American Journal of Epidemiology
Vol. 170, No. 9
DOI: 10.1093/aje/kwp264
Advance Access publication October 6, 2009

Original Contribution

Prospective Study of Urban Form and Physical Activity in the Black Women's Health Study

Patricia F. Coogan*, Laura F. White, Thomas J. Adler, Kevin M. Hathaway, Julie R. Palmer, and Lynn Rosenberg

* Correspondence to Dr. Patricia F. Coogan, Slone Epidemiology Center, Boston University, 1010 Commonwealth Avenue, Boston, MA 02215 (e-mail: pcoogan@bu.edu).

Initially submitted April 14, 2009; accepted for publication August 3, 2009.

The authors used data from the Black Women's Health Study to assess the association between neighborhood urban form and physical activity. Women reported hours/week of utilitarian and exercise walking and of vigorous activity in 1995 and on biennial follow-up questionnaires through 2001. Housing density, road networks, availability of public transit, sidewalks, and parks were characterized for the residential neighborhoods of 20,354 Black Women's Health Study participants living in New York, New York; Chicago, Illinois; and Los Angeles, California. The authors quantified the associations between features of the environment and physical activity using odds ratios for $\geq$5 relative to $<$5 hours/week of physical activity. For all women, housing density had the strongest association with utilitarian walking (odds ratio for the most- compared with the least-dense quintile = 2.72, 95% confidence interval: 2.22, 3.31), followed by availability of public transit. Women who moved during follow-up to neighborhoods of lower density were 36% more likely to decrease their levels of utilitarian walking, and those who moved to neighborhoods of higher density were 23% more likely to increase their levels of utilitarian walking, relative to women who moved to neighborhoods of similar density. These data suggest that increases in housing density may lead to increases in utilitarian walking among African-American women.

African Americans; environment; follow-up studies; motor activity; walking; women

Abbreviations: CI, confidence interval; OR, odds ratio; SMARTRAQ, Strategies for Metro Atlanta's Regional Transportation and Air Quality.

Studies consistently show that people who live in traditional neighborhoods characterized by high densities, mixed land use, and interconnected streets walk more than people who live in suburban, automobile-oriented neighborhoods (1–5). It might be inferred that policies that deter low-density development and encourage mixed land use will benefit the public health by increasing physical activity levels (5). However, all previous studies of the built environment and walking have been cross-sectional, and associations observed may reflect selection bias, a simultaneous preference for walking and for living in dense urban neighborhoods, rather than a causal effect of urban form on walking (1). Most previous studies have covered one city and have included relatively small numbers of subjects. The largest known to date is the Strategies for Metro Atlanta's Regional Transportation and Air Quality (SMARTRAQ) travel survey ($n \approx 13{,}000$) (6, 7), but most other studies include fewer than 1,000 people. Few studies have included appreciable numbers of African-American women, who have low levels of physical activity (8) and high levels of obesity (9, 10). To address these limitations, we used data from a large cohort study of African-American women to longitudinally assess the association between neighborhood urban form and physical activity in 3 major US cities. The present study advances the field because it is the first known longitudinal assessment of the issue. In addition, the study encompasses 3 geographic areas and includes, to our knowledge, the largest population in which the issue has been considered to date.

Table 1. Individual and Neighborhood Characteristics of Black Women's Health Study Participants Living in New York, New York; Chicago, Illinois; and Los Angeles, California, Metropolitan Areas in 1995[a,b]

	New York (*n* = 9,992)	Chicago (*n* = 4,310)	Los Angeles (*n* = 4,223)	Total (*n* = 18,525)
Individual characteristics				
Mean body mass index, kg/m^2	27.9	28.4	27.4	27.9
Mean age, years	38.6	39.4	40.1	39.2
Mean energy intake, kcal/day	1,614.7	1,625.8	1,509.9	1,593.4
Years of education, %				
≤12	19.0	14.6	13.4	14.5
13–15	32.8	37.5	40.8	35.7
≥16	47.4	47.3	45.1	46.9
Parity, %				
0	38.5	35.3	35.7	37.1
1	22.8	22.3	21.5	22.4
2	20.8	22.5	23.4	21.8
≥3	17.8	19.8	19.3	18.6
Smoking status, %				
Current	18.3	18.2	13.4	17.3
Former	20.8	20.1	19.6	20.4
Never	60.9	61.7	66.6	62.4
Presence of chronic disease, %	8.5	9.6	8.7	8.8
Utilitarian walking (hours/week), %				
0	17.3	26.4	41.9	25.1
<1	26.7	30.3	27.2	27.7
1–2	27.1	24.7	18.2	24.5
3–4	11.1	6.9	4.4	8.6
5–6	6.2	4.3	2.4	4.9
≥7	8.9	4.9	3.2	6.6
Exercise walking (hours/week), %				
0	18.2	20.8	16.5	18.4
<1	22.9	23.7	22.0	22.9
1–2	29.2	27.4	28.4	28.6
3–4	13.5	13.5	16.1	14.1
5–6	7.0	6.8	8.2	7.2
≥7	6.7	5.9	5.6	6.3

Table continues

MATERIALS AND METHODS

The study population

The Black Women's Health Study is a prospective cohort study established in 1995, when approximately 59,000 African-American women aged 21–69 years were recruited mainly from subscribers to *Essence* magazine (11, 12). The baseline questionnaire elicited information on demographic and lifestyle factors, medical and reproductive history, and dietary intake. The cohort is followed biennially by mailed questionnaire, and follow-up has averaged more than 80% of the original cohort through 5 questionnaire cycles. The study was approved by the institutional review board of Boston University, Boston, Massachusetts.

