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Neighborhood Factors Influence Physical Activity among African American and Hispanic or Latina Women

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Abstract

This study investigated the relationship between neighborhood street scale elements, such as traffic lights and crossing aids, and physical activity (PA) adoption and maintenance in African American and Hispanic or Latina women. Women (N=309) participated in a 6-month intervention and completed baseline and post-intervention assessments of PA. Trained field assessors completed the Pedestrian Environment Data Scan in participants' neighborhoods. Adjusted linear regression models found attractiveness for bicycling significantly predicted post-intervention accelerometer-measured PA. Greater traffic control devices and crossing aids were associated with greater PA among women assigned to the PA intervention group, and greater street amenities were associated with greater PA among those in the comparison group. Neighborhood factors may interact favorably with behavioral interventions to promote PA adoption and maintenance, and should be considered in health promotion efforts.

Keywords

Physical activity; obesity; built environment; Geographic Information Systems (GIS); minority health; women

1. Introduction

Although the benefits of adopting physical activity are well publicized (U.S. Department of Health and Human Services, 1996, U.S. Department of Health and Human Services, 2008, World Health Organization, 2011, Centers for Disease Control and Prevention, 2009b), worldwide, approximately 31% of adults are physically inactive (World Health Organization, 2008). Recent data show physical *in*activity rates remain high in the U.S., especially among minorities and women (Troiano et al., 2008, Centers for Disease Control and Prevention, 2009a). Ethnic minority women report the lowest rates of PA of any population sub-group in the US, with only 36.3% of African American and 41.8% of Hispanic or Latina women achieving recommended levels of physical activity compared to 50.1% of white women (Centers for Disease Control and Prevention, 2007). In response to this alarming health disparity, a growing number of intervention studies have been

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conducted, specifically focusing on African American and Hispanic or Latina women. However, adoption and maintenance of new health behaviors in these groups has been difficult to achieve, and has resulted in researchers looking to the importance of physical environmental factors in the adoption and maintenance of physical activity. Neighborhood features may influence physical activity (Sallis and Owen, 1997, Sallis et al., 1998, Spence and Lee, 2003, Heinrich et al., 2007). In countries like the U.S. and Australia, many forms of routine physical activity are done in convenient places, like neighborhood streets and sidewalks (Brownson et al., 2005, Giles-Corti and Donovan, 2003, Lopez et al., 2008). Perhaps the most commonly reported physical activity, walking, has the advantage of better sustainability with minimal equipment or additional costs (e.g., gym memberships) (Centers for Disease Control and Prevention, 2011, Spence and Lee, 2003, Humpel et al., 2002, Heinrich et al., 2008). Thus, interventions which focus on lifestyle physical activities, which can be done in convenient neighborhood locations (Lee and Cubbin, 2009) and incorporate relevant neighborhood environmental factors, have great promise (Sallis et al., 1998, Spence and Lee, 2003, Heinrich et al., 2007, Handy et al., 2002, Parks et al., 2003, Saelens et al., 2003). However, few studies have investigated micro, street-scale elements, like traffic control devices, pedestrian crossing aids, and overall attractiveness and safety, which may be important to inform these efforts, and fewer studies have looked at the longitudinal relationship between the environment and physical activity.

The Ecologic Model of Physical Activity (EMPA) identifies micro-, exo-, meso- and macro-environmental influences that shape physical activity adoption and maintenance (Spence and Lee, 2003). The EMPA posits that proximal micro-environmental factors, such as neighborhood street-scale elements, that create favorable or unfavorable routes for residents' physical activities are critical for physical activity adoption. These include factors like having attractive and safe paths for doing physical activities like walking or cycling (Lee and Cubbin, 2009, Spence and Lee, 2003). Neighborhoods where residents report safe and attractive streets promote walking, the most commonly reported physical activity among ethnic minority women (Giles-Corti and Donovan, 2003, Moudon et al., 2007, Reis et al., 2008, Centers for Disease Control and Prevention, 2000, Eyler et al., 2003). People who live near streets with minor traffic and trees, or streets with footpaths or sidewalks, are more likely to achieve recommended levels of physical activity, regardless of their individual income, education or ethnic background (Giles-Corti and Donovan, 2003). Although research has begun to investigate the hypothesized relationship between neighborhood street-scale elements and physical activity, few studies have looked at this relationship due to the laborious nature of data collection. Street-scale elements require detailed auditing of individual street segments and complex analytic strategies to combine aggregated environmental characteristics with individual physical activity patterns.

