 000 annually.

<sup>b</sup>\$20 000 and higher annually.

<sup>c</sup>Respondents replying "agree" or "strongly agree."

<sup>d</sup>Respondents replying "often" or "very often."

sex or income group, noted the presence of sidewalks. Among both women and men, those with lower incomes were more than 20% as likely to report heavy traffic as those with higher incomes. Similar differences between income groups were revealed for unattended dogs and for foul air from cars and factories.

Respondents who reported some degree of physical activity were also asked where and how they engaged in such activity. The most common responses were as follows: on neighborhood streets (66.1%), at shopping malls (37.0%), at parks (29.6%), on a walking and jogging trail (24.8%), on a treadmill (24.7%), and at an indoor gym (21.3%).

A series of social factors and personal barriers were examined across sex and income groups (Table 3). Regarding social factors,

there were not generally large differences between men and women. Among social determinants, the largest difference was that between income groups for the high crime rate variable. The relative difference between income groups for this variable was 40% among both women and men. The 4 personal barriers most common across sex and income groups were lack of time, feeling too tired, obtaining enough physical activity at one's job, and no motivation to be physically active. For most variables, women more frequently reported a personal barrier to physical activity than did men. There were no consistent patterns between income groups in regard to personal barriers.

There was high support for health policy-related measures to enhance physical activity (Table 4). For example, a majority of respon-

dents (70.6%) believed that employers should provide time during the workday for employees to exercise. Among all variables measured, the most support was shown for requiring physical education in schools (95.2% of respondents). There was also strong support for use of government funds to provide areas to engage in physical activity and for zoning requirements that would include walking and biking paths. Few sex- or income-related differences were observed in the area of health policy determinants.

### Associations Between Environmental–Policy Determinants and Behavior

The array of environmental and policy variables described in Tables 2 through 4 was also examined in terms of relations to physi-

**TABLE 4—Health Policy Attitudes Among Participants in the US Physical Activity Study, by Sex and Income Level, 1999–2000**

Characteristic	Women, % (95% CI)			Men, % (95% CI)		
	Total	Lower Income <sup>a</sup>	Higher Income <sup>b</sup>	Total	Lower Income <sup>a</sup>	Higher Income <sup>b</sup>
Employers should provide time	72.7 (70.0, 75.4)	73.1 (69.2, 77.0)	72.3 (68.5, 76.1)	66.7 (62.7, 70.7)	65.8 (59.3, 72.3)	67.3 (62.3, 72.3)
Local schools should require physical education	95.2 (93.9, 96.5)	94.0 (92.0, 96.0)	96.4 (94.9, 97.9)	95.0 (93.2, 96.8)	92.2 (88.5, 95.9)	96.7 (94.8, 98.6)
Local government funds						
Walking/jogging trails	90.2 (88.4, 92.0)	90.7 (88.2, 93.2)	89.6 (87.0, 92.2)	90.9 (88.5, 93.3)	90.6 (86.6, 94.6)	91.1 (88.1, 94.1)
Swimming pools	84.6 (82.4, 86.8)	85.7 (82.7, 88.7)	83.5 (80.4, 86.6)	85.0 (82.0, 88.0)	83.7 (78.6, 88.8)	85.8 (82.1, 89.5)
Recreation centers	91.8 (90.2, 93.4)	93.4 (91.3, 95.5)	90.4 (87.9, 92.9)	91.9 (89.6, 94.2)	91.7 (87.9, 95.5)	92.0 (89.1, 94.9)
Bicycle paths	89.1 (87.2, 91.0)	88.6 (85.8, 91.4)	89.5 (86.9, 92.1)	91.1 (88.7, 93.5)	90.2 (86.1, 94.3)	91.7 (88.8, 94.6)
Zoning should include walking/bike paths	85.8 (83.8, 87.8)	82.7 (79.8, 85.6)	87.7 (84.9, 90.5)	87.6 (84.6, 90.6)	87.3 (82.1, 92.5)	87.8 (84.3, 91.3)

Note. CI = confidence interval.

