Impact of Perceptions of Neighborhood Walkability and Perceptions of Behavioral Control over Exercise on Obesity in a Diverse Population

By

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Abstract

Objectives: To examine relationships between body mass index (BMI) and perceptions of neighborhood walkability and perceptions of control over one's ability to exercise.

Methods: Participants (n=295) completed a telephone interview, a written questionnaire and a home visit to assess various aspects of health and social behaviors. Factor analysis was used to develop scales measuring perceptions of neighborhood walkability and behavioral control and the psychometric properties of the scales were measured using Cronbach's alpha. Linear regression was used to model BMI, adjusting for gender, education, wealth, household income, self-assessed social-status, and stratifying by race.

Results: There was a significant association between higher perceived neighborhood walkability and lower BMI for two of the four factor loadings of walkability. Similarly, there was a significant association between higher perceived control over exercise and lower BMI. The associations between BMI and perceptions of neighborhood walkability and behavioral control were similar in African American and non-African American participants.

Conclusions: Individual perceptions of neighborhood walkability and their ability to exercise were associated with BMI and may be useful targets for interventions to reduce obesity.

Background and Significance

In recent years there has been a growing interest in the relationship between the built environment and obesity.[1,2] So far, efforts to study the effects of the built environment on obesity have largely focused on using objective measures.[3,4] The built environment can be described as the design of infrastructure that affects how people interact with their environment.[2] This paper aims to take recent research a step further and to bring to light the impact that individual perceptions have on obesity. The perception of certain neighborhood features and use of recreational facilities vary between individuals.[5] Thus, the use of self-report surveys can complement work with objective geographic assessment to provide a better understanding of how people perceive their own surroundings. The scales used in this study focus on measuring individual perceptions and examine the extent to which such perceptions are related to obesity.

Many studies that have been conducted on obesity have found an increase in the prevalence of overweight and obesity during recent decades.[6-10] The rise in obesity is of great concern because of the morbidity and mortality resulting from obesity and related chronic conditions.[11,12] A higher prevalence of obesity, and obesity-related outcomes, has been found among African-American populations as well as among low-income families.[11,13,14] Concern over the increasing public health burden of obesity and the related racial health disparities has led to multiple calls for innovative and multi-level prevention strategies.[15,16]

One proposed cause of obesity that can be intervened upon is the built environment. [1,2,12,17-20] Neighborhood walkability, defined broadly as how pleasant

and accessible everyday living amenities are to pedestrians in a particular area, is one measure of the built environment that is hypothesized to affect obesity.[17] Indicators of walkability previously linked with physical activity or obesity include availability of sidewalks and walking destinations, safety from crime and traffic hazards, compact urban form, and aesthetic amenities that enhance pedestrian comfort and interest.[17] Improving such features of the built environment could encourage more neighborhood walking and thereby decrease the prevalence of obesity.

The literature is divided between studies using self-report to assess the environment, and those using geographic information systems (GIS) data or audits. The self-report measures have typically been more strongly associated with individual behavior or health outcomes,[21] perhaps because the perceptions themselves play a role in the decision to walk from point A to point B.[22] Care should be taken when interpreting discordance between objective and self-reported neighborhood walkability since the views of an investigator may not correspond to the views of individuals living in a given neighborhood. While self-reporting is also subject to bias,[23] attention to individual perception may be important for planning ethically sound and effective neighborhood health promotion strategies.[22]

A domain that may help to reconcile the data on perceived and objectively assessed walkability is perceived behavioral control. Overweight and obese individuals tend to have lower perceived behavioral control and self-efficacy than normal weight individuals.[24-26] Additionally, feelings of hopelessness, stress, and negative coping behaviors resulting from discrimination or social disadvantage may

reduce perceived behavioral control over exercise.[25] However, few studies have looked at how perceived behavioral control over exercise is related to walkability or racial disparities in obesity. Seeing how these feelings of control over exercise differ among populations and geographic contexts can help researchers and policy makers to develop more targeted interventions aimed at decreasing the obesity epidemic.

