January 2013

Community Greenspace's Impact On Perceived Health Of New Haven Adults

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Thesis by

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In Partial Fulfillment of the Requirements
for the Degree of
Master of Public Health

Yale University School of Public Health
New Haven, Connecticut

2013
(Submitted May 1, 2013)

ABSTRACT

Background: In 2008, for the first time in history, urban space is the predominant dwelling place of the human race, which raises concerns about how the presence or absence of green spaces influences the health of residents. The Urban Resources Initiative (URI) in New Haven, Connecticut offers a Community Greenspace Program that provides community members with resources for designing and stewarding an area within their neighborhood. The goal of this study is to determine if these community-developed green spaces improve the self-perceived health of the adults living in that neighborhood.

Methods: Data on self-perceived health was gathered from the Community Alliance for Research and Engagement (CARE) 2009 Neighborhood Adult Survey and locations and participation history for green spaces were contributed by URI. Groups were included if they were active in 2009 and for at least one year prior. Neighborhoods were labeled high green space if they had >3 sites or >5% area covered by these sites. Logistic regression models were used to compare health to green space and neighborhoods while likelihood ratio tests were consulted to determine the amount of neighborhood difference in self-perceived health that could be attributed to differences in Community Greenspace groups.

Results: There was no significant relationship between a neighborhood having high amounts of active URI Greenspace groups and better overall self-perceived health. However, having high amounts of these spaces did account for some of the differences in health between the various neighborhoods.

Conclusions: While no association between URI Community Greenspace sites and health was realized, there is no evidence to the contrary. Future studies should seek to examine this relationship on a smaller, block group-level scale.

ACKNOWLEDGEMENTS

It would not have been possible to write this master's thesis without the help and support of the kindhearted people around me, to only some of whom it is possible to mention here:

I would like to express my sincere gratitude to my thesis advisor, Dr. Theodore Holford, for the support and guidance he showed me throughout my thesis writing process. This project would not have been possible without his help and vast knowledge of biostatistics. I would also like to thank my second reader, Dr. William Burch, founder of the Urban Resources Initiative. His insight into the environment and human behavior proved invaluable in the development of my project. In addition, I would like to thank my academic advisor, Dr. Brian Leaderer, for providing me with advice and encouragement throughout my entire graduate school career.

Special thanks go to The Urban Resources Initiative for giving me the opportunity to serve as an intern in the Community Greenspace Program and the High School GreenSkills program which allowed me to apply my public health knowledge to urban forestry. Additional thanks to URI and CARE for permitting me to utilize their data to explore the relationship between health and the environment in the wonderful City of New Haven.

Last but not least, I would like to thank my friends and family for their endless love and support throughout my entire life and my many years of education. Without their encouragement, I never would have made it this far.

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BACKGROUND

In 2008, for the first time in history, the predominant habitat for humans is urban (13). The growth of cities worldwide is expected to continue, with 5 billion living in urban areas by 2030 (13). With urbanization on the rise and many cities already at a loss for green spaces in these giant concrete jungles, it is important to understand the contributions of these natural areas to the health of city residents so that decisions can be made now in order to promote health and wellness as growth continues. E.O. Wilson asserts that contact with nature is a basic need for humans. The biophilia hypothesis furthers this idea by noting that humans have a need to associate with life and life processes and humans respond powerfully to nature and its processes (3, 12). Studies have built off of this hypothesis and demonstrated that nature has the potential to benefit humans through many mechanisms.

The first suggested mechanism is that green spaces and natural elements provide ecosystem services that can reduce air pollution, diminish the urban heat island effect, reduce noise, and reduce surface runoff (1). These services may lead to residents spending more time outdoors and increasing their physical activity (6). Moreover, ecosystem services improve the overall environment which can directly affect health. For example, children who live in areas with more street trees tend to have a lower prevalence of asthma (12).

A second potential mechanism is that the passive viewing of the natural environment has the ability to reduce stress and ultimately provide health benefits such as reduced blood pressure, lessened muscle tension, and improved attention (1, 12). Some studies have reported that more green space is associated with increased survival in elderly populations and lower stroke mortality (6). Some of the first evidence of this relationship between health and environmental

enjoyment was introduced by Roger Ulrich's 1984 study of hospital patients. In his study hospital patients recovering from surgery that had rooms with a view of the outdoor landscape used less narcotics and milder analgesics, stayed in hospitals for a shorter amount of time, and had a more positive overall recovery than similar patients staying in rooms that faced a brick wall. These studies suggest that the simple aesthetics of nature exert a powerful influence on human health.