The present analysis includes Black Women's Health Study participants who lived in the geographic areas encompassed by the metropolitan planning organizations for the New York, New York; Chicago, Illinois; and Los Angeles, California, metropolitan regions. Study boundaries include areas ranging from the inner city to rural places. Follow-up for the present analysis began at baseline in 1995 and continued through 2001. The study population included Black Women's Health Study participants who reported on any of the 1995, 1997, or 1999 questionnaires that they lived in a study city and returned a survey 2 years later (1997, 1999, or 2001). Of the 21,820 women who met the inclusion

Table 1. Continued

	New York (n = 9,992)	Chicago (n = 4,310)	Los Angeles (n = 4,223)	Total (n = 18,525)
Vigorous activity (hours/week), %				
0	33.6	32.6	29.5	32.4
<1	15.0	16.2	14.8	15.2
1–2	21.8	22.6	22.6	22.2
3–4	12.3	13.0	14.1	12.9
5–6	5.9	5.5	7.9	6.3
≥7	7.1	6.3	8.3	6.9
Neighborhood characteristics				
Density and land use				
Median housing density, units/acre[c]	15.4	6.7	6.0	8.9
Median nonresidential land use, %	61	25	19	41
Median residential land use, %	61	59	67	62
Street structure				
Median block area, acres	4.6	5.4	6.9	5.2
Median intersection density, no./square mile[d]	177.1	135.9	134.5	151.1
Median ratio of 4-way to total intersections	0.5	0.6	0.4	0.5
Participants with no major roads in buffer, %	58	60	77	63
Public transit availability				
Median miles to a transit stop	0.7	0.8	8.1	1.0
Median miles of bus routes	2.2	1.5	1.5	1.6
Amenities				
Participants for whom ≥50% street segments had sidewalk coverage, %	91.7	95.1	97.1	94.0
Median miles to the nearest park	0.4	0.3	0.9	0.4
Other neighborhood characteristics				
Mean crime measure[e]	105.6	192.2	146.8	135.1
Mean SES score[f]	−0.07	−0.05	0.25	0.01
Mean vacant housing units, %	5.4	7.0	4.4	5.4

Abbreviation: SES, socioeconomic status.
[a] Percentages may not add to 100% because of missing values.
[b] Excludes 1,829 women who moved into a study area in 1997 or 1999 (930 in New York, 465 in Chicago, and 434 in Los Angeles).
[c] One acre = 0.4 hectare.
[d] One mile = 1.6 km.
[e] Overall range, 1 to 1,204.
[f] Overall range, −4.6 to 3.8.

criteria, we excluded 61 who reported gastric bypass surgery, 199 who reported incident cancer during follow-up, and 1,206 whose addresses could not be geocoded (e.g., post office boxes), for a final population of 20,354 women (49,140 observations). Sixty-three percent (n = 12,790) of the women contributed 6 years of follow-up, 16% (n = 3,206) 4 years of follow-up, and 21% (n = 4,358) 2 years of follow-up, for a total 98,280 person-years of follow-up.

Ascertainment of outcomes

On all questionnaires, respondents were asked how many hours a week on average in the prior year they spent "walking for exercise" and in "vigorous exercise (such as basketball, swimming, running, aerobics)," with 7 response categories ranging from 0 to ≥10 hours a week. On all but the 1995 questionnaire, respondents were asked how many hours a week on average in the prior year they spent "walking to and from church, store, school, work" (i.e., utilitarian walking), with 7 response categories.

Individual-level covariates

Data on age, parity, smoking history, alcohol consumption, and presence of chronic disease were first obtained in 1995 and were updated in all subsequent questionnaire

Table 2. Association Between Urban-form Variables and Utilitarian Walking in Individual and Mutually Adjusted Models, Black Women's Health Study, 1995–2001

Urban-form Variable	No. ≥5 Hours/Week[a]	Total in Quintile[a]	Individual Model OR[b]	95% CI	Mutually Adjusted Model OR[b]	95% CI
Housing density quintile, units/acre[c]						
<1–4.0	484	9,881	1		1	
4.1–6.7	671	9,550	1.45	1.26, 1.67	1.33	1.14, 1.55
6.8–11.6	839	9,132	1.71	1.48, 1.98	1.48	1.26, 1.75
11.7–25.2	1,256	9,112	2.48	2.17, 2.85	1.98	1.66, 2.34
25.3–161	2,072	9,071	4.21	3.67, 4.83	2.72	2.22, 3.31
P for trend			<0.0001		<0.0001	
Average block area quintile, acres						
7.7–428	595	9,800	1		1	
5.7–7.6	803	9,458	1.24	1.09, 1.41	0.96	0.83, 1.11
4.8–5.6	1,095	9,281	1.53	1.35, 1.74	0.99	0.83, 1.17
4.1–4.7	1,355	9,223	1.71	1.51, 1.95	1.02	0.85, 1.23
<0.5–4.0	1,473	8,981	1.73	1.51, 1.97	1	0.81, 1.23
P for trend			0.015		0.78	
Intersection density quintile, no./mile[2d]						
0–117.0	662	9,687	1		1	
117.1–141.3	913	9,424	1.29	1.14, 1.46	1.05	0.91, 1.20
141.4–163.4	1,068	9,290	1.41	1.25, 1.59	1.09	0.94, 1.26
163.5–199.3	1,275	9,272	1.4	1.24, 1.58	1.01	0.86, 1.19
199.4–600.0	1,404	9,073	1.43	1.26, 1.61	1.05	0.88, 1.27
P for trend			<0.0001		0.52	
Intersections that are 4-way quintile, %						
0–25	632	10,187	1		1	
26–40	783	8,748	1.24	1.09, 1.41	0.92	0.79, 1.06
41–54	1,115	9,661	1.51	1.32, 1.72	0.9	0.77, 1.04
55–68	1,383	9,434	1.96	1.72, 2.23	0.97	0.83, 1.14
69–100	1,409	8,698	2.08	1.81, 2.38	0.93	0.79, 1.11
P for trend			<0.0001		0.55	

Table continues

cycles. Marital status, prior cancer, caregiver responsibilities, and years of education were obtained at baseline in 1995. We estimated energy intake based on responses in 1995 to a 68-item Block National Cancer Institute food frequency questionnaire (13) that assessed consumption of specified foods during the previous year.

Census-block-level covariates

Participants' addresses in 1995, 1997, and 1999 were geocoded. We used factor analysis to create a score for each block group that indicated neighborhood socioeconomic status using 13 variables from the 2000 US Census: median household income; median housing value; median dwelling age; percentage of households receiving interest, dividends, or net rental income; percentage of adults aged ≥25 years who have completed college; percentage of employed persons aged ≥16 years in white-collar occupations; percentage of families with children; percentage of families with children headed by a single female; percentage of owner-occupied units; percentage of the labor force unemployed; percentage below the poverty line; percentage African American; and percentage married. We obtained a measure indicating crime at the block-group level from the Crime-Risk database (Applied Geographic Solutions, Inc., Simi Valley, California). We used the US Census variable percentage of vacant homes as a measure of neighborhood physical disorder (14).