The current study aims to examine how perceptions of neighborhood walkability and perceptions of control over exercise influence obesity in adults recruited from a birth cohort, while controlling various demographic characteristics and SES. Both perceived behavioral control and perceived neighborhood walkability are hypothesized to predict lower BMI. This study also aims to examine whether the relationship between perceptions of neighborhood walkability or behavioral control with obesity differs in African American adults compared with non-African American adults.

Methods

Sample

Participants in the current study are a subsample from an earlier study, the Child Health and Development Study (CHDS), conducted between 1959 and 1967, and three follow-up assessments at 5 years, 9-11 years, and 15-17 years. This study included approximately 20,000 offspring of women who were receiving prenatal care in Alameda County Kaiser Permanente Medical Care Plan clinics.[27] The current ongoing study includes the participants from CHDS who completed the initial study and all three follow-up assessments. A random sample of male and female

Caucasian participants and all male and female African-American who were involved in the earlier study and follow-up assessments were recruited for inclusion in the current study. Potential participants were sent letters in the mail describing the new study. They were given a form to fill out that included their willingness to participate, a refusal form, and contact information. Ten days after the initial letters were sent out, reminder cards were sent out to those who did not yet respond. Finally, phone calls were made to those who did not respond to either mailing. Participants in the current study were living in the state of California. This paper will focus on 295 participants who have completed all sections of the current study as of December 1, 2011. All study participants provided informed consent and all study procedures were approved by the Columbia University Medical Center Institutional Review Board.

Telephone Interview and Sociodemographic Characteristics

Participants completed a 30-40 minute Computer Assisted Telephone Interview (CATI). The CATI included questions on demographic and socioeconomic characteristics. To measure income, participants were asked if their yearly household income was greater than or less than a specified amount. Their answer prompted further questions with different levels of income until they ended in one of 10 income categories. Wealth was measured using a similar structure. Education was measured as the number of years of completed education. Self-assessed social status was measured on a picture of a ladder with a scale ranging from 0 to 10, with participants asked to place themselves in relation to the rest of society.

Home Visit Anthropometry

After the CATI was completed, a home visit lasting approximately 60 minutes was scheduled. The home visit was conducted through a subcontracted agency by a registered nurse or licensed phlebotomist. Height (cm) and weight (kg) were taken twice and the mean of the two measurements were used to calculate BMI.

Perceived Walkability and Behavioral Control Questionnaire Items

Additionally, participants were mailed a written questionnaire to be completed at home and either collected at the time of the home visit or returned by mail. This questionnaire included questions on neighborhood walkability and perceived behavioral control.

Questions on neighborhood walkability were taken from the Neighborhood Environment Walkability Survey – Abbreviated version (NEWS-A).[28] Participants responded on an ordered scale of 1 to 4, ranging from definitely true to definitely untrue. Questions were recoded so that all items in the scale were in the direction hypothesized to represent greater walkability. Factor analysis of the perceived neighborhood walkability scale showed 4 factor loadings based on the density of neighborhood destinations (e.g. stores are within easy walking distance of my home), neighborhood aesthetics (e.g. there are many interesting things to look at while walking in my neighborhood), neighborhood safety (e.g. the crime rate in my neighborhood makes it unsafe to go on walks during the day), and neighborhood accessibility (e.g. there are sidewalks on most of the streets in my neighborhood). Cronbach's alpha was used to measure internal reliability of each subscale (density: α=0.83, aesthetics: α=0.69, safety α=0.60, accessibility α=0.52).

Questions pertaining to perceptions of behavioral control over one's exercise schedule were modeled on questions used by Armitage, C. and Conner, M. (1999).[29] Participants were asked how much personal control and confidence they felt over exercising regularly (e.g. whether you exercise in the next month is beyond your control). Responses were based on a continuous scale of 1 to 7, ranging from strongly disagree/very little control to strongly agree/complete control. All questions in the scale were recoded so that all items were in the direction hypothesized to represent greater control. The dimensional structure of the perceived control over exercise scale was assessed using factor analysis to check that the scale measured a single factor as hypothesized. The internal reliability of the scale was measured using Cronbach's alpha (α=0.87).