Many associations between environmental variables and physical activity have been found worldwide (Hoehner et al., 2005, Humpel et al., 2002, Gebel et al., 2007, Moudon and Lee, 2003, Sallis et al., 2009). For example, the presence of bicycle lanes and bicycle facilities has been associated with both leisure-time and transportation-related physical activity (Hoehner et al., 2005, Sallis et al., 2009). However, many of these findings are based on perceived or resident self-reported environmental variables (Humpel et al., 2002, Gebel et al., 2007) and self-reported physical activity (Hoehner et al., 2005), with few studies using objective, in-person audits of the environment and objectively measured physical activity (Moudon and Lee, 2003). Earlier research suggests that perceived and objective measures of environmental attributes may relate to physical activity differently (Boehmer et al., 2006, McCormack et al., 2008, McGinn et al., 2007), and self-reported and objectively measured physical activity may relate to environmental attributes differently (Van Dyck et al., 2010, Saelens et al., 2003). Reported neighborhood characteristics may be colored by experience or biased by memories, while objective assessment of street-scale elements can document what is actually there and provide information important for policy and municipal improvements.

This study investigated the relationship between neighborhood street scale elements and physical activity adoption and maintenance in a sample of African American and Hispanic or Latina women. We hypothesized that neighborhood street scale elements, such as path connectivity, number of automobile travel lanes, traffic control devices, crossing aids, posted speed limit, pedestrian amenities and observed safety and attractiveness for walking and bicycling, would influence physical activity, specifically moderate-vigorous intensity physical activity and walking, after a physical activity intervention.

2. Method

Health Is Power (HIP) was a multi-site, longitudinal, community based, randomized controlled trial to increase physical activity in African American and Hispanic or Latina women in Houston and Austin, Texas (Lee et al., 2011). Study details have been presented previously; thus, only a brief description of environmental and individual measures and procedures relevant to the current study will be presented here (Kueht et al., 2008, Layne et al., 2011, Lee et al., 2011a, Lee et al., 2011b, Mama, et al., 2011, McAlexander et al., 2011, McMillan et al., 2010, Parmenter et al., 2008). All HIP study assessments, measures and procedures were approved by the Committee for the Protection of Human Subjects at the University of Houston, and participants provided written informed consent to participate.

2.1. Environmental Assessment Measures and Procedures

The *Pedestrian Environmental Data Scan (PEDS)* instrument was chosen as an objective measure of street scale elements. The PEDS assesses street segment environmental features and pedestrian facilities related to walking and cycling. It contains 40 questions that measure macro environment features, such as land use, segment type, and connectivity (Clifton, 2007), and micro environment features, such as lighting, amenities, and articulation. Additional measures include pedestrian and bicycle facilities, road attributes, and safety and attractiveness of the walking and cycling environment (Clifton, 2007). Pedestrian facilities, path condition, path obstructions, curb cuts, crosswalks, path lighting, traffic buffers (e.g., fence, trees, grass), sidewalk connections, vehicle lanes, traffic speed limit, traffic control devices, amenities (e.g., benches, trash cans, street vendors), crossing aids, and bicycle facilities were some of the variables from the PEDS that represented pedestrian street-scale elements. The PEDS instrument showed good inter-rater (89% of the variables with 80% agreement among the raters) and overall reliability varied (poor, moderate or good) by item (Clifton, 2007).

Neighborhood Definition and Data Collection—Neighborhoods (N=309) were mapped using Geographical Information Systems (GIS) technology in ArcGIS 9.3 (Esri, Redlands, CA) and were defined as the area within an 800 meter radius Euclidean buffer surrounding each participants' residence (Parmenter et al, 2008). A random sample of 25% of residential street segments and all arterial street segments within a 400 meter radius were assessed using the PEDS instrument (McMillan et al., 2010). A street segment is a portion of a street that is intersected by 2 cross streets, or by a cross street at one end and a dead end at the other (Parmenter, 2008). All assessments were conducted by trained research team members in teams of at least 2 people following established data collection and safety protocols (Heinrich et al., 2007, Heinrich et al., 2008, Lee et al., 2005, Lee et al., 2010).

2.2. Participants

Four hundred and ten African American and Hispanic or Latina women (311 in Houston and 99 in Austin) were assessed at Time 1 (T1). Three hundred and nine women (African American N=202 and Hispanic or Latina N=107) returned for randomization and were included in analyses.