Urban-form variables

Urban-form factors were extracted from the 2000 Census, aerial photography, road network files, and other

Table 2. Continued

Urban-form Variable	No. ≥5 Hours/Week[a]	Total in Quintile[a]	Individual Model OR[b]	95% CI	Mutually Adjusted Model OR[b]	95% CI
Miles to nearest train/ subway/ferry stop quintile, no.						
2.7–97.6	533	9,786	1		1	
1.3–2.6	695	9,467	1.08	0.94, 1.24	0.99	0.86, 1.15
0.7–1.2	964	9,438	1.38	1.20, 1.58	1.07	0.92, 1.25
0.5–0.6	1,285	8,932	1.88	1.64, 2.16	1.15	0.98, 1.35
0–0.4	1,844	9,106	2.63	2.29, 3.03	1.35	1.14, 1.59
P for trend			0.0017		0.63	
Miles of bus routes quintile, no.						
0–0.7	532	9,952	1		1	
0.8–1.3	788	9,569	1.47	1.28, 1.68	1.18	1.03, 1.36
1.4–2.0	873	9,150	1.62	1.41, 1.86	1.16	0.99, 1.35
1.9–3.0	1,240	9,025	2.26	1.98, 2.58	1.41	1.20, 1.64
3.1–10.3	1,889	9,049	3.23	2.83, 3.68	1.44	1.21, 1.72
P for trend			<0.0001		<0.0001	
Street segments with sidewalk coverage, %						
<50	178	2,911	1		1	
≥50	5,144	43,835	1.85	1.54, 2.22	0.95	0.78, 1.17
P for trend			<0.0001		0.25	
Miles to nearest park quintile, no.						
0.85–15.2	806	9,449	1		1	
0.52–0.84	973	9,261	1.2	1.07, 1.35	0.99	0.88, 1.11
0.30–0.51	1,064	9,358	1.26	1.12, 1.41	0.99	0.88, 1.11
0.13–0.29	1,224	9,314	1.45	1.29, 1.62	1.07	0.95, 1.20
0.0–0.12	1,255	9,361	1.41	1.26, 1.58	1.01	0.89, 1.13
P for trend			<0.0001		0.055	

Abbreviations: CI, confidence interval; OR, odds ratio.

[a] Number of observations, not individuals.

[b] Adjusted for age in 5-year categories, region (New York, New York; Chicago, Illinois; Los Angeles, California), year (1995, 1997, 1999), body mass index (<25, 25–29, 30–34, 35–39, ≥40 kg/m^2 and missing), smoking status (former, current, never), alcohol intake (past, current, never, missing), parity (0, 1, 2, 3, ≥4), marital status (separated/divorced/widowed, married, single, missing), caregiver responsibilities (yes, no), years of education (<12, 12, 13–15, 16, >16, missing), number of residential moves in the last 2 years (0, 1, 2), presence of chronic disease (yes, no, missing), history of cancer at baseline (yes, no), energy intake (kilocalories/day) in quintiles and missing, hours of TV viewing per day (<1, 1–2.9, 3–4.9, ≥5), percentage of vacant housing units (quintiles), neighborhood socioeconomic status index (quintiles), and crime index (quintiles).

[c] One acre = 0.4 hectare.

[d] One mile = 1.6 km.

geographic-based data by using geographic information systems. We quantified the following aspects of urban form within a 0.5-mile (1 mile = 1.6 km) network buffer (i.e., a radius based on the street network) around each participant's residential location.

Density and land use. Housing density (units/acre) (1 acre = 0.4 hectare) was calculated from the 2000 US Census as the average of all block areas with a centroid located within each participant's buffer. Land use was described by 2 variables: percentage of the land area in residential use and percentage of the land area in nonresidential use.

Street interconnectedness. The average block size was calculated as the average of all blocks whose centroid was within the buffer. We calculated the number of intersections per square mile and the ratio of 4-way to total intersections for each buffer.

Table 3. Association Between Urban-form Variables and Exercise Walking in Individual and Mutually Adjusted Models, Black Women's Health Study, 1995–2001

Urban-form Variable	No. ≥5 Hours/Week[a]	Total in Quintile[a]	Individual Model OR[b]	95% CI	Mutually Adjusted Model OR[b]	95% CI
Housing density quintile, units/acre[c]						
<1–4.0	1,277	9,984	1		1	
4.1–6.7	1,247	9,596	1.03	0.93, 1.15	1.04	0.93, 1.17
6.8–11.6	1,178	9,167	1.05	0.94, 1.18	1.06	0.93, 1.20
11.7–25.2	1,231	9,109	1.18	1.05, 1.32	1.19	1.03, 1.37
25.3–161	1,300	8,997	1.31	1.16, 1.47	1.28	1.07, 1.52
P for trend			<0.0001		0.013	
Average block area quintile, acres						
7.7–428	1,301	9,889	1		1	
5.7–7.6	1,269	9,497	1.06	0.96, 1.17	0.99	0.88, 1.12
4.8–5.6	1,239	9,307	1.08	0.97, 1.21	0.97	0.84, 1.11
4.1–4.7	1,251	9,214	1.13	1.01, 1.26	0.98	0.84, 1.14
<0.5–4.0	1,172	8,943	1.09	0.97, 1.22	0.92	0.78, 1.10
P for trend			0.87		0.35	
Intersection density quintiles, no./mile[2d]						
0–117.0	1,248	9,787	1		1	
117.1–141.3	1,258	9,457	1.08	0.98, 1.20	1.08	0.96, 1.20
141.4–163.4	1,269	9,298	1.13	1.01, 1.25	1.12	1.00, 1.27
163.5–199.3	1,250	9,283	1.11	1.00, 1.23	1.11	0.97, 1.27
199.4–600.0	1,208	9,028	1.13	1.01, 1.26	1.16	0.99, 1.36
P for trend			0.14		0.77	
Intersections that are 4-way quintile, %						
0–25	1,341	10,271	1		1	
26–40	1,183	8,786	1.07	0.96, 1.18	1.05	0.94, 1.17
41–54	1,266	9,686	1.06	0.95, 1.18	0.99	0.88, 1.12
55–68	1,289	9,428	1.14	1.02, 1.27	1.05	0.91, 1.20
69–100	1,154	8,664	1.13	1.00, 1.27	1.03	0.89, 1.20
P for trend			0.036		0.93	

Table continues

Traffic. We used the total length per buffer of major roads (highways, arterials, and divided secondary roads) to indicate the relative safety of the walking environment in terms of barriers from traffic and infrastructure.