In addition to these suggested relationships between nature and health, green spaces may serve as locations where persons interact with other community members and build relationships. A Chicago study of neighborhood social ties found that people who lived in apartment buildings that had trees and grass in their common spaces tended to use the spaces more, have more social interaction with neighbors, and feel safer than those living in architecturally similar buildings with common areas devoid of vegetation (5). Moreover, a sense of community seems to affect perceptions of safety. When residents feel safer and form bonds with neighbors they are more likely to utilize neighborhood outdoor space and reap the benefits of physical activity and aesthetics that their surroundings provide.

The Urban Resources Initiative (URI) is a non-profit established in Baltimore, MD in 1989 and then in New Haven in 1991. It is partnered with Yale University and looks to cultivate community-based stewardship of green spaces, contribute to environmental restoration, and to promote community-building. The URI Community Greenspace program serves to allow New Haven residents to identify an area of need in their neighborhood to restore and maintain such as an abandoned lot or neglected park. To become a group, unrelated neighbors must come together, identify their potential project, and complete an application about their ideas and timeline. Once accepted, the program provides self-assembled community groups with

materials, technical expertise, and other training to help them transform derelict spaces into green spaces for their neighborhoods. The neighbors who start up the group work with an assigned intern to canvas the neighborhood and to reach out to other community members regarding their project. They hold community meetings to gather a greater support and to hear others' ideas regarding neighborhood space. Groups can work in parks, vacant lots, front yards, and even in the streetscape planting trees, shrubs, and perennials to build their green space. While the main goals of the project are stewardship, environmental restoration, and community-building, these projects have the potential to contribute greatly to the health of all persons in their neighborhood because they create natural spaces for everyone to enjoy. First of all, adding new vegetation provides ecosystem services that help improve the environment, which can directly impact the health of the residents. Additionally, persons can actively utilize these spaces for physical activity and can passively enjoy them just by viewing them. Some people cite gardening as a means by which they gain personal satisfaction and that it helps them to relax (11). These places can further facilitate community building by allowing residents to meet one another. Those directly involved in working on the space gain health benefits because some of the work is physical (digging, moving heavy trees, etc.), they get outside into the fresh air, and they are performing work that studies have shown to be calming (3). Moreover, persons involved with the creation and maintenance of the space through the Greenspace program can meet new neighbors involved in the project and build a community within their neighborhood. These feelings of community can evolve into a group taking other actions within their neighborhood that reduce crime or other unfavorable behaviors and makes the neighborhood safer (9). This group can become an active entity that brings about positive change for the neighborhood (7).

URI Greenspace interns have noted the ability of this program to influence the dynamics of a neighborhood. For example, one new group was located in a neighborhood that experienced a lot of noise during the day and night and most adults did not know each other. The group started out being a core group of adults and many of the curious energetic neighborhood children working to build a community garden in a large vacant lot filled with trash. As the group started working, the neighborhood children helped bring their parents out of the house and into the group. Each week, more adults came out, curious to see what was going on. They expressed excitement about the project and joined in. Neighbors that had never met before were working side by side and conversing with one another. A community was being built on that very vacant lot. Throughout the summer as the group grew and became closer, there was a noticeable drop in the neighborhood noise level and littering stopped. Having a group of residents demonstrate their dedication to their street prevented others from trashing their hard work. In showing that they cared, they deterred some of the common loitering and littering activities that previously took place there. These changes contribute to an improved sense of community, which helps residents to feel safer. Moreover, they were outside in the fresh air doing physically demanding work that can help improve their overall health. In addition to potentially improving their own health by participating, these residents were creating a space for other neighbors to enjoy and derive health benefits from be it from aesthetic viewing or the contributions of the new ecosystem services to things like air quality. All of this can be brought about by planting trees.