2.3. Individual Measures

Sociodemographics—Items assessing ethnicity, household income, education and parental education were adapted from the Maternal Infant Health Assessment (MIHA) survey (California Department of Public Health, 2006), derived from the CDC’s Pregnancy Risk Assessment Monitoring System (PRAMS) Questionnaire (Centers for Disease Control and Prevention, 2006). These items have been used with samples representing diverse ethnicities and socioeconomic status with good reliability (Sarnoff and Hughes, 2005).

Body composition—Anthropometric measures of BMI and body fat were collected by trained personal using established protocols (Lee et al., 2011b). Height was measured using a stadiometer. Body weight and percent body fat were measured in both pounds and kilograms using a Tanita TBF-310 body composition analyzer (Tanita, Arlington Heights, Illinois; 2007). BMI was calculated from measured height and weight. Each measure was taken twice, and an average of the two measurements was used in analyses.

Physical activity—Physical activity was measured using the International Physical Activity Questionnaire (IPAQ) long form, and accelerometers. The *International Physical Activity Questionnaire* (IPAQ) long form, measured self-reported total PA, including work-related, transportation, domestic and leisure-time PA and walking-, moderate- and vigorous-intensity PA, over the last seven days (Booth, 2000). PA was reported in terms of MET-minutes per week. IPAQ is widely used and reliable (r=0.8) but has shown relatively lower validity (r=0.3) compared to accelerometry (Craig et al., 2003).

Objective physical activity data were collected using a uni-directional ActiGraph GT1M accelerometer (ActiGraph, Pensacola, Florida; 2009). The ActiGraph accelerometer exhibits strong associations between activity counts and measured energy expenditure, is responsive to different intensities of physical activity and has the lowest amount of variance across measurement devices, indicating strong (ICC=0.87) reliability and validity (Welk, 2005). Participants were asked to wear the accelerometer over their hip for seven consecutive days (Layne et al., 2011). Accelerometer activity counts were collected using a one minute epoch setting. The criterion for including accelerometer data in the analysis was ≥ 4 days of valid wear, with a valid day being ≥ 8 hours of valid wear time. Participants without ≥ 4 valid days of data were not included in the analysis, and invalid days were also not included in the analysis. As previously described, an individual-specific cutpoint was developed using an individual’s average activity counts during a group leisurely-paced, orientation walk plus one standard deviation (Layne et al., 2011). This cutpoint was applied to determine whether each minute in a 24 hour day was spent doing what we considered moderate or greater intensity activity for that individual, or ‘increased’ physical activity for that individual participant (Layne et al., 2011). Accelerometer data were translated into minutes of moderate or greater intensity physical activity (MVPA) per valid day for use in analyses.

2.4. Individual Participant Procedures

Women were phone screened to self identify as African American or Hispanic or Latina, between the ages of 25 and 60 years old, able to read, speak, and write in English or Spanish, not pregnant or planning to become pregnant within the next 12 months, a Harris or Travis County resident, not planning on moving in the next 12 months, physically inactive or doing fewer than 30 minutes of physical activity per day on 3 or more days per week, and able to participate safely in physical activity determined by the Physical Activity Readiness Questionnaire (PAR-Q; Thomas et al., 1992), and invited to an in person baseline Time 1 (T1) health assessments. Women who completed a baseline health assessment were invited to a randomization session, where they were randomized to a physical activity or vegetable and fruit group. Women met in groups six times over the course of six months and were exposed to a group cohesion intervention to promote walking or increase vegetable and fruit consumption. Intervention content was similar for both groups and tailored to increasing walking or increasing vegetable and fruit consumption. At the end of the six month intervention period, women completed post-intervention Time 2 (T2) health assessments.

2.5. Analyses

Environmental cross-sectional data and longitudinal individual-level data were used to determine the relationship between street scale elements and physical activity among women. All statistical analyses were conducted in SPSS Version 18.0 (SPSS 18.0 for Windows, SPSS Inc, Chicago, Ill). Bivariate associations (correlations, cross tabs, t-tests and analyses of variance) were conducted for PEDS variables to reduce the number of potential variables to include in analyses (analyses not shown). Final selection of variables was done to achieve minimal multicollinearity with other PEDS variables, consistency with theoretical considerations, consistency with previously reported relationships, and based on extensive field experience of investigators. The principal investigator, project director and analytic team along with several doctoral students reviewed the bivariate analyses, and considered each variable individually using a systematic rating grid. Only continuous variables that met all above criteria were selected. The final variables selected included sidewalk buffers, path connectivity, number of travel lanes, posted speed limit, traffic control devices, pedestrian crossing aids, count of amenities (e.g., public garbage cans, benches and water fountains) and safety and attractiveness of the walking and cycling environment. Street-scale data were aggregated to the neighborhood level by taking the mean across street segments for each neighborhood, using established protocols for ecologic analyses (Heinrich et al., 2008, Heinrich et al., 2007, McAlexander et al., 2009).