Statistical Analysis

All analyses were conducted using SAS version 9.2 (SAS Institute Inc., 2011). Participants with missing data were excluded from calculations. Income, wealth, and self-assessed social status were all analyzed as binary variables with income less than or equal to $42,500 compared to income greater than $42,500, wealth less than or equal to $175,000 compared to wealth greater than $175,000, and self-assessed social status greater than or equal to a self-rating of 5 compared to greater than a self-rating of 5. Education was analyzed as a continuous variable. Association of obesity with the primary exposures was examined using BMI as a continuous measure.

Linear regression was used to examine the overall relationship between the primary exposures of interest and BMI, adjusting for race, household income, wealth, education, sex, and self-assessed status. Race-stratified models and a model including an interaction term for race were used to explore potential effect modification.

Results

Demographics

A total of 295 participants completed the telephone questionnaire, the written questionnaire and the home visit. 22 participants who did not respond to at least one item in the perceived control over exercise section or in the perceived neighborhood walkability section were excluded from calculations. Additionally, 3 participants who were missing at least one of two height or weight measurements were also excluded from calculations. Thus, a total of 270 participants were included in the analysis.

Participants included in this sample range from 47-51 years of age, with an average age of 49 years. Non-African American participants were more educated and more likely to report higher income and wealth than African American participants (Table 1). Non-African American participants were also more likely to rate themselves higher on the self-assessed status scale. On a scale of 1 to 10, 81% of Non-African American participants ranked themselves as a 6 or higher compared to 54% of African American participants who ranked themselves as a 6 of higher.

Primary Outcome: BMI

The prevalence of obesity was higher in African American participants than among non-African American participants. 85% of African American participants in the study sample have a BMI greater than or equal to 25 and are considered either overweight or obese by WHO standards, with 66% of the total African American sample falling into the obese category. 76% of non-African American participants are overweight or obese, with only 32% of total Non-African American subjects being obese.

Perceived Control over Exercise and Perceived Neighborhood Walkability

In general, African American participants had higher perceived walkability scores for questions relating to neighborhood density, p-value < 0.01, and neighborhood accessibility, p-value < 0.02, compared to non-African American participants. Conversely, Non-African American participants reported higher walkability scores on questions relating to neighborhood safety, p-value < 0.01. Non-African American participants have higher scores for perceived control over exercise, though the difference was not statistically significant (p-value = 0.08).

Table 4a shows the results of the regression models run with perceived neighborhood walkability as the primary exposure. There were two factor groups of perceived neighborhood walkability, neighborhood aesthetics and neighborhood safety, which were significantly associated with obesity and remained significant after adjusting for all other variables overall and among non-African American participants ($p < 0.05$ and $p < 0.01$, respectively). None of the factor groups were

found to be significantly associated with obesity among African American subjects, though there was no statistically significant interaction with race.

Table 4b shows the results of the linear regression models that were run with perceived control over exercise as the primary exposure. Perceived control over exercise was found to be a significant predictor of obesity among non-African American participants even after adjusting for all other variables ($p < 0.01$). There was no evidence of statistically significant effect modification by race.

The results of the regression models run with both primary exposures (Table 4c) show a significant interaction between perceived behavioral control and two factor groups of perceived neighborhood walkability, neighborhood density ($p < 0.05$) and neighborhood aesthetics ($p < 0.05$).

Discussion

There was an overall significant association between both perceived neighborhood walkability and perceived control over exercise and lower BMI, even after adjusting for all other controlling variables. There was no evidence of significant effect modification by race and no trend for these associations to be stronger among African American participants than among non-African American participants after stratifying by race. However, a pattern of effect modification was observed between two perceived neighborhood walkability factors, density and aesthetics, and perceived behavioral control, such that walkability was not as strongly associated with BMI for individuals with high control over exercise.

This effect modification could be because individuals who have higher perceived control over exercise have other resources available to them. Perhaps these individuals have exercise equipment in their homes or utilize gyms that are not near their homes. These individuals may have other means of controlling their weight, so choosing to live in an neighborhood with higher walkability may not be as important to them.