Availability of public transit and buses. We calculated the shortest distance from each participant's residence to a subway, train, or ferry stop. The availability of bus service was represented by length of bus routes contained within each buffer.

Presence of sidewalks and distance to parks. We superimposed road networks on aerial photographs to determine the percentage of road segments with sidewalks in each buffer. Using geographic information systems park data layers, we defined as parks polygons of at least 5 acres that were categorized as developed and maintained recreation areas.

Statistical analysis

We estimated the associations of the urban-form variables with utilitarian walking, exercise walking, and vigorous physical activity using a repeated-measures generalized estimating equation model in SAS 9.1 software (SAS Institute, Inc., Cary, North Carolina). Because correlation between block groups was negligible, it was not necessary to adjust for that level of clustering. The associations were measured with odds ratios and 95% confidence intervals for $\geq$5 hours a week relative to $<$5 hours a week. We chose 5 hours a week as the cutoff rather than the recommended physical activity level of 2.5 hours a week of moderate-level activity (including brisk walking) because 1) the response categories for the physical activity questions did not enable us to identify 2.5

Table 3. Continued

Urban-form Variable	No. ≥5 Hours/Week[a]	Total in Quintile[a]	Individual Model OR[b]	95% CI	Mutually Adjusted Model OR[b]	95% CI
Miles to nearest train/ subway/ferry stop quintile, no.						
2.7–97.6	1,378	9,893	1		1	
1.3–2.6	1,210	9,501	0.98	0.88, 1.09	0.98	0.88, 1.09
0.7–1.2	1,184	9,474	1.01	0.90, 1.13	0.97	0.86, 1.10
0.5–0.6	1,203	8,936	1.11	0.98, 1.25	1.02	0.89, 1.16
0–0.4	1,258	9,032	1.16	1.02, 1.31	1.01	0.87, 1.17
P for trend			0.046		0.15	
Miles of bus routes quintiles, no.						
0–0.7	1,328	10,063	1		1	
0.8–1.3	1,177	9,603	0.95	0.85, 1.05	0.91	0.82, 1.02
1.4–2.0	1,202	9,187	1.02	0.91, 1.13	0.96	0.85, 1.08
1.9–3.0	1,243	9,037	1.09	0.98, 1.21	0.99	0.87, 1.13
3.1–10.3	1,283	8,962	1.16	1.04, 1.30	0.98	0.84, 1.15
P for trend			0.0007		0.55	
Street segments with sidewalk coverage, %						
<50	398	2,939	1		1	
≥50	5,835	43,914	0.97	0.84, 1.11	0.86	0.74, 1.01
P for trend			0.29		0.51	
Miles to nearest park quintile, no.						
0.85–15.2	1,302	9,509	1		1	
0.52–0.84	1,161	9,236	0.91	0.82, 1.01	0.89	0.80, 0.99
0.30–0.51	1,199	9,368	0.96	0.86, 1.06	0.93	0.83, 1.03
0.13–0.29	1,258	9,336	1.02	0.92, 1.13	0.98	0.88, 1.09
0.0–0.12	1,313	9,401	1.06	0.96, 1.17	1.01	0.91, 1.12
P for trend			0.11		0.57	

Abbreviations: CI, confidence interval; OR, odds ratio.

[a] Number of observations, not individuals.

[b] Adjusted for age in 5-year categories, region (New York, New York; Chicago, Illinois; Los Angeles, California), year (1995, 1997, 1999), body mass index (<25, 25–29, 30–34, 35–39, ≥40 and missing), smoking status (former, current, never), alcohol intake (past, current, never, missing), parity (0, 1, 2, 3, ≥4), marital status (separated/ divorced/widowed, married, single, missing), caregiver responsibilities (yes, no), years of education (<12, 12, 13–15, 16, >16, missing), number of residential moves in the last 2 years (0, 1, 2), presence of chronic disease (yes, no, missing), history of cancer at baseline (yes, no), energy intake (kilocalories/day) in quintiles and missing, hours of TV viewing per day (<1, 1–2.9, 3–4.9, ≥5), percentage of vacant housing units (quintiles), neighborhood socioeconomic status index (quintiles), and crime index (quintiles).

[c] One acre = 0.4 hectare.

[d] One mile = 1.6 km.

hours a week, and 2) most walking was likely to have been at a slower pace than the recommended pace of brisk.

We categorized most urban-form variables as quintiles based on the distribution of all study areas combined in 1995. Length of major roads was categorized in 4 groups (zero and tertiles of nonzero length based on distribution in all study areas in 1995), and percentage of streets with sidewalks was categorized as a binary variable (<50%, ≥50%). We ordered the urban-form variables so that the lowest category was the least urban and the highest was the most urban. All odds ratios were adjusted for age, study region, survey year, body mass index (weight in kilograms/height in meters^2), smoking status, alcohol intake, parity, marital status, caregiver responsibilities, years of education, number of residential moves over the follow-up period, presence of chronic disease, history of cancer at baseline, energy intake (kilocalories/day), hours of TV viewing per day, percentage of vacant housing units in the block group, neighborhood socioeconomic status score, and crime index. Missing values were modeled as a separate category.

We estimated the effect of each urban-form factor in separate multivariate models and then included all urban-form factors in a single model to estimate their independent effects. We tested for trend by including urban-form variables in the model as continuous variables. We conducted analyses stratified by study area, neighborhood socioeconomic status (quintiles), housing density (tertiles), years of education (<12, ≥12), and age (<45, ≥45 years). We assessed interaction by including cross-product terms in the models. All reported P values are 2-sided. Models were lagged such that the independent variables predicted walking and physical activity 2 years later.

We used multinomial logistic regression generalized estimating equation models in SUDAAN Statistical Software (RTI International, Research Triangle Institute, Research Triangle Park, North Carolina) to estimate the odds that a woman changed her level of utilitarian walking or exercise walking among women who moved once during the follow-up period. The 3-category outcome was 1) increased walking by at least one category of the original 7-category variable (0, <1, 1–2, 3–4, 5–6, 7–9, and ≥10 hours/week), 2) decreased walking by at least one category of the 7-category variable, and 3) no change in the level of walking (reference). The exposure variable was categorized as 1) increased housing density by at least one quintile, 2) decreased housing density by at least one quintile, and 3) remained in the same quintile of housing density (reference group). We considered the effect of change in neighborhood on change in walking within the same 2-year period because changes in walking behavior are likely to occur in a short period after moving to a more- or less-dense area.