<sup>a</sup>Less than \$20 000 annually.

<sup>b</sup>\$20 000 and higher annually.

cal activity behavior (Table 5). After adjustment for potential confounders, most of the general and specific access variables were associated with meeting the recommendations for physical activity. Access to parks (adjusted OR=1.95, 95% CI=1.52, 2.52), indoor gyms (adjusted OR=1.94, 95% CI=1.45, 2.60), and treadmills (adjusted OR=1.48, 95% CI=1.13, 1.93) was positively associated with physical activity.

Neighborhood characteristics, including the presence of sidewalks, enjoyable scenery, heavy traffic, and hills, were positively associated with physical activity. Several social factors were also associated with physical activity, including surroundings in which many people were exercising, friends who encouraged exercise, and having at least 1 friend with whom to exercise.

Six personal barriers—having too little time, being too tired, not being in good health, lacking energy, lacking motivation, and not liking physical activity—showed inverse relationships with physical activity. Finally, 2 policy variables were positively associated with physical activity: believing that employers should provide time for exercise (adjusted OR=1.27, 95% CI=1.01, 1.59) and supporting the use of local government funds for walking and jogging trails (adjusted OR=1.42, 95% CI=1.00, 2.01).

In addition to the analyses presented in Table 5, adjusted odds ratios were calculated separately for women, men, lower income

respondents, and higher income respondents. Some general patterns are summarized. Access and neighborhood variables were more highly correlated with physical activity among women than among men. Personal barrier–behavior correlations differed by sex. For example, the personal barriers exhibiting the strongest associations with physical activity behavior were lack of energy among women (adjusted OR=0.48, 95% CI=0.32, 0.72) and not being in good health among men (adjusted OR=0.26, 95% CI=0.12, 0.53).

Among those with lower incomes, the most important neighborhood variable was enjoyable scenery (adjusted OR=1.53, 95% CI=1.07, 2.18). The presence of sidewalks was the most important neighborhood variable among those with higher incomes (adjusted OR=1.46, 95% CI=1.08, 1.97). Only 1 personal barrier (not being in good health) was inversely related to activity among lower income respondents. Conversely, 6 personal barriers (lacking time, being too tired, not being in good health, lacking energy, lacking motivation, not liking exercise) showed inverse associations with activity among those with higher incomes.

Respondents who had used an environmental support (i.e., a facility or piece of equipment) were asked whether they had changed their amount of physical activity since they began using the support and, if so, whether the amount increased or decreased.

Among individuals indicating some degree of physical activity, the following environmental supports were associated with reports of increases in activity: neighborhood streets (22.6% of respondents), shopping malls (25.9%), parks (28.5%), walking and jogging trails (29.9%), treadmills (30.6%), and indoor gyms (33.7%).

## DISCUSSION

Ours is among the first population-based, comprehensive US studies to address a variety of environmental and policy determinants of physical activity. Our findings can be viewed in the context of an ecological, or systems, framework in which “appropriate changes in the social environment will produce changes in individuals, and . . . the support of individuals in a population is essential for implementing environmental changes.”<sup>27</sup> Such frameworks point to the importance of addressing problems at multiple levels and stress the interaction and integration of factors within and across all levels (i.e., individual, interpersonal, community, organizational, and governmental). The goal is to create a healthy community environment that provides health-promoting information and social support to enable people to develop healthier lifestyles.<sup>28</sup> Increasingly, emphasis is being placed on ecologic models as important frameworks that can lead to more effective physical activity interventions.<sup>6,12,29</sup>

**TABLE 5—Associations Between Perceived Environmental and Policy Variables and Physical Activity Behavior in the US Physical Activity Study, 1999–2000**