To date, most research has looked to see if green spaces in general have any effect on the health of persons living within a certain distance of that site. While active involvement in tree-planting programs has been shown to improve a community's self-esteem and demonstrates that they can work together to control the condition of the environment in their neighborhood (2),

there is no information on how this extends to the self-perceived health of the community members. There is suggestion that there is a positive correlation between quantity of urban green space and perception of general health but this includes all green spaces and does not distinguish among those that are community organized and maintained and those that are not (6, 8). Data is lacking on the effectiveness of the green spaces designed and stewarded by the community members, such as those developed through the Urban Resources Initiative Greenspace Program, to improve the health and safety of the residential community as a whole. The goal of this study is to determine if the presence of community designed and stewarded green spaces improves the perceived health of most of the people living in that neighborhood.

METHODS

Data on perceived health, perceived safety during the day and night, age, gender, marital status, education, and neighborhood were gathered from New Haven's Community Alliance for Research and Engagement (CARE) 2009 Neighborhood Adult Survey. This survey included six New Haven neighborhoods: Dixwell, Fair Haven, Newhallville, West River/Dwight, and West Rock. For this survey, the Hill neighborhood was divided at Columbus Ave into Hill North and Hill South and only the Hill North portion was included in the survey. Additionally, the boundaries of the West Rock neighborhood were redrawn to include small sections of the adjoining Amity and Beaver Hills neighborhoods.

CARE developed a list of all addresses in each neighborhood. This list was used to randomly select a sample of 500 households within each of the six areas. It was sorted by neighborhood and separate spreadsheets were made for each neighborhood. In the new spreadsheets, data was re-sorted by property number and street name so that multi-unit addresses were kept together. Then, a sequential list of numerical and unique address identifiers was generated for each entry. A random number generator (www.random.org/integers) was used to select 300 random integers between one and the total number of addresses in that neighborhood. The numbers generated were used to identify addresses that had been selected for surveying. The randomly chosen addresses were then put into a separate spreadsheet for team members to utilize when out in the field.

Each selected address was sent a letter or had a flyer posted on their door prior to being approached for a survey. Outreach activities were also done to attempt to schedule survey interviews. Field workers were instructed to knock on the doors of those addresses selected between 3-8pm on weekdays and 11am-3 or 4pm on Saturdays. Teams knocked 3 times. If

there was no answer, this was logged and a different time was chosen for the next attempted knock. When the door was answered, the person answering the door was designated as the "screener" and was asked questions regarding number of adults in the home and based on this, an adult was selected for the survey. If there was only 1 adult in the home, they were selected. If there were 2 adults, a randomization procedure was used to choose an adult. If there were more than 2 adults, the adult with the most recent birthday was selected for surveying.

The selected adult was then briefed on the importance of the study, confidentiality procedures, and incentives. If a language barrier existed, the address was recorded as a non-response and was not approached again. If the adult spoke Spanish and no Spanish-speaking team member was nearby, a Spanish flyer was left and a time was scheduled for a Spanish-speaking team to return and conduct the interview.

For quality control purposes, the numbers of males and females and their age categories (18-24, 25-34, 35-44, 45-54, 55-64) were recorded so adjustments could be made in analysis to ensure that the sample represented the underlying age and gender structure of the city.

Data on URI Community Greenspace locations and participation histories was also used for this study and was provided by the organization. This data is collected and recorded each year by student interns. Interns are assigned about seven community groups and they record the dates and hours that the group met to work, the activities performed, and the number of volunteers present at each meeting. This data has been condensed into a spreadsheet for the years of 1995-2007 and data from 2007-2012 is readily available on Urban Resource Initiative's website, www.urbanresourcesinitiative.org, via an interactive map.

Interested individuals may apply to become a URI Community Greenspace group or an existing group may renew their membership each summer. Some groups started early on when

the program was founded in New Haven in 1991 and have continued operating for many years. Others exist for only a short period of time. For this study, Greenspace groups were included in the analysis only if they were located within the six neighborhood areas of interest and if they were active in 2009 and for at least one year prior. This decision was made because the survey was conducted in fall 2009 and time needed to be allowed for the effects of the group's presence to permeate the neighborhood.

Once the groups that met these criteria were established, they were analyzed via two methods. The first method involved assigning a simple count of URI Community Greenspace sites in the associated neighborhood (e.g. Dixwell has four active groups).