ANOVAs and t-tests were used to determine differences in physical activity and environmental factors by ethnicity, time point and site. Multiple regression models were used to estimate the effect of aggregated environmental factors on time two physical activity variables adjusting for time one physical activity, age, education, income, site, ethnicity and intervention group. Interaction terms were added to test whether intervention group assignment moderated the relationship between the environment and physical activity adoption and maintenance. A significant interaction term would indicate a differential relationship between an environmental variable and intervention group, providing support for a potential moderating effect of the intervention on physical activity adoption and maintenance. Significance for all analyses was set at $p<.05$.

3. Results

3.1. Descriptive Characteristics

Overall, participants were of higher socioeconomic status. Over half (53%) had completed some college, and nearly half (49.1%) reported an income that was over 400% of the Federal Poverty Level (U.S. Department of Health and Human Services, 2007). Women who did not attend randomization were somewhat older (M=43.5 years, SD=9.6 vs. M=45.7 years, SD=9.5; t=−2.690, p=.007), had a higher BMI (M BMI=36.2 kg/m^2, SD=11.1 vs. M BMI=34.2 kg/m^2, SD=8.1; t=2.739, p=.006), had lower educational attainment (37% completed college), and had a lower income adjusted for family size (38.3% reported an income that was over 400% of the Federal Poverty Level) compared to those who were randomized. There were no differences in physical activity between those not randomized and those assigned to a treatment group.

Of those included in the current study, most participants were middle-aged (M=45.2 years, SD=9.3) and overweight or obese (M BMI=34.7 kg/m^2, SD=8.5). Nearly half (44.2%) had graduated from college, and nearly half (48.6%) reported an income 401% or greater above the Federal Poverty Level (U.S. Department of Health and Human Services, 2007). Women were similar in age and BMI by ethnicity and site.

Physical activity by ethnicity and time point are shown in Table 1. Accelerometer measured moderate-vigorous physical activity (MVPA) (F(1,186)=40.8, p<.001) varied by ethnicity at T1. African American women did more MVPA (M=24.6 vs. 9.1 minutes per day) than Hispanic or Latina women. Women who were randomized to the intervention did not differ in physical activity from women who were not randomized and did not complete the intervention. Post-intervention, African American women still did more MVPA than Hispanic or Latina women (M=24.4 vs. 11.7 minutes per day). However, African American women did not significantly increase their MVPA from T1 to T2; there were no differences in MVPA or IPAQ measured PA by site at T2.

3.2. Neighborhood Characteristics

Over 6,000 street segments were assessed across all neighborhoods. On average, neighborhood street segments had three sidewalk connections (M=3.2, SD=1.0), between two and three travel lanes (M=2.6, SD=0.7), and the average speed limit was 31 miles per hour (SD=6.1). African American participants' neighborhoods had a greater number of travel lanes (F(1, 289)=5.6, p=.018) and higher speed limit (F(1, 229)=4.9, p=.028) than Hispanic or Latina participants' neighborhoods. When comparing project sites, Houston street segments had more travel lanes (F(1, 290)=11.5, p=.001) and were rated less safe for bicycling (F(1, 290)=6.125, p=.014) than Austin street segments. Other environmental characteristics by ethnicity and site are presented in Tables 2 and 3, respectively. There were no significant differences in environmental characteristics by group assignment.

3.3. Bivariable Associations

Intercorrelations among selected PEDS variables are presented in Table 4. Buffers between the sidewalk and road were significantly correlated with attractiveness for walking (r=.218, p<.001) and cycling (r=.240, p<.001) and safety for walking (r=.355, p<.001) and cycling (r=.247, p<.001). No other PEDS variables were correlated with attractiveness for walking or cycling. Travel lanes (r=−.209, p<.001) and speed limit (r=−.124, p=.030) were correlated with safety, and showed as the number of travel lanes and speed limit increased, safety for bicycling decreased.