Characteristic	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
<b>Access variables</b>		
Places to exercise		
Indoor or outdoor	2.50 (1.94, 3.22)	1.85 (1.39, 2.47)
Indoor only	1.64 (1.18, 2.27)	1.31 (0.91, 1.88)
Outdoor only	2.32 (1.55, 3.46)	2.05 (1.32, 3.19)
Walking/jogging trail		
Streets	1.59 (1.25, 2.02)	1.55 (1.19, 2.02)
Park	1.18 (0.96, 1.46)	1.24 (0.98, 1.57)
Shopping mall	1.93 (1.53, 2.43)	1.95 (1.52, 2.52)
Indoor gym	0.68 (0.56, 0.84)	0.81 (0.64, 1.02)
Treadmill	2.11 (1.62, 2.76)	1.94 (1.45, 2.60)
Treadmill	1.59 (1.25, 2.03)	1.48 (1.13, 1.93)
<b>Neighborhood characteristics</b>		
Sidewalks present	1.25 (1.03, 1.51)	1.28 (1.02, 1.59)
Enjoyable scenery	1.50 (1.20, 1.89)	1.46 (1.13, 1.88)
Heavy traffic	1.13 (0.94, 1.36)	1.28 (1.04, 1.58)
Hills	1.42 (1.17, 1.71)	1.28 (1.04, 1.58)
Streetlights	0.99 (0.80, 1.23)	1.08 (0.85, 1.37)
Unattended dogs	0.87 (0.72, 1.05)	0.91 (0.74, 1.12)
Foul air from cars/factories	1.20 (0.95, 1.51)	1.21 (0.93, 1.56)
<b>Social factors</b>		
Many people exercising	1.46 (1.21, 1.76)	1.33 (1.09, 1.64)
High crime	0.72 (0.57, 0.90)	0.78 (0.60, 1.01)
Exercise with family/friend	0.80 (0.64, 1.01)	0.70 (0.54, 0.90)
Friends encourage	1.27 (1.05, 1.53)	1.23 (1.00, 1.52)
One friend to exercise	1.49 (1.21, 1.83)	1.45 (1.15, 1.81)
Relatives encourage exercise	1.03 (0.84, 1.25)	1.02 (0.83, 1.27)
One relative to exercise	1.10 (0.91, 1.34)	1.16 (0.98, 1.51)
<b>Personal barriers</b>		
Others discourage me	0.89 (0.57, 1.37)	1.01 (0.61, 1.67)
Self-conscious	1.14 (0.85, 1.52)	1.11 (0.81, 1.52)
Afraid of injury	0.72 (0.51, 1.02)	0.75 (0.50, 1.12)
Do not have time	0.76 (0.61, 0.94)	0.58 (0.46, 0.75)
Too tired	0.64 (0.50, 0.81)	0.56 (0.43, 0.73)
No safe place	0.63 (0.44, 0.90)	0.75 (0.50, 1.11)
No child care	1.06 (0.68, 1.65)	1.05 (0.65, 1.68)
Bad weather	0.87 (0.61, 1.24)	0.79 (0.53, 1.16)
Not in good health	0.47 (0.34, 0.65)	0.60 (0.42, 0.85)
No energy	0.47 (0.35, 0.64)	0.46 (0.33, 0.64)
Get exercise at job	1.38 (1.10, 1.72)	1.53 (1.19, 1.96)
No motivation	0.61 (0.46, 0.79)	0.58 (0.43, 0.78)
Do not like exercise	0.64 (0.48, 0.85)	0.62 (0.45, 0.84)
<b>Policy attitudes</b>		
Employers should provide time	1.28 (1.04, 1.57)	1.27 (1.01, 1.59)
Local schools should require physical education	1.18 (0.76, 1.81)	1.19 (0.74, 1.92)
Local government funds		
Walking/jogging trails	1.62 (1.18, 2.23)	1.42 (1.00, 2.01)