RESULTS

Women in New York were younger and had completed fewer years of education than women in the other cities (Table 1). Women were heaviest in Chicago, and women from Los Angeles were least likely to smoke. Levels of vigorous exercise and exercise walking were highest in Los Angeles, and levels of utilitarian walking were highest in New York. New York was the most dense and urban regarding most measures of urban form, and Los Angeles was the least. No urban-form variable was significantly associated with vigorous physical activity (data not shown). The remainder of this paper concerns utilitarian and exercise walking only.

Table 2 shows the associations between utilitarian walking and the urban-form variables when included in the individual models and in the mutually adjusted model. Because length of major roads and the 2 measures of land use were not associated with any of the 3 outcomes (data not shown), they were not included in the mutually adjusted model. All of the urban-form variables in Table 2, when considered individually, were significantly and positively associated with utilitarian walking. Upon mutual adjustment, housing density, bus availability, and distance to transit retained significant associations with utilitarian walking, although the trend was not significant for distance to transit. The association with housing density was strongest: the odds ratio was 2.72 (95% confidence interval (CI): 2.22, 3.31) for the highest relative to the lowest quintile.

Housing density, bus availability, and distance to transit were associated with exercise walking (Table 3) when considered individually, but the associations were considerably weaker than those for utilitarian walking. After mutual adjustment, housing density was the only significant predictor of exercise walking: the odds ratio was 1.28 (95% CI: 1.07, 1.52) for the highest relative to the lowest quintile.

To determine whether the associations of utilitarian walking with bus availability and distance to transit reflected residual correlations with housing density, we estimated odds ratios associated with quintiles of the 2 variables within tertiles of housing density (Table 4). The associations between bus availability and distance to transit were more marked in the second and third tertiles of housing density than in the first (least-dense) quintile. There was evidence of statistical interaction between housing density and bus availability ($P = 0.025$).

To assess whether the amount of sidewalk coverage influenced walking in areas of low density, we restricted the analysis to the first 2 quintiles of housing density and calculated the odds of walking ≥5 hours a week for women living in areas in which ≥80% of the street had sidewalk-coverage segments (93% of observations) compared with <50%. The odds ratios were 1.05 (95% CI: 0.84, 1.31) for utilitarian walking and 0.90 (95% CI: 0.76, 1.07) for exercising walking. In the 2 highest quintiles of housing density, there were too few observations (<0.5%) with <50% sidewalk coverage for analysis.

We calculated city-specific odds ratios for utilitarian walking using models that included housing density, distance to transit, and bus availability (Table 5). In each of the 3 cities, the association with housing density was stronger than associations with distance to transit or bus availability. Odds ratios were highest in New York, with significant trends for all 3 variables. In Chicago, there were significant trends for associations with housing density and distance to transit, with a weaker association and marginally significant trend for bus availability. In Los Angeles, the odds ratios for housing density and bus availability were in the same direction as in the other cities, but trends were not significant. We found no association with distance to transit.

The proportion of women who reported utilitarian walking was highest in New York and lowest in Los Angeles (Table 1). When we accounted for all confounders in the analysis except the urban-form variables, women in Chicago were 42% less likely to walk ≥5 hours a week (odds ratio (OR) = 0.58, 95% CI: 0.52, 0.62), and women in Los Angeles were 65% less likely to walk ≥5 hours a week (OR = 0.36, 95% CI: 0.32, 0.40) than women in New York. Part, but not all, of this difference was explained by urban

Table 4. Effect of Bus and Transit Availability on Utilitarian Walking by Tertile of Housing Density, Black Women's Health Study, 1995–2001

Tertile of Housing Density[a]	Miles[b] of Bus Routes					Distance to the Nearest Transit Stop				
	Quintile	No. ≥5 Hours/Week[c]	Total in Quintile[c]	OR[d]	95% CI	Quintile	No. ≥5 Hours/Week[c]	Total in Quintile[c]	OR[d]	95% CI
1	1	409	8,087	1		1	302	6,444	1	
	2	278	4,633	1.12	0.93, 1.34	2	284	5,118	1.06	0.86, 1.30
	3	161	2,246	1.34	1.06, 1.70	3	201	2,951	1.23	0.97, 1.56
	4	57	1,008	0.96	0.69, 1.33	4	107	1,309	1.36	1.01, 1.83
	5	24	302	1.69	0.98, 2.92	5	35	452	1.21	0.76, 1.95
P for trend				0.059					0.9336	
2	1	111	1,734	1		1	206	2,991	1	
	2	321	3,711	1.32	1.01, 1.71	2	272	3,369	0.95	0.75, 1.19
	3	454	4,881	1.42	1.10, 1.83	3	419	4,267	1.05	0.83, 1.34
	4	469	4,077	1.79	1.38, 2.31	4	355	3,128	1.23	0.97, 1.57
	5	103	923	1.93	1.37, 2.70	5	206	1,568	1.45	1.11, 1.90
P for trend				<0.0001					0.1517	
3	1	12	131	1		1	25	351	1	
	2	189	1,225	1.82	0.92, 3.58	2	139	980	1.05	0.58, 1.92
	3	258	2,023	1.37	0.70, 2.68	3	344	2,220	1.18	0.67, 2.06
	4	714	3,940	1.81	0.94, 3.48	4	823	4,495	1.36	0.78, 2.38
	5	1,762	7,824	2.17	1.13, 4.16	5	1,603	7,086	1.72	0.99, 2.99
P for trend				<0.0001					<0.0001	

Abbreviations: CI, confidence interval; OR, odds ratio.
[a] Range in units per acre (1 acre = 0.4 hectare): tertile 1, <1–5.6; tertile 2, 5.7–14.4; tertile 3, 14.5–161.0.
[b] One mile = 1.6 km.
[c] Number of observations, not individuals.
[d] Adjusted for age in 5-year categories, region (New York, New York; Chicago, Illinois; Los Angeles, California), year (1995, 1997, 1999), body mass index (<25, 25–29, 30–34, 35–39, ≥40 kg/m^2 and missing), smoking status (former, current, never), alcohol intake (past, current, never, missing), parity (0, 1, 2, 3, ≥4), marital status (separated/divorced/widowed, married, single, missing), caregiver responsibilities (yes, no), years of education (<12, 12, 13–15, 16, >16, missing), number of residential moves in the last 2 years (0, 1, 2), presence of chronic disease (yes, no, missing), history of cancer at baseline (yes, no), energy intake (kilocalories/day) in quintiles and missing, hours of TV viewing per day (<1, 1–2.9, 3–4.9, ≥5), percentage of vacant housing units (quintiles), neighborhood socioeconomic status index (quintiles), and crime index (quintiles).

form; when all urban-form variables were included in the model, the odds ratios were attenuated to 0.83 (95% CI: 0.75, 0.94) for Chicago and 0.61 (95% CI: 0.53, 0.70) for Los Angeles.