The second method sought to examine the area of influence that a URI Community Greenspace project could exert on the surrounding community. Sites were plotted using GIS (ArcMap 10.1). Sites that were vacant lots or parks were constructed as new polygons and a buffer area of 50m was established around it. This distance was used because research has indicated that, for at least large urban parks, those living within 50m are likely to be the primary users of that space and therefore experience health benefits (10). The buffer was only drawn on the outside of parks and vacant lots since no neighborhood residents reside within the parks. The area that this buffer covered was determined and recorded. If the group was for community housing, the site was drawn and the buffer included both the site and a 50m buffer to account for the fact that residents do live within the area of the site. If the group worked primarily on streetscapes, project histories were read to determine which streets were worked on during the summer of 2008-2009. These streets were then selected and a 50m buffer was constructed on either side of the road to determine influence. As with the other sites, the area that these buffer regions covered was recorded. GIS was also used to determine the approximate area of each

neighborhood surveyed. Green space buffer areas were totaled and divided by the total area of the neighborhood to determine the percentage of the neighborhood that was likely to be influenced by the presence and activity of a URI Greenspace group.

SAS (Version 9.3) was used for data analysis. Chi-square tests were used to examine the frequency and differences in potential confounders such as age, gender, marital status, education level, race, and perceived safety during the day and night across each neighborhood. The same procedure was used to examine distribution of perceived health and URI Community Greenspace sites for each neighborhood.

The variable for green space was defined two ways. The first assigned neighborhoods with fewer than 3 URI Community Greenspace sites to the low green space group and those with 3 or more sites to the high green space group. This division was made based on the median of the range of the number URI Greenspace sites in the neighborhoods. The second utilized the percent area and assigned neighborhoods with less than 5% area accounted for to the low green space group and neighborhoods with 5% or more area likely to be influenced by the presence of an active URI Greenspace group to the high green space group. This division was an arbitrary midpoint based on a range from 0% to almost 10% seen across neighborhoods. Likewise, the variable for health was defined as those individuals who perceived their health to be fair or poor being assigned the poor health group while those who perceived their health to be good, very good, or excellent being assigned to the good health group.

Associations between health and each potential confounder were examined via logistic regression, as were associations between green space and each potential confounder to determine which variables were important to control for in the model.

An unadjusted logistic regression model was run to examine the scale of the difference between the neighborhoods in regards to health. A similar model was run using the green space variables. Odds ratios, 95% confidence intervals, and p-values of significance were derived from these models. Additionally, the likelihood ratio test statistics were recorded for each model and then the green space chi-square value and degrees of freedom were subtracted from the neighborhood values to determine how much of the difference in the perceived health of neighborhoods could be explained by the presence of URI Community Greenspace groups.

Then, adjusted models were run. These models used backward elimination techniques that initially ran the model with all potential confounders and then dropped those that did not significantly contribute to the model until only significant covariates remained. These models compared health and neighborhood or health and green space while adjusting for age and education covariates. Again, odds ratios, 95% confidence intervals, and p-values of significance were derived from these models. Likelihood ratio test statistics were also recorded and used as described previously to determine how much the presence of URI Community Greenspace groups accounted for the difference in the perceived health between the six neighborhoods when they were controlled for age and educational differences.

RESULTS

Figure 1 depicts the locations of those URI Community Greenspace sites that were active in 2009 and for at least one year prior to that in each of the six surveyed neighborhoods. The yellow dots signify the location of a lot or park where the team works or if the group primarily works on streetscapes, the dot indicates a central meeting location.