Although previous literature supports the finding that individuals with a lower perception of behavioral control over exercise tend to have a higher BMI regardless of race,[30,31] there has been little research on how this effect differs among different populations.[26] As seen by the effect modification between perceived behavioral control and perceived neighborhood density, the lack of association found between BMI and perceptions of behavioral control among African American participants may be due to potential confounding variables such as availability of recreational facilities or cultural values.

The findings of this study agree with findings from previous research studies that there is an association between lower neighborhood walkability and obesity.[1,32] Along with other recent evidence,[33] this study suggests that neighborhood aesthetics and safety could play a role in strategies to reduce the prevalence of obesity. Results from one study showed that low-income women suggest that improved neighborhood safety, cleaner streets, and more recreational centers would encourage more physical activity.[20] Using targeted interventions in low-income and African-American neighborhoods that take these recommendations into

account may be important in lowering the prevalence of obesity in these populations.[20]

Study Limitations

Several limitations should be noted. This is a cross-sectional study does not use temporality to refine inference about direction of causation.[17] We hypothesized that negative perceptions of behavioral control over exercise and negative perceptions of walkability would lead to obesity. However, being obese may lead an individual to feel that they have less control over their ability to exercise or that their neighborhood is less walkable. Questions pertaining to individuals' weight at an earlier stage of life can be incorporated into the analyses to help show whether or not the exposure preceded the outcome.

Another limitation of this study is generalizability. This study was limited to adults between the ages of 47 and 51 years who originated in the San Francisco Bay area. Therefore, the findings of this study may not be applicable to individuals of other ages or who come from other regions.

This study looked at the role of individual perceptions. While several studies have looked at the role of perceptions in obesity research,[4,31] this study uses comprehensive scales to understand the role of perceptions on obesity in a more diverse group.

Although the findings did not show a significant association between perceptions of behavioral control over exercise and obesity or a significant association between perceptions of neighborhood walkability and obesity among African American participants, this could be attributed to the study not having

enough African American participants. Therefore, the statistical power may not have been sufficient to detect patterns of effect modification by race.

Conclusion

In sum, this study showed the role of individual perceptions in adult obesity. There were two key findings of this study. First we found that a lower perception of control over an individual's ability to exercise was associated with an increased BMI. Secondly, a lower perception of neighborhood walkability was associated with an increased BMI. We did not find evidence of effect modification by race for either perceived behavioral control or perceived walkability. Future research should focus on individual perceptions that complement researcher defined indices. If the causes of obesity can be further isolated, than more specific interventions can be developed to help reduce the occurrence of obesity and obesity-related illnesses.

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Table 1. Demographic characteristics of study sample by race

	% of Subjects by Race	
	African American	**Non-African American***
Characteristic	N=91	N=179
Age	Mean (SD) 49 (0.9) yrs	Mean (SD): 49 (0.9) yrs
Gender		
Male	37%	48%
Female	63%	52%
BMI		
<25	15%	24%
≥ 25	85%	76%
Education		
< 12th grade	3%	1%
12th grade	37%	24%
Some college 1 year college	24%	25%
Finished college	24%	22%
Graduate-professional	11%	27%
Household Income		
≤ 42,500	46%	22%
> 42,500	54%	78%
Wealth		
≤ 175,000	70%	47%
> 175,000	30%	53%
Self-Assessed Social Status		
0-5	46%	19%
6-10	54%	81%

*N=153 Caucasian and N=26 Asian, American Indian, or other race

Table 2. A) Means for each question in perceived control over exercise scale by race. B) Means for each question in perceived neighborhood walkability scale for each factor group by race.

a.