PEDS variables were significantly correlated with self-reported walking at T1. As neighborhood safety (*Spearman's* r=−.144, p=.014) and attractiveness (*Spearman's* r=−.149, p=.011) for bicycling increased, self-reported walking decreased. Objectively measured physical activity as measured by an accelerometer and pedestrian environment measures were not significantly correlated at T1. However, at T2, accelerometer measured MVPA was significantly correlated with attractiveness for walking (r=.244, p=.047) and cycling (r=.281, p=.021). Correlations between PEDS variables and physical activity at T1 and T2 are presented in Table 5.

3.4. Regression Models

Linear regression models indicated attractiveness for bicycling predicted T2 MVPA (β=.245, t=2.290, p=.026), after adjusting for T1 MVPA. In addition to this main effect, several regression models with interaction terms were significant indicating that the effect of environment on physical activity adoption and maintenance (walking, total or MVPA) varied by group assignment, after adjusting for T1 physical activity, age, education, income, site, ethnicity and intervention group. Group moderated the effect of the number of traffic control devices on walking (β=−.801, t=−2.189, p=.031), the number of crossing aids on total physical activity (β=−.456, t=−3.755, p<.001), and the number of amenities on walking (β=.454, t=2.506, p=.014) and total physical activity (β=.326, t=2.622, p=.010). Figure 1 illustrates that as the number of traffic control devices such as stop signs and street lights and crossing aids increased, physical activity adoption and maintenance increased in women in the physical activity group. Figure 2 illustrates the opposite effect, indicating as amenities such as benches and trash cans increased, physical activity adoption and maintenance increased in women assigned to the vegetable and fruit group.

4. Discussion

This study found that street-scale elements in the neighborhood micro-environment can contribute to physical activity adoption and maintenance among African American and Hispanic or Latina women participating in a walking adoption program. Results suggest that the attractiveness of the neighborhood environment plays a role in objectively measured but not self-reported physical activity. Previous studies have found that residents in Australia who found their neighborhood highly attractive were more likely to report more recreational physical activity than residents who reported lower perceived attractiveness (Sugiyama et al., 2009). This study corroborates these findings and expands on them by using an objective measure of physical activity among a multiethnic sample of women in the U.S.

We found significant interactions between neighborhood factors and group assignment, suggesting that behaviorally based interventions can profit from the presence of a supportive neighborhood. These findings underscore the importance of considering the environmental context when planning interventions and programming to increase physical activity. Although the mere presence of a supportive neighborhood may not be sufficient to increase physical activity on its own, the addition of skills and social support that come with a behavioral intervention can work more effectively when participants reside in a supportive neighborhood. In particular, we found that crossing aids and traffic control devices, both extremely important for helping pedestrians to navigate the world of the automobile--the street--were related to physical activity adoption and maintenance in the physical activity group. This group received specific instruction during the intervention about neighborhood traffic safety, including interactive mapping of their neighborhoods to understand the locations of the safest routes for pedestrians nearby their homes (Lee et al., 2011c). It is likely that the interaction was in part due to the specific training regarding the pedestrian environment that this group received that the vegetable and fruit comparison group did not receive.

In contrast, the women assigned to the vegetable and fruit group who lived in neighborhoods with greater amenities were more likely to adopt or maintain their physical activity. A possible explanation may be attributed to the specific instruction women in this group received about how to locate and purchase fresh vegetables and fruits in their neighborhoods. It may be that those women found areas in their neighborhoods with greater amenities that are typically found near shops and restaurants, like public garbage cans, benches and water fountains. Perhaps their greater familiarity with these amenities unwittingly increased their physical activity. Regardless, this issue is fruitful for more study, particularly as the field of obesity research has brought studies on physical activity and dietary habits together to consider energy balance in a more holistic manner.

Mixed research findings have been reported on the relationship between neighborhood safety and walking and bicycling and physical activity (Velasquez et al., 2009, Suminski et al., 2005, Sallis et al., 2009, Hooker et al., 2005, Oh et al., 2010). Several studies in the U.S. have shown no relationship between neighborhood safety and physical activity, despite interest in crime and safety as barriers to physical activity (Sallis et al., 2009), while other international studies have shown a positive association between neighborhood traffic safety and walking and cycling (Carver et al., 2008, Cleland et al., 2008). We found that the rated safety of the walking and cycling environment did not influence self-reported walking, despite the initial relationship at baseline, suggesting neighborhood factors associated with attractiveness, or specific pedestrian safety aids, may be more influential than the general sense of safety or the sense of safety from crime, when considering physical activity adoption (Zenk et al., 2009). Beautiful places that provide safe routes specifically for non-motorized transit may be important not only for increasing physical activity, but may work through more complex psychosocial pathways by improving morale, inspiring social activities and enhancing quality of life (Abraham et al., 2010).