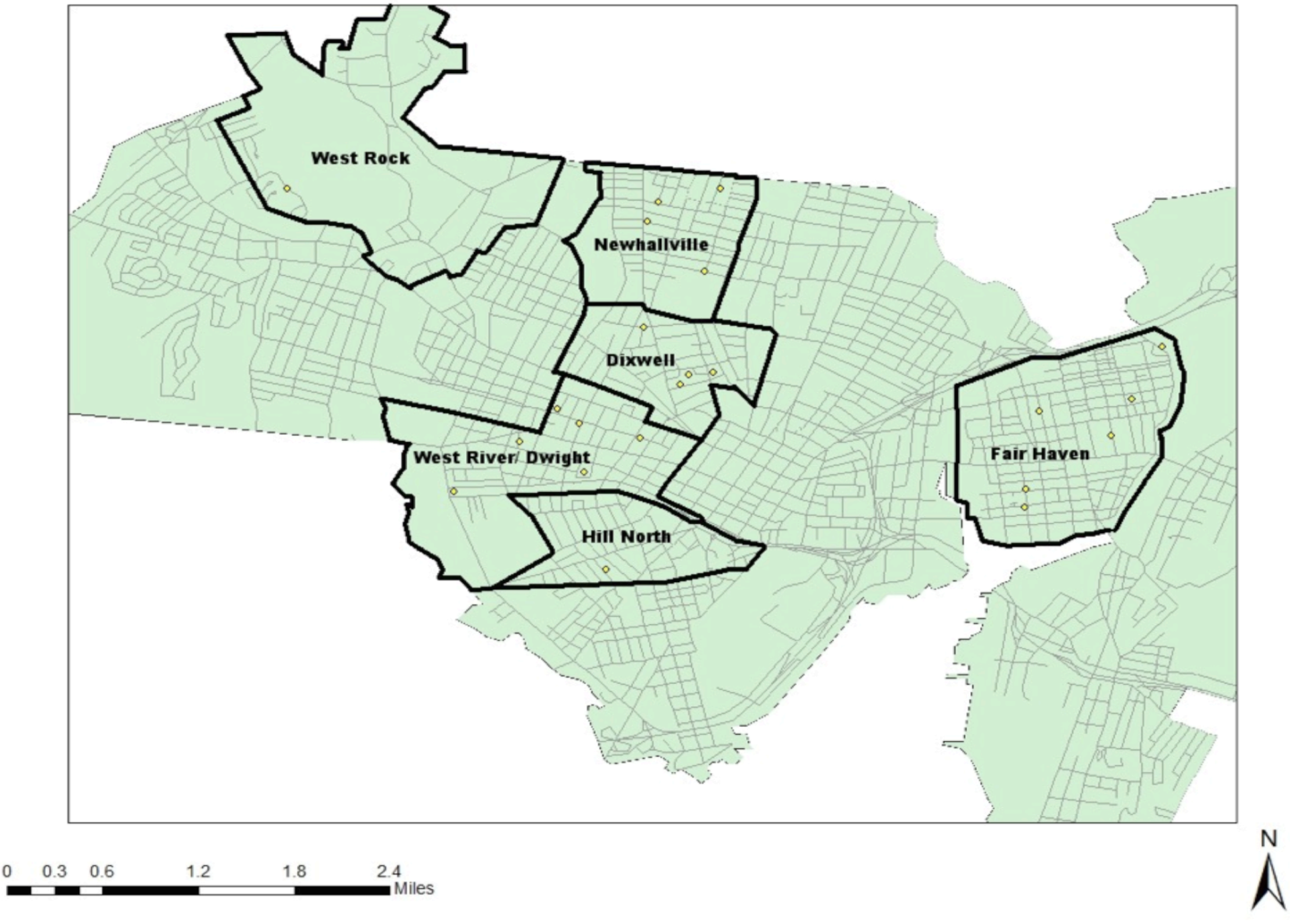

Figure 1: The 6 New Haven Neighborhoods and the locations of URI Greenspace Groups (indicated by yellow dots) active during the time of the CARE Adult Survey.

Figure 2: Each surveyed neighborhood is depicted with each of its active URI Greenspace sites. Each site has a buffer of 50m drawn around it to demonstrate the area that the site is most likely to positively impact. **A.** Newhallville, **B.** Fair Haven, **C.** Hill North, **D.** West River/Dwight, **E.** Dixwell, **F.** West Rock.

Figure 2 shows each neighborhood individually and the URI Greenspace groups that met the criteria of "active". In this figure, a 50m buffer region was established around each green space signifying the area of influence that the group could potentially reach as previously discussed. This provides a visual for how the number and size of different sites vary by each neighborhood. Fair Haven, Dixwell, West River/Dwight, and Newhallville have relatively large amounts of green space (4 or more active project sites, >5% total area) while Hill North and West Rock have only a single active Greenspace group. Through visual inspection it is obvious that large portions of each neighborhood are not within 50m of an active URI Greenspace site and therefore are less likely to experience the potential health benefits. Moreover, many of the groups are clustered close to one another in Fair Haven, West River/Dwight, and Dixwell. Only Newhallville appears to have a more evenly spread distribution of active groups.