*Continued***Our Findings in the Context of Earlier Research**

Access to locations and facilities where people can be physically active appeared to be important based on several different variables. Both cross-sectional<sup>22,30</sup> and longitudinal<sup>19,31</sup> studies have shown that access to facilities (e.g., walking trails, swimming pools, gyms) has a positive correlation with physical activity behavior patterns in adults. A recent study conducted in a rural section of Missouri suggests that access to and use of community walking trails may be beneficial in promoting physical activity among the segments of the population at highest risk for inactivity, particularly women and people of lower socioeconomic status.<sup>7</sup> In addition, 3 studies<sup>11,30,32</sup> have shown associations between number of pieces of exercise equipment in the home and rates of physical activity.

Our results showed that access to a treadmill was correlated with physical activity. Objectively measured density of facilities around homes has been correlated with physical activity rates, even after adjustment for demographic variables.<sup>21</sup> Qualitative data from Australia suggest that people believe they are more likely to be physically active when they have access to both free and pay facilities.<sup>33</sup> Yet, at least 1 experimental study suggests that actually providing free access to convenient facilities may not in itself lead to increases in physical activity levels.<sup>34</sup>

In our study, nearly every access variable investigated showed a positive association with physical activity after adjustment for potential confounders. Self-reported estimates of levels of access were generally higher among men. Importantly, between 23% and 34% of individuals who had used a range of environmental supports such as walking trails reported increases in physical activity.

Among interpersonal factors influencing physical activity, social support for exercise from family, friends, or exercise program staff is probably the most clearly established determinant.<sup>35</sup> Social support can be direct and tangible (e.g., providing a nondriver with a ride to an exercise class) or informational (e.g., talking about physical activity and encouraging a friend to participate). Both quantitative (cross-sectional and longitudinal)<sup>23,30,31,36–38</sup> and qualitative studies<sup>39–42</sup>

TABLE 5—Continued

Swimming pools	1.13 (0.87, 1.46)	1.07 (0.80, 1.42)
Recreation centers	0.90 (0.64, 1.26)	0.82 (0.56, 1.19)
Bicycle paths	1.44 (1.06, 1.95)	1.19 (0.85, 1.67)
Zoning should include walking/bike paths	1.14 (0.86, 1.50)	1.10 (0.81, 1.49)

Note. Physical activity behavior was defined as meeting public health recommendations for moderate or vigorous activity (see Methods section). OR = odds ratio; CI = confidence interval.

<sup>a</sup>Adjusted for age, sex, race, income, and education.

have shown the importance of social support in enhancing physical activity. In our study, social variables that were associated with physical activity included surroundings in which many people were exercising, having friends who encouraged exercise, and having at least 1 friend with whom to exercise.

Another potentially important social factor is neighborhood crime. A recent 5-state study showed that perceived neighborhood safety may have a direct relationship with rates of physical activity.<sup>43</sup> In the case of older adults, physical activity rates were more than 2-fold higher among those perceiving their neighborhoods to be safe. However, in the Missouri study mentioned previously, lack of neighborhood safety did not appear to be an important barrier among walking trail users (only 1% of users perceived unsafe conditions).<sup>7</sup> Our study revealed large differences between income groups in regard to self-reported exposure to high rates of crime, with 40% more exposure to crime among low-income groups. We found a modest inverse relationship between crime and physical activity (adjusted OR = 0.78) that was not statistically significant after multivariate adjustment.