Existing literature has shown that it is essential that the built environment supports physical activity (Transportation Research Board of the National Academies, 2005, Heath et al., 2006) and have further demonstrated that changing certain elements of the built environment can increase physical activity levels in a given population or community (National Institute for Health and Clinical Excellence, 2006, Heath et al., 2006). The current study partially supports these findings and shows that in addition to attractiveness, sidewalk connectivity and buffers are cross-sectionally associated with self-reported physical activity; however, these relationships did not hold in longitudinal associations looking at the adoption and maintenance process. Sidewalk connectivity is the total number of connections of one sidewalk to other sidewalks on each side of a street segment (Clifton, 2007), and implies several alternative routes may be available to pedestrians to navigate through traffic intersections (Sallis et al., 2009). Buffers, the space between the sidewalk and street, are often filled with grass, trees or amenities, such as a bench or trash can, and provide a safety barrier between street traffic and pedestrians. These associations imply that safety as it relates to street traffic may as important as safety related to crime in urban neighborhoods. This study also found that neighborhood attractiveness and safety for cycling may not solely promote bicycling, but also may influence other types of physical activity. Previous studies have shown bicycle facilities, such as designated bike lanes, influence recreational activity and total physical activity (Sallis et al., 2009, Hoehner et al., 2005).

Results suggest that physical activity adoption and maintenance, and longitudinal relationships between neighborhood factors and physical activity are complex. Behavioral interventions must specifically address neighborhood factors related to traffic safety, as well as increasing the time-tested, important psychosocial factors of motivation, self efficacy and social support. Future research should also consider neighborhoods surrounding commonly visited locations such as work, children’s schools, social or religious organizations, and other places. Perhaps these locations and their surrounding environments are even more important than the home neighborhood micro-environment for people who do not do regular physical activity. It is likely that those who are already regularly physically active may select their residence based in part on physical activity supportiveness, and the relationships between neighborhood factors and physical activity would be stronger among those who do physical activity regularly.

Strengths of this study include systematic protocols and detailed in person audits of the neighborhood environment and street scale elements. This study also followed a sizeable sample of African American and Hispanic or Latina women in neighborhoods widely distributed throughout the cities of Houston and Austin, Texas, maximizing geographic variability and increasing generalizability, and is among the first to study these kinds of factors longitudinally. However, since our participant (and as a result, our neighborhood) sample consisted of volunteers, we were unable to eliminate all selection bias.

Although our findings are generalizable to only urban and suburban neighborhoods, the quality of the data and consistency of the findings may inform research and practice among other populations and neighborhoods. The linkage between street scale elements and physical activity is multifaceted and should be addressed in future physical activity interventions and programming. Future studies should incorporate additional measures of attractiveness and safety to identify specific aesthetic and safety features related to various types of physical activity, including leisure-time and transportation related physical activity. Future studies should also explore places and neighborhoods other than the home neighborhood, such as community centers, schools and other physical activity resources, to determine additional locations that may be convenient for various forms of physical activity.

Community leaders and policy makers must consider the importance of having a neighborhood built environment that supports healthy lifestyles that include daily physical activity. This is particularly important in communities of color, whose residents tend to report lower rates of physical activity. Like other studies, these findings support the need for built environment policies that facilitate environments which are attractive and safe to encourage physical activity. Aesthetically pleasing environments are a common feature of countries with high rates of recreational activity (Sugiyama et al., 2009); thus, policies that contribute to beauty as well as safety in the built environment may lead to many beneficial outcomes, not the least of which is increased physical activity.

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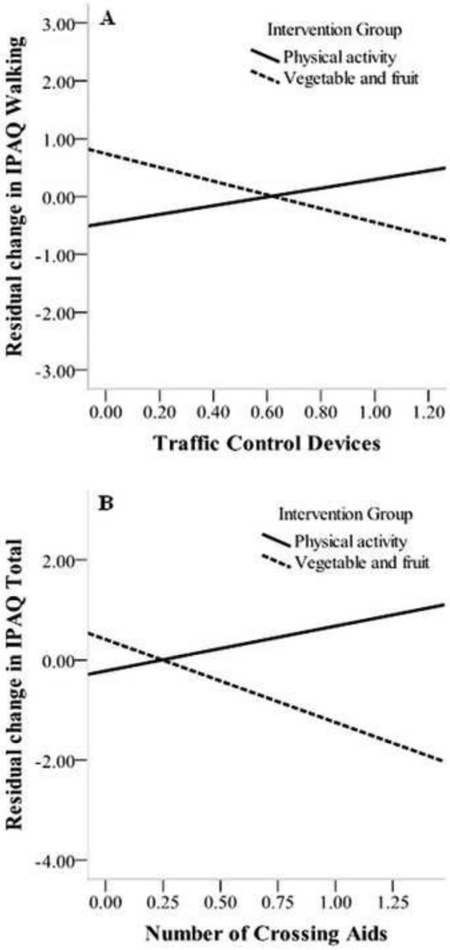