Table 1 summarizes the demographic characteristics for each of the surveyed neighborhoods. The neighborhoods are significantly different from one another with respect to all of the variables included in the analysis. In terms of age distribution, Newhallville has the largest percentage of adults over the age of 65 included in the survey (8.6%) while the West River/Dwight neighborhood has 0.7% of its interviewed population over the age of 65. Across the neighborhoods, the p-value for the variance in age was 0.0395, which is statistically significant at a significance level of 0.05. This means that each neighborhood has a different age structure and these differences are likely to influence overall health in the neighborhood. For example, Newhallville is home to more persons over the age of 65 (8.6% of those surveyed) as compared to other neighborhoods. The percentage of males included in the survey ranged from 33.0% in Newhallville to 46.6% in Fair Haven, but the difference was not significant (p=0.065).

Characteristic	Dixwell (n=209)	Fair Haven (n=208)	Hill North (n=213)	Newhallville (n=197)	West Rock (n=164)	West River/Dwight (n=214)	p-value#
Age							0.0395
<25	41 (19.6)	33 (15.9)	36 (16.9)	28 (14.2)	31 (18.9)	41 (19.2)	
25-44	82 (39.2)	88 (42.3)	92 (43.2)	73 (37.1)	66 (40.2)	89 (41.6)	
45-64	79 (37.8)	85 (40.9)	82 (38.5)	79 (40.1)	61 (37.2)	76 (35.5)	
65+	7 (3.4)	2 (1.0)	3 (1.4)	17 (8.6)	6 (3.7)	8 (3.7)	
Male, n (%)	75 (35.9)	97 (46.6)	88 (41.3)	65 (33.0)	58 (35.8)	85 (39.7)	0.065
Education, n (%)							<.0001
Less than High School	15 (7.2)	47 (22.8)	43 (20.3)	19 (9.7)	12 (7.4)	23 (10.8)	
High School Graduate	77 (37.0)	97 (47.1)	108 (50.9)	85 (43.6)	58 (35.8)	89 (41.6)	
At least some college	116 (55.8)	62 (30.1)	61 (28.8)	91 (46.7)	92 (56.8)	102 (47.7)	
Marital Status, n (%)							0.005
Single	107 (51.2)	89 (42.8)	99 (46.5)	77 (39.1)	80 (48.8)	108 (50.5)	
Married or w/ partner	71 (34.0)	82 (39.4)	80 (37.6)	62 (31.5)	57 (34.8)	59 (27.6)	
Widowed	10 (4.8)	4 (1.9)	11 (5.2)	17 (8.6)	5 (3.1)	10 (4.7)	
Separated or Divorced	21 (10.1)	33 (15.9)	23 (10.8)	41 (20.8)	22 (13.4)	37 (17.3)	
Race, n (%)							<.0001
White	29 (13.9)	40 (19.5)	10 (4.8)	8 (4.1)	28 (17.3)	32 (15.3)	
Black	146 (70.2)	64 (31.2)	121 (57.9)	168 (85.7)	109 (67.3)	127 (60.8)	
Hispanic	19 (9.1)	86 (41.9)	72 (34.5)	15 (7.7)	14 (8.6)	34 (16.3)	
Other	14 (6.7)	15 (7.3)	6 (2.9)	5 (2.6)	11 (6.8)	16 (7.7)	
Perceived Safety During the Day, n (%)							.0001
Safe	144 (68.9)	154 (74.0)	147 (69.0)	109 (55.4)	123 (75.0)	159 (74.3)	
Unsafe	65 (31.1)	54 (26.0)	66 (31.0)	88 (44.7)	41 (25.0)	55 (25.7)	
Perceived Safety At Night, n (%)							.0022
Safe	66 (31.6)	73 (35.1)	96 (45.1)	51 (25.9)	62 (37.8)	71 (33.2)	
Unsafe	143 (68.4)	135 (64.9)	117 (54.9)	146 (74.1)	102 (62.2)	143 (66.8)	

*Numbers may not sum to totals due to missing data, and column percentages may not sum to 100% due to rounding.
P-value for analysis of variance χ^2 test (categorical variable)

Table 1: Demographic characteristics in each of the six surveyed neighborhoods.