Odds ratios for utilitarian walking and exercise walking were similar across strata of education, age, and neighborhood socioeconomic status score (data not shown).

Table 6 shows the odds of increasing or decreasing the level of utilitarian and exercise walking among women who moved once within the study region during follow-up. Women who moved to less-dense neighborhoods were significantly more likely to report decreased levels of utilitarian walking (OR = 1.36, 95% CI: 1.14, 1.62) compared with women who moved to neighborhoods of similar density (reference). Women who moved to more-dense neighborhoods were 23% more likely to report increased levels of utilitarian walking, although the odds ratio was not significant (OR = 1.23, 95% CI: 0.98, 1.55). Women who moved to more dense neighborhoods were more likely to report increased (OR = 1.26, 95% CI: 1.05, 1.52) or decreased (OR = 1.31, 95% CI: 1.09, 1.56) levels of exercise walking compared with the reference group. Women who moved to less-dense neighborhoods were not more likely than the reference group to report changes in exercise walking.

DISCUSSION

In this population of African-American women, housing density was strongly related to utilitarian walking. Bus availability and distance to transit were less strongly, but significantly associated with utilitarian walking, and their influence was stronger in areas of higher housing density. Housing density was also associated with walking for exercise, but the association was much weaker than that with utilitarian walking. None of the urban-form variables studied was associated with vigorous exercise.

The associations of housing density, distance to transit, and length of bus routes with utilitarian walking were strongest in New York, with weaker associations in Chicago and weaker yet in Los Angeles. As noted, the effects of bus availability and distance to transit increased as housing density increased. Los Angeles is, on average, far less dense than New York and Chicago and may lack

Table 5. Association of Housing Density and Measures of Transit Availability With Utilitarian Walking by City, Black Women's Health Study, 1995–2001

	New York, New York				Chicago, Illinois				Los Angeles, California			
	No. ≥5 Hours/Week[a]	Total in Quintile[a]	OR[b]	95% CI	No. ≥5 Hours/Week[a]	Total in Quintile[a]	OR[b]	95% CI	No. ≥5 Hours/Week[a]	Total in Quintile[a]	OR[b]	95% CI
Housing density quintile												
1	200	4,061	1		144	2,670	1		140	3,150	1	
2	236	2,766	1.57	1.24, 1.99	259	3,124	1.42	1.08, 1.86	176	3,660	0.95	0.72, 1.25
3	362	3,722	1.55	1.22, 1.97	296	2,751	1.7	1.26, 2.29	181	2,659	1.25	0.92, 1.69
4	941	5,997	2.33	1.82, 2.97	235	2,052	1.84	1.33, 2.54	80	1,063	1.42	0.95, 2.13
5	2,001	8,465	3.16	2.42, 4.13	70	534	1.93	1.24, 3.02	1	72		
P for trend			<0.0001				0.06				0.18	
Distance to the nearest transit stop quintile												
1	140	2,295	1		75	1,350	1		318	6,141	1	
2	403	4,616	1.06	0.84, 1.35	139	1,999	1.03	0.72, 1.46	153	2,852	0.97	0.76, 1.23
3	637	5,571	1.15	0.91, 1.46	259	2,867	1.11	0.76, 1.64	68	1,000	1.17	0.87, 1.58
4	961	5,472	1.29	1.01, 1.64	294	2,982	1.11	0.76, 1.63	30	478	0.98	0.63, 1.54
5	1,599	7,047	1.46	1.14, 1.88	236	1,930	1.34	0.91, 1.97	9	129	1.15	0.59, 2.25
P for trend			0.02				0.02				1	
Miles of bus routes quintile												
1	241	4,328	1		176	2,828	1		115	2,796	1	
2	384	4,067	1.25	1.02, 1.54	271	2,938	1.13	0.88, 1.45	133	2,564	1.14	0.86, 1.53
3	418	3,639	1.31	1.04, 1.65	314	3,214	1.02	0.78, 1.34	141	2,297	1.25	0.90, 1.72
4	935	5,299	1.68	1.34, 2.09	168	1,621	1.05	0.78, 1.41	137	2,105	1.25	0.90, 1.74
5	1,762	7,677	1.66	1.30, 2.11	75	530	1.25	0.83, 1.87	52	842	1.18	0.76, 1.84
P for trend			<0.0001				0.05				0.27	

Abbreviations: CI, confidence interval; OR, odds ratio.

[a] Number of observations, not individuals.

[b] Adjusted for age in 5-year categories, year (1995, 1997, 1999), body mass index (<25, 25–29, 30–34, 35–39, ≥40 kg/m^2 and missing), smoking status (former, current, never), alcohol intake (past, current, never, missing), parity (0, 1, 2, 3, ≥4), marital status (separated/divorced/widowed, married, single, missing), caregiver responsibilities (yes, no), years of education (<12, 12, 13–15, 16, >16, missing), number of residential moves in the last 2 years (0, 1, 2), presence of chronic disease (yes, no, missing), history of cancer at baseline (yes, no), energy intake (kilocalories/day) in quintiles and missing, hours of TV viewing per day (<1, 1–2.9, 3–4.9, ≥5), percentage of vacant housing units (quintiles), neighborhood socioeconomic status index (quintiles), and crime index (quintiles).

Table 6. Association Between Change in Housing Density and Change in Utilitarian and Exercise Walking Among Black Women's Health Study Participants Who Moved Once Between 1995 and 2001

Change in Housing Density	Change[a] in Utilitarian Walking								Change[a] in Exercise Walking							
	Increased vs. No Change				Decreased vs. No Change				Increased vs. No Change				Decreased vs. No Change			
	No.[b]	Total in Cell[b]	OR[c]	95% CI	No.[b]	Total in Cell[b]	OR[c]	95% CI	No.[b]	Total in Cell[b]	OR[c]	95% CI	No.[b]	Total in Cell[b]	OR[c]	95% CI
No change	2,081	7,008	1		2,017	7,008	1		3,332	11,029	1		3,541	11,029	1	
Increase of at least 1 quintile	145	449	1.23	0.98, 1.55	133	449	1.09	0.86, 1.38	231	739	1.26	1.05, 1.52	268	739	1.31	1.09, 1.56
Decrease of at least 1 quintile	209	774	1	0.83, 1.21	259	774	1.36	1.14, 1.62	400	1,393	0.97	0.85, 1.12	471	1,393	1.04	0.91, 1.19

Abbreviations: CI, confidence interval; OR, odds ratio.