Figure 1.

Interactions between (A) traffic control devices and (B) crossing aids and intervention group assignment

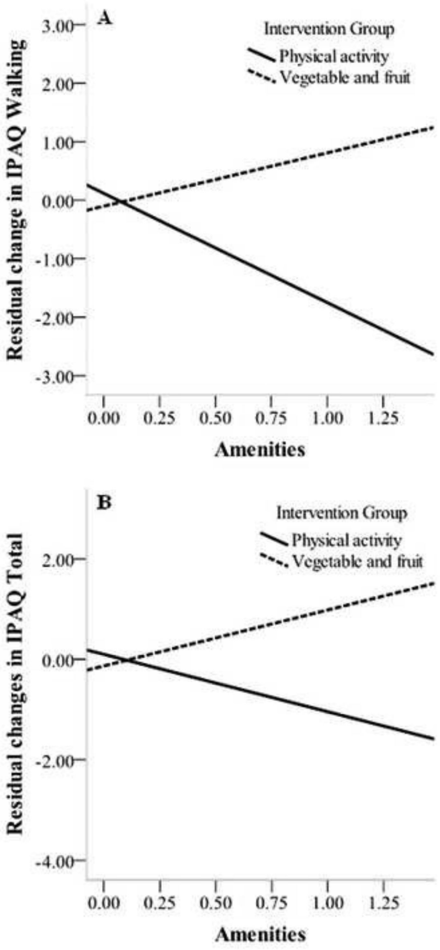

Figure 2.

Interactions between amenities and intervention group

Table 1

Physical activity by ethnicity and time point

	African American		**Hispanic or Latina**	
	T1 ***M (SD)***	**T2** ***M (SD)***	**T1** ***M (SD)***	**T2** ***M (SD)***
Physical Activity				
IPAQ Walking[b] (MET-min/week)	906.0 (3107.4)	941.7 (1113.6)	741.4 (1362.9)	812.4 (872.6)
IPAQ Total[b] (MET-min/week)	2608.8 (3760.1)	3326.5 (3169.5)	3139.6 (3734.3)	2840.5 (2067.0)
Accelerometer (MVPA min/day)	24.6 (21.5)[a]	24.4 (19.9)	9.1 (9.1)[a]	11.7 (9.1)

[a] Significantly different at T1 by ethnicity (p<.001)

[b] Significantly different by time (p<.01)

Table 2

Environmental characteristics by ethnicity

	African American	Hispanic or Latina
	M (SD)	**M (SD)**
Buffers	1.0 (0.5)	0.8 (0.5)
Sidewalk Connections	3.3 (1.0)	3.1 (0.9)
Travel Lanes	2.6 (0.6)	2.4(0.6)[a]
Speed Limit (mph)	31.5 (6.5)	29.6 (5.3)[a]
Traffic Control Devices	0.7 (0.2)	0.6 (0.2)
Crossing Aids	0.3 (0.3)	0.2 (0.2)
Amenities	.09 (0.2)	0.1 (0.2)
Safety for Walking	2.7 (0.4)	2.8 (0.4)
Attractive for Walking	2.7 (0.4)	2.8 (0.4)
Safety for Cycling	2.5 (0.5)	2.6 (0.4)
Attractive for Cycling	2.7 (0.4)	2.7 (0.4)

[a] Significantly different by ethnicity (p<.05)