Education levels varied widely between neighborhoods. Fair Haven and Hill North had the largest percentage of persons whom had not completed high school at 22.8% and 20.3% respectively. Conversely, Dixwell and West Rock Neighborhoods had the largest number of individuals whom had completed at least some college (55.8% and 56.8% respectively).

Each of the neighborhoods has a unique racial profile ($p<.0001$). Blacks represent the majority of the population in each neighborhood with Newhallville having the largest percentage at 85.7%. Fair Haven and Hill North communities also have large Hispanic populations which make up 41.9% and 34.5% of their respective populations. White residents are a minority in each neighborhood; Fair Haven has the largest percentage at 19.5%.

Perceived safety was utilized as a proxy for crime in each neighborhood. This assumes that in neighborhoods where persons felt less safe going outside, there was more crime. In terms of perceived safety during the day and night, each neighborhood had a majority say they felt safe to walk outside during the day and a majority respond that they felt unsafe to walk outside at night. Newhallville had the largest percentage, 44.7%, say that they felt unsafe outside during the day and the largest percentage, 74.1% say they felt unsafe to go outside at night. West Rock had 75.0% of survey respondents say that felt safe during the day while Hill North had the greatest percentage, 45.1%, say that they felt safe at night.

Overall, these 6 neighborhoods have incredibly varied demographic profiles (Table 1). The differences between neighborhoods for these characteristics are all statistically significantly different from one another at a significance level of 0.05.

	Dixwell (n=209)	Fair Haven (n=208)	Hill North (n=213)	Newhallville (n=197)	West Rock (n=164)	West River/Dwight (n=214)	p-value#
Active URI Community Greenspace Groups	4	6	1	4	1	6	<.0001
% of neighborhood area (w/ 50m buffer around sites)	6.996%	6.038%	0.744%	8.966%	0.356%	6.795%	<.0001
Perceived Health, n (%)							<.0001
Excellent/Good	165 (79.0)	139 (66.8)	146 (68.5)	135 (68.5)	139 (84.8)	171 (79.9)	
Fair/Poor	44 (21.1)	69 (33.2)	67 (31.5)	62 (31.5)	25 (15.2)	43 (20.1)	

*Numbers may not sum to totals due to missing data, and column percentages may not sum to 100% due to rounding.
P-value for analysis of variance χ^2 test (categorical variable)

Table 2: Distribution of numbers of active URI Greenspace Groups and self-perceived health in each neighborhood.

Fair Haven and West River/Dwight have the largest number of active URI Greenspace groups with 6 apiece (Table 2). Dixwell and Newhallville both have 4 while Hill North and West Rock only have 1 active group. When the 50m buffer region was added to each site, the area of each was determined and summed to calculate the percent of the neighborhood's area that

was most likely to be affected by and to utilize the spaces. Newhallville has the largest percentage of their total area being potentially influenced by these sites with nearly 9%. Dixwell and West River/Dwight neighborhoods are both around 7% while Fair Haven has about 6% coverage. Hill North and West Rock both have less than 1%. In creating the variables that grouped neighborhoods into high and low green space, both count and percent area measures resulted in the same neighborhoods being assigned to the high and low groups. For further analyses, the results are simply defined as high vs. low green space because the results for percent area of influence and total count were identical.

The self-perceived health of residents of the various neighborhoods is displayed in Table 2. West Rock residents' perceived health is better than all other neighborhoods with 84.8% believing themselves to be in good, very good, or excellent health. Dixwell and West River/Dwight have the next best self-perceived health with 79.0% and 79.9%, respectively, perceiving their health to be good. Fair Haven, Hill North, and Newhallville have larger percentages of resident perceive their health to be fair or poor with 33.2%, 31.5%, and 31.5% respectively. Self-perceived health is statistically significantly different across neighborhoods at a significance level of 0.05 with a p-value of <.0001.