	Mean (SD)	
Question	**African American**	**Non-African American**
Whether or not I exercise regularly in the next month is entirely up to me.	5.79 (1.84)	6.28 (1.27)
How much personal control do you feel you have over exercising regularly in the next month?	5.93 (1.64)	6.17 (1.25)
Whether you exercise in the next month is beyond your control.	5.53 (1.88)	5.98 (1.54)
I believe I have the ability to exercise regularly in the next month.	6.02 (1.57)	6.27 (1.13)
To what extent do you see yourself as being capable of exercising regularly in the next month?	5.79 (1.48)	5.88 (1.40)
How confident are you that you will be able to exercise regularly in the next month?	5.52 (1.60)	5.64 (1.49)
If it were entirely up to me, I am confident that I would be able to exercise regularly in the next month.	5.77 (1.64)	5.98 (1.32)
Overall Average*:	5.94 (1.10)	

Scale ranges from 1 to 7 with higher scores representing greater perceived control over exercise

*Includes African American and Non-African American participants

b.

	Mean (SD)	
Question (Neighorhood1 - Density)	**African American**	**Non-African American**
Stores are within easy walking distance of my home.	3.20 (1.13)	2.85 (1.15)
There are many places to go within easy walking distance of my home.	2.81 (1.14)	2.52 (1.12)
It is easy to walk to a transit stop (bus, train) from my home.	3.53 (0.87)	2.94 (1.13)
Overall Average:	2.91 (0.97)	
Question (Neighborhood2 - Aesthetics)		
There are many interesting things to look at while walking in my neighborhood.	3.05 (0.96)	3.07 (0.80)
There are many attractive natural sights in my neighborhood (such as landscaping, views).	3.02 (0.89)	3.09 (0.94)
The speed of traffic on most nearby streets is usually slow (30 mph or less).	3.00 (1.00)	3.13 (0.86)
Overall Average:	3.07 (0.71)	
Question (Neighborhood3 - Safety)		
There are major barriers to walking in my local area that make it hard to get from place to place (for example, freeways, railway lines, rivers).	3.57 (0.83)	3.43 (0.92)
There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood.	3.08 (0.96)	3.27 (0.78)
The crime rate in my neighborhood makes it unsafe to go on walks during the day.	3.41 (0.77)	3.77 (0.60)
The crime rate in my neighborhood makes it unsafe to go on walks at night.	2.80 (1.07)	3.34 (0.81)
Overall Average*:	3.37 (0.57)	
Question (Neighborhood4 - Accessibility)		
The streets in my neighborhood are hilly, making my neighborhood difficult to walk in.	3.24 (1.08)	3.16 (1.05)
There are sidewalks on most of the streets in my neighborhood.	3.68 (0.71)	3.28 (1.09)
My neighborhood streets are well lit at night.	2.90 (0.97)	2.77 (0.93)
Overall Average:	3.14 (0.72)	

Scale ranges from 1 to 4, with a higher score representing greater walkability
*Includes African American and Non-African American participants

Table 3. Correlations between main predictor variables: perceived control over exercise and all 4 groups of perceived neighborhood walkability.

a. Overall correlations regardless of race

Variables	1	2	3	4	5
1. Behavioral Control over Exercise	–				
2. Neighoborhood1 (Density)	-0.02	–			
3. Neighoborhood2 (Aesthetics)	0.06	0.12	–		
4. Neighoborhood3 (Safety)	0.22***	0.02	0.30***	–	
5. Neighoborhood4 (Accessibility)	0.07	0.42***	0.08	0.12*	–

*p < 0.05, **p < 0.01, ***p < 0.001

b. Correlations among African American participants

Variables	1	2	3	4	5
1. Behavioral Control over Exercise	–				
2. Neighoborhood1 (Density)	0.00	–			
3. Neighoborhood2 (Aesthetics)	0.01	0.21*	–		
4. Neighoborhood3 (Safety)	0.35***	-0.05	0.36***	–	
5. Neighoborhood4 (Accessibility)	0.23*	0.15	0.30**	0.20	–

*p < 0.05, **p < 0.01, ***p < 0.001

c. Correlations among non-African American participants

Variables	1	2	3	4	5
1. Behavioral Control over Exercise	–				
2. Neighoborhood1 (Density)	-0.00	–			
3. Neighoborhood2 (Aesthetics)	0.09	0.09	–		
4. Neighoborhood3 (Safety)	0.09	0.13	0.25***	–	
5. Neighoborhood4 (Accessibility)	0.03	0.49***	0.00	0.14	–

*p < 0.05, **p < 0.01, ***p < 0.001

Table 4. Linear regression models with BMI as the outcome and a) perceived control over exercise as the primary predictor b) perceived neighborhood walkability as the primary predictor (N=270).

a.