[a] Increased or decreased by at least 1 category of the multinomial outcome (0, <1, 1–2, 3–4, 5–6, 7–9, and ≥10 hours/week).

[b] Number of observations, not individuals.

[c] Adjusted for age in 5-year categories, region (New York, New York; Chicago, Illinois; Los Angeles, California), year (1995, 1997, 1999), body mass index (<25, 25–29, 30–34, 35–39, ≥40 kg/m^2 and missing), smoking status (former, current, never), alcohol intake (past, current, never, missing), parity (0, 1, 2, 3, ≥4), marital status (separated/divorced/widowed, married, single, missing), caregiver responsibilities (yes, no), years of education (<12, 12, 13–15, 16, >16, missing), presence of chronic disease (yes, no, missing), history of cancer at baseline (yes, no), energy intake (kilocalories/day) in quintiles and missing, hours of TV viewing per day (<1, 1–2.9, 3–4.9, ≥5), percentage of vacant housing units (quintiles), neighborhood socioeconomic status index (quintiles), and crime index (quintiles).

the housing density necessary for bus and transit availability to exert an influence on walking. There was a similar finding in the SMARTRAQ study, in which intersection density was related to walking in only the highest tertile of housing density (15). That study was conducted in Atlanta, Georgia, which is also a low-density city. Urban form only partly explained the difference in associations among the cities. Region-specific cultural attitudes toward walking, automobiles, and public transit are likely to differ, and these differences may have contributed to the different effects of density and transit availability on walking in the 3 regions.

Our findings agree with those of previous geographic information systems–based cross-sectional studies, which have consistently shown that residents of dense, traditional neighborhoods report higher levels of utilitarian walking than do residents of automobile-oriented suburban neighborhoods (1–6, 16–20). The most consistently reported observations have been positive associations between utilitarian walking and measures of density (19, 21–26), street interconnectedness (21, 22, 24, 27), public transit accessibility (19, 28, 29), and mixed land use (6, 23, 30) and inverse associations with proximity to retail and other attractive destinations (22–24, 28, 30–33). Data are less consistent for the presence and condition of sidewalks (19, 28, 34) and accessibility of parks (19, 28, 33, 35). Our finding of a stronger association between urban form and utilitarian walking than with exercise walking is also consistent with previous findings (5).

Ours is the first study of objectively measured urban form and physical activity in a large cohort of African-American women. The SMARTRAQ survey published sex- and race-specific results: street connectivity, land use mix, and residential density were directly associated with distance walked (as reported in a 2-day travel diary) among 2,240 black women, although the associations were statistically significant for only the first 2 variables (7). Another study found no association between neighborhood walkability and 3-month adherence to a walking intervention program among 253 black women (36). Seven other studies have been conducted among African Americans (37) but used self-reported perceptions of neighborhood characteristics as the exposures and are not comparable with our data.

To our knowledge, our study is unique in having estimated changes in walking among women who moved to neighborhoods of higher or lower density. We found that women who moved to neighborhoods of lower housing density were more likely to decrease their level of utilitarian walking than women who moved to neighborhoods of a similar housing density. Conversely, women who moved to neighborhoods of higher density were more likely to increase their level of utilitarian walking, although this result was not statistically significant. The analysis of movers precluded selection bias because women served as their own controls.

Major strengths of the present study were its large size, conferring statistical power; geographic scope, allowing comparisons among 3 regions; and focus on African-American women, who have been understudied with respect to the influence of urban form on physical activity. We were able to control for a wide range of individual- and neighborhood-level factors that might confound associations with urban form. The major challenge was to describe the urban form of each participant's neighborhood with detail adequate to capture urban form for the 9,850 square miles included in the study. We used information available from centralized sources such as Census Tiger files (digital geographic databases) and aerial photography. We lacked data available only from field survey or self-report, such as neighborhood aesthetics and sidewalk conditions. Our land use measure was relatively crude because it was the common denominator available for all areas. This is a limitation because other studies have shown that specific destinations within walking distance may be key factors influencing walking behavior (22–24, 28, 30–33). In general, the methods we used to characterize urban form were the best available that were also feasible given the size of the study areas and the different ways that data were maintained in the 3 areas. Our measurement of physical activity had limitations; we ascertained exercise and walking as an average of activity over the past year and did not obtain frequency or intensity of activity. Misclassification, if random, would have tended to dilute associations.

We used a model that accounted for correlation between observations across time but not for correlations at the level of a 0.5-mile buffer or the block group because there was little overlap between the 0.5-mile buffers, and the intraclass correlation coefficients at the block group level were negligible. In a sensitivity analysis, we estimated the effects of the urban-form variables on utilitarian walking while adjusting for clustering at the block group level, and results did not change.

In conclusion, our data suggest that dense neighborhoods with accessible public transportation promote utilitarian walking and that increases in housing density may lead to increases in utilitarian walking. The Centers for Disease Control and Prevention recommends that adults engage in 2.5 hours of moderate-intensity aerobic activity per week and suggest that they do so by walking, since it is aerobic, is associated with a low injury rate, and can be accomplished in many settings (38). Dense neighborhoods may allow people to reach recommended levels of walking in the course of accomplishing daily activities.

ACKNOWLEDGMENTS

Author affiliations: Slone Epidemiology Center at Boston University, Boston, Massachusetts (Patricia F. Coogan, Julie R. Palmer, Lynn Rosenberg); Department of Biostatistics, Boston University School of Public Health, Boston, Massachusetts (Laura F. White); and Resource Systems Group, Inc., White River Junction, Vermont (Thomas J. Adler, Kevin M. Hathaway).

This work was supported by a grant from the National Heart, Lung, and Blood Institute (HL08139). Study infrastructure, data collection, and follow-up of study participants were supported by the National Cancer Institute (CA58420).

Conflict of interest: none declared.