In a recent population-based study involving the same scale used in the current study, King et al.<sup>44</sup> investigated a variety of neighborhood determinants of physical activity among older minority women in the United States. After multivariate adjustment, there were significant correlations between physical inactivity and lack of hills, absence of enjoyable scenery, and infrequent observation of others exercising. The findings of King et al.<sup>44</sup> largely correspond to our results. It may seem contradictory that the presence of hills was positively associated

with physical activity. In part, hilly areas may correlate with more scenic locales. The association with heavy traffic is less intuitive but may in part relate to higher levels of physical activity in urban than rural areas<sup>45</sup> and the corresponding traffic density. Test-retest kappa values for these environmental characteristics were in the moderate to high range (0.44 to 0.84).<sup>17</sup>

### Considerations in Interpreting Our Data

There are several limitations to our study that deserve mention. First, we relied on self-reported telephone survey data, for which there are several potential biases (e.g., possible underrepresentation of individuals of lower socioeconomic status).<sup>46,47</sup> To address this limitation, we oversampled lower income populations across the United States.

Second, although BRFSS questions on physical activity behavior have been tested for reliability,<sup>24,48</sup> some of the items included in our survey (e.g., perceived access to walking trails and indoor facilities) have not been systematically examined in regard to their psychometric properties. However, we used tested scales whenever possible, and many of the measurement properties of the questions used in our study have been summarized elsewhere.<sup>12</sup>

Our questions regarding the environment involved self-report responses and did not include separate objective measures. A study conducted in San Diego, Calif, showed no significant correlation between perceived convenience of facilities and objectively measured density of facilities.<sup>21</sup> However, one recent study revealed relatively high levels of agreement between self-reported and objectively measured environmental variables that may influence physical activity.<sup>49</sup>

Finally, because our data are cross sectional, causal relationships cannot be inferred. In spite of these caveats, our study provides nationwide, population-based data on a wide array of environmental and policy determinants, along with comprehensive measures of physical activity behavior.

### Implications and Future Needs

The present findings suggest several areas of emphasis for research and intervention. Presently, new resources at the federal and state levels are available to conduct interventions aimed at promoting physical activity.<sup>50</sup> Our results, coupled with findings of other recent studies and reviews,<sup>2,5,6,10,51</sup> suggest that a range of environmental and policy variables are important to consider when designing interventions. However, it is likely that these determinants vary in importance across settings, so community-specific tailoring of approaches will be needed.

Others<sup>52,53</sup> have described surveillance needs related to individual-level physical activity behaviors. New surveillance systems need to be developed to capture environmental and policy indicators related to physical activity. To support community-based interventions for promoting physical activity, it is essential to develop systems that are more responsive to data needs at the local level (i.e., city, county, or neighborhood).

As with the variables reported in our study, data on health policy attitudes can be used in a variety of ways within community-based health promotion programs. For example, these data can help to determine which types of policy interventions are likely to have the highest support among community members. In our study, support appeared to be greatest for changes in school physical education requirements and for local funding for areas in which people can engage in physical activity (e.g., walking and jogging trails). Support for health policy initiatives was consistent across sex and income groups.

To date, most studies of environmental and policy determinants of physical activity have relied on localized or convenience samples. Our study extended the literature by examining an array of factors and by including a representative sample of lower income individuals. Longitudinal and time-series studies are

needed to clearly determine the influences of these determinants over time and their effects on adoption vs maintenance of physical activity. Also, there is a need for well-conducted studies that compare perceived environments with objective assessments.<sup>11</sup>

Numerous authoritative reports have called upon practitioners and researchers to develop and evaluate new physical activity interventions that focus on environmental and policy changes.<sup>2,5,6,10,54</sup> Significant challenges will be encountered, however, in implementing these interventions across the United States. For example, it has been noted that in modern US society, land use has been engineered for automobiles as opposed to foot or bicycle travel.<sup>8</sup> We hope that our findings will help researchers, practitioners, and policymakers design assessments and identify priority areas for intervention. ■

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### Contributors

R.C. Brownson conceptualized the study and wrote the draft of the paper. E.A. Baker, R.A. Housemann, and L.K. Brennan helped in designing the questionnaire and contributed to the writing and revision of the paper. R.A. Housemann provided day-to-day oversight of data collection. S.J. Bacak conducted the analyses and contributed to the writing and revision of the paper.

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I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).			
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