	Neighborhood1		Neighborhood2		Neighborhood3		Neighborhood4	
Variable	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3
Intercept	36.68***	40.21***	39.98***	32.81***	39.66***	31.34***	34.80***	47.87***
Neighborhood1 (Density)	-0.38	-1.47						
Neighborhood2 (Aesthetics)			-2.11***	0.11				
Neighborhood3 (Safety)					-1.47*	1.10		
Neighborhood4 (Accessibility)							0.12	-3.88
African American	-3.78***	-5.73	-3.72***	0.46	-3.40***	2.11	-3.65***	-10.88*
Sex (Male)	1.90*	1.86*	2.02*	2.08*	1.80*	1.76*	1.88*	1.93*
Education	-0.13	-0.13	-0.03	-0.01	-0.12	-0.12	-0.12	-0.12
Wealth	-0.63	-0.62	-0.55	-0.57	-0.51	-0.50	-0.53	-0.41
Income	0.13	0.07	0.12	0.20	0.44	0.46	0.17	-0.13
Self-Assessed Status	0.01	0.08	0.43	0.35	-0.06	0.02	-0.04	-0.17
Neighborhood*Race		0.64		-1.38		-1.66		2.27
N	270	270	270	270	270	270	270	270
R^2	0.10	0.11	0.15	0.15	0.12	0.12	0.10	0.11

*p < 0.05, **p < 0.01, ***p < 0.001

b.

	Exercise	
Variable	Model 2	Model 3
Intercept	41.21***	31.36***
Behavioral Control over Exercise	-1.26**	0.43
African-American	-3.37***	3.02
Sex (Male)	2.10*	2.07*
Education	-0.07	-0.07
Wealth	-0.62	0.91
Income	0.04	0.05
Self-Assessed Status	0.14	0.26
Exercise*Race		-1.09
N	270	270
R^2	0.14	0.14

*p < 0.05, **p < 0.01, ***p < 0.001

c.

	Neighborhood1		Neighborhood2		Neighborhood3		Neighborhood4	
Variable	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3	Model 2	Model 3
Intercept	38.01***	52.99***	41.24***	62.71***	40.66***	31.16**	35.81***	28.00*
Beh Ctrl over Exercise	-1.40***	-3.89**	-1.30**	-4.84**	-1.23**	0.56	-1.45***	-0.16
Neighborhood1 (Density)	-0.15	-5.11*						
Neighborhood2 (Aesthetics)			-1.92**	-8.82**				
Neighborhood3 (Safety)					-1.25	1.83		
Neighborhood4 (Accessibility)							0.61	-3.16
Sex (Male)	2.45**	2.41**	2.55*	2.64*	2.32**	2.26**	2.44**	2.44**
Education	-0.12	-0.11	-0.05	-0.09	-0.12	-0.14	-0.12	-0.12
Wealth	-0.96	-1.02	-0.92	-0.86	-0.86	-0.91	-0.79	-0.78
Income	-0.45	-0.49	-0.47	-0.65	-0.15	-0.06	-0.39	-0.40
Self-Assessed Status	-0.37	-0.46	0.02	0.18	-0.39	-0.31	-0.37	-0.17
Neighborhood1*Beh Ctrl over Exercise		0.83*						
Neighborhood2*Beh Ctrl over Exercise				1.16*				
Neighborhood3*Beh Ctrl over Exercise						-0.56		
Neighborhood4*Beh Ctrl over Exercise								-0.42
N	270	270	270	270	270	270	270	270
R^2	0.09	0.11	0.13	0.14	0.10	0.10	0.09	0.10

*p < 0.05, **p < 0.01, ***p < 0.001