REFERENCES

1. Transportation Research Board. Committee on Physical Activity, Health, Transportation, and Land Use. *Does the Built Environment Influence Physical Activity? Examining the Evidence*. Washington, DC: Transportation Research Board; 2005. (TRB special report 282).
2. Badland HM, Schofield G. Transport, urban design, and physical activity: an evidence-based update. *Trans Res Part D: Trans Environ*. 2005;10(3):177–196.
3. Humpel N, Owen N, Leslie E. Environmental factors associated with adults' participation in physical activity: a review. *Am J Prev Med*. 2002;22(3):188–199.
4. Owen N, Humpel N, Leslie E, et al. Understanding environmental influences on walking; review and research agenda. *Am J Prev Med*. 2004;27(1):67–76.
5. Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc*. 2008;40(7 suppl): S550–S566.
6. Frank LD, Schmid TL, Sallis JF, et al. Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ. *Am J Prev Med*. 2005; 28(2 suppl. 2):117–125.
7. Frank LD, Andresen MA, Schmid TL. Obesity relationships with community design, physical activity, and time spent in cars. *Am J Prev Med*. 2004;27(2):87–96.
8. Schoenborn CA, Barnes PM. *Leisure-Time Physical Activity Among Adults: United States, 1997–1998.* Advance Data From Vital and Health Statistics; No. 325. Hyattsville, MD: National Center for Health Statistics; 2002.
9. Flegal KM, Carroll MD, Ogden CL, et al. Prevalence and trends in obesity among US adults, 1999–2000. *JAMA*. 2002; 288(14):1723–1727.
10. Freedman DS, Khan LK, Serdula MK, et al. Trends and correlates of class 3 obesity in the United States from 1990 through 2000. *JAMA*. 2002;288(14):1758–1761.
11. Rosenberg L, Adams-Campbell L, Palmer JR. The Black Women's Health Study: a follow-up study for causes and preventions of illness. *J Am Med Womens Assoc.* 1995;50(2): 56–58.
12. Russell C, Palmer JR, Adams-Campbell LL, et al. Follow-up of a large cohort of black women. *Am J Epidemiol*. 2001; 154(9):845–853.
13. Block G, Hartman AM, Naughton D. A reduced dietary questionnaire: development and validation. *Epidemiology.* 1990;1(1):58–64.
14. Perkins DD, Taylor RB. Ecological assessments of community disorder: their relationship to fear of crime and theoretical implications. *Am J Community Psychol*. 1996;24(1): 63–107.
15. Frank LD, Kerr J, Sallis JF, et al. A hierarchy of sociodemographic and environmental correlates of walking and obesity. *Prev Med*. 2008;47(2):172–178.
16. Cervero R, Gorham R. Commuting in transit versus automobile neighborhoods. *J Am Plann Assoc.* 1995;Spring:210–225.
17. Friedman B, Gordon SP, Peers JB. Effect of neo-traditional neighborhood design on travel characteristics. *Transp Res Rec*. 1994;1466:63–70.
18. Handy S. Understanding the link between urban form and nonwork travel behavior. *J Plann Educ Res.* 1996;15:183–198.
19. Kitamura R, Mokhtarian PL, Laidet L. A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay area. *Transportation*. 1997;24(2):125–158.
20. Rodriguez DA, Khattak AJ, Evenson KR. Can new urbanism encourage physical activity? *J Am Plann Assoc.* 2006;72(1): 43–54.

21. Greenwald J, Boarnet M. Built environment as determinant of walking behavior: analyzing nonwork pedestrian travel in Portland, Oregon. *Transp Res Rec*. 2001;1780:32–42.
22. Moudon AV, Lee C, Cheadle AD, et al. Operational definitions of walkable neighborhood: theoretical and empirical insights. *J Phys Act Health*. 2006;3(suppl 1):S99–S117.
23. Frank LS, Pivo G. Impacts of mixed use and density on utilization of three models of travel: single-occupant vehicle, transit, and walking. *Transp Res Rec*. 1995;1466:44–52.
24. Berke EM, Koepsell TD, Moudon AV, et al. Association of the built environment with physical activity and obesity in older persons. *Am J Public Health*. 2007;97(3):486–492.
25. Li F, Fisher KJ, Brownson RC, et al. Multilevel modelling of built environment characteristics related to neighbourhood walking activity in older adults. *J Epidemiol Community Health*. 2005;59(7):558–564.
26. Forsyth A, Oakes JM, Schmitz KH, et al. Does residential density increase walking and other physical activity? *Urban Stud*. 2007;44(4):679–697.
27. Li F, Harmer PA, Cardinal BJ, et al. Built environment, adiposity, and physical activity in adults aged 50–75. *Am J Prev Med*. 2008;35(1):38–46.
28. Hoehner CM, Brennan Ramirez LK, Elliott MB, et al. Perceived and objective environmental measures and physical activity among urban adults. *Am J Prev Med*. 2005;28(2 suppl. 2): 105–116.
29. McCormack GR, Giles-Corti B, Bulsara M. The relationship between destination proximity, destination mix and physical activity behaviors. *Prev Med*. 2008;46(1):33–40.
30. Cervero R, Duncan M. Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay Area. *Am J Public Health*. 2003;93(9):1478–1483.
31. Cerin E, Leslie E, du Toit L, et al. Destinations that matter: associations with walking for transport. *Health Place*. 2007; 13(3):713–724.
32. King WC, Brach JS, Belle S, et al. The relationship between convenience of destinations and walking levels in older women. *Am J Health Promot*. 2003;18(1):74–82.
33. Nagel CL, Carlson NE, Bosworth M, et al. The relation between neighborhood built environment and walking activity among older adults. *Am J Epidemiol*. 2008;168(4): 461–468.
34. Rodríguez DA, Aytur S, Forsyth A, et al. Relation of modifiable neighborhood attributes to walking. *Prev Med*. 2008;47(3): 260–264.
35. King WC, Belle SH, Brach JS, et al. Objective measures of neighborhood environment and physical activity in older women. *Am J Prev Med*. 2005;28(5):461–469.
36. Zenk SN, Wilbur J, Wang E, et al. Neighborhood environment and adherence to a walking intervention in African American women. *Health Educ Behav*. 2009;36(1):167–181.
37. Casagrande SS, Whitt-Glover MC, Lancaster KJ, et al. Built environment and health behaviors among African Americans: a systematic review. *Am J Prev Med*. 2009;36(2): 174–181.
38. US Department of Health and Human Services. *2008 Physical Activity Guidelines for Americans*. (www.health.gov/paguidelines). (Accessed February 1, 2009).