Table 3

Environmental characteristics by project site

	Houston	Austin
	M (SD)	**M (SD)**
Buffers	1.0 (0.5)	0.6 (0.3)
Sidewalk Connections	3.3 (1.0)	3.0 (0.8)
Travel Lanes	2.6 (0.6)	2.3 (0.5)[b]
Speed Limit (mph)	31.2 (6.4)	29.9 (5.3)
Traffic Control Devices	0.7 (0.2)	0.6 (0.2)
Crossing Aids	0.3 (0.3)	0.2 (0.2)
Amenities	0.1 (0.2)	0.2 (0.2)
Safety for Walking	2.7 (0.4)	2.9 (0.4)
Attractive for Walking	2.7 (0.4)	2.8 (0.3)
Safety for Cycling	2.5 (0.5)	2.7 (0.4)[a]
Attractive for Cycling	2.7 (0.4)	2.7 (0.4)

[a] Significantly different by site (p<.05);

[b] Significantly different by site (p<.001)

Table 4

Intercorrelations among PEDS variables

	1	2	3	4	5	6	7	8	9	10	11
1. Buffers	1.000										
2. Sidewalk Connectivity	.317^{b}	1.000									
3. Travel Lanes	−.061	.175^{b}	1.000								
4. Speed Limit	−.019	.115^{a}	.372^{b}	1.000							
5. Traffic Control Devices	.094	.200^{b}	.275^{b}	−0.001	1.000						
6. Crossing Aids	−.040	.113^{a}	.684^{b}	.226^{b}	.302^{b}	1.000					
7. Amenities	−.101^{a}	.171^{b}	.526^{b}	.180^{b}	.246^{b}	.453^{b}	1.000				
8. Attractive for Walking	.218^{b}	.095	−.070	−.077	.072	−.049	−0.05	1.000			
9. Attractive for Cycling	.240^{b}	.078	−.076	−.086	.072	−.080	−.058	.963^{b}	1.000		
10. Safety for Walking	.355^{b}	.261^{b}	−.089	−.043	.080	−.046	.010	.771^{b}	.780^{b}	1.000	
11. Safety for Cycling	.247^{b}	.056	−.209^{b}	−.124^{a}	−.001	−.231^{b}	−.106^{a}	.648^{b}	.685^{b}	.736^{b}	1.000

[a] Significant Pearson correlation ($p<.05$);

[b] Significant Pearson correlation ($p<.01$)

Table 5

Correlations between PEDS variables and physical activity at T1 and T2

	T1			T2		
	IPAQ Walking	**IPAQ Total**	**Accelerometer**	**IPAQ Walking**	**IPAQ Total**	**Accelerometer**
Buffers	−.078	−.125[a]	.071	.105	.049	.158
Sidewalk Connectivity	−.038	−.160[b]	.093	.000	.000	.156
Travel Lanes	−.046	−.060	−.016	−.006	−.126	−.006
Speed Limit	−.122	−.079	.060	.038	−.026	.050
Traffic Control Devices	−.064	−.052	.108	−.030	−.039	.216
Crossing Aids	.064	.012	−.024	−.039	−.150	−.053
Amenities	−.024	−.047	−.034	−.016	−.012	−.034
Attractive for Walking	−.104	−.054	.031	−.029	.039	.244[c]
Attractive for Cycling	−.149[a]	−.083	−.010	−.008	.040	.281[c]
Safety for Walking	−.123[a]	−.093	.039	.058	.069	.206
Safety for Cycling	−.144[a]	−.069	−.058	−.022	.078	.076

[a] Significant Spearman correlations ($p<.05$);

[b] Significant Spearman correlations ($p<.01$);

[c] Significant Pearson correlations ($p<.05$)

Table 6

Regression models for IPAQ walking, IPAQ total and accelerometer physical activity

Regression Model[a]	β	t	p
T2 IPAQ Walking			
Group	.752	2.173	.032
Traffic Control Devices	.216	1.675	.097
Group*Traffic Control Devices	−.801	−2.189	.031
T2 IPAQ Walking			
Group	−.081	−.771	.443
Amenities	−.427	−2.416	.018
Group*Amenities	.454	2.506	.014
T2 IPAQ Total			
Group	.318	2.972	.004
Crossing Aids	.123	1.257	.211
Group*Crossing Aids	−.456	−3.755	.000
T2 IPAQ Total			
Group	−.073	−.813	.418
Amenities	−.167	−1.430	.155
Group*Amenities	.326	2.622	.010
T2 Accelerometer			
Group	1.079	1.207	.233
Attractive for Walking	.329	2.211	.031
Group*Attractive for Walking	−1.003	−1.121	.268
T2 Accelerometer			
Group	1.008	1.159	.252
Attractive for Cycling	.341	2.421	.019
Group*Attractive for Cycling	−.901	−1.045	.301

[a] All regression models included T1 physical activity, age, education, income, ethnicity and site.