The logistic regression model relating health and neighborhood yielded a Chi-Square value of 29.25 (degrees of freedom(DF)=5) for the likelihood ratio test in which the global null hypothesis was that beta=0 (Table 3). The p-value for this was <.0001. The model relating green space and health yielded a Chi-Square value of 0.51 (DF=1) and a p-value of 0.4770. Subtracting the Chi-square values to determine how much of the difference in neighborhood self-perceived health could be accounted for by the difference in amount of active URI Greenspace sites yielded a Chi-square value of 28.74 (DF=4) and an associated p-value of <.0001.

	X^2	Degrees of Freedom (DF)	P-value
Neighborhood	29.25	5	<.0001
+ Hi/Lo Greenspace	0.51	1	0.4770
	28.74	4	<.0001

Table 3: Unadjusted likelihood ratio test results

Characteristic	OR (95% CI)	p
High Green Space	1.107 (0.836, 1.467)	0.4785
Neighborhood		
Dixwell	1.483 (0.864, 2.545)	0.1766
Fair Haven	2.760 (1.650, 4.616)	0.0030
Hill North	2.551 (1.525, 4.269)	0.0163
Newhallville	2.553 (1.516, 4.300)	0.0194
West River/ Dwight	1.398 (0.814, 2.403)	0.0849
West Rock	1.000	
Age*		
Less than 25	1.000	
25-44	1.857 (1.179, 2.924)	0.0076
45-64	3.342 (2.140, 5.218)	<.0001
Greater than 65	2.538 (1.150, 5.599)	0.0211
Education*		
Less than High School	1.000	
High School Graduate	0.660 (0.452, 0.964)	0.0318
At least some College	0.443 (0.297, 0.661)	<.0001
Male*	1.258 (0.958, 1.653)	0.0991
Race*		
White	1.000	
Black	1.563 (0.986, 2.478)	0.0573
Hispanic	1.380 (0.827, 2.303)	0.2180
Other	0.933 (0.438, 1.989)	0.8575
Marital Status*		
Single	1.000	
Married/ Living with Partner	1.367 (1.012, 1.846)	0.0418
Widowed	1.400 (0.752, 2.606)	0.2893
Separated/ Divorced	2.022 (1.389, 2.944)	0.0002
Feels Safe During the Day*	0.782 (0.590, 1.038)	0.0885
Feels Safe at Night*	0.852 (0.643, 1.130)	0.2659

Table 4: Unadjusted associations between study variables and self-perceived health (N=1,205)

Relating health and green space without adjusting for covariates resulted in an odds ratio of 1.107 (95% CI 0.836, 1.467), which suggests that those living in areas with more URI Greenspace groups are more likely to perceive their health to be fair or poor (Table 4). However, this relationship is not statistically significant (p=0.4785).

The relationship between neighborhood and health was also examined without adjustment (Table 4). The results of this analysis found that Fair Haven (OR=2.760 95% CI= 1.650, 4.616), Hill North (OR=2.551 95% CI=(1.525, 4.269), and Newhallville (OR=2.553 95% CI=1.516, 4.300) all perceived their health to be worse than residents in West Rock. There was no significant difference between self-perceived health in either Dixwell or West River/Dwight neighborhoods as compared to West Rock. Overall, the likelihood ratio test yielded a Chi-square value of 29.25 (DF=5, p <.0001) indicating that there is a significant difference in self-perceived health across the six neighborhoods.

Categories of age and education were all significantly associated with self-perceived health. Marital status appeared to be associated, but when backward elimination model building was used to build a final model, marital status came out as not being a significant contributor to the relationship between either neighborhood and health or green space and health. This is likely due to the existing correlation between age and marital status. Interestingly, race was not significantly associated with self-perceived health and was therefore not included in the adjusted model. Gender and perceived safety during the day and night were also not included in the model because they were not associated with perceptions of health.

After adjusting for age and education, the only two covariates that remained significant following a reverse selection model building method, those with more green spaces or greater percentage area covered in their neighborhoods were 1.130 (95% CI 0.845, 1.511) times as likely

to perceive their health to be worse than those living in neighborhoods where there is less green space (Table 5). This association was not significant with a p-value of 0.4110. The global tests for age and education are significant which indicates that both contribute to the self-perceived health of neighborhood residents. After adjusting for age and education in the logistic regression model relating health and neighborhood, Fair Haven and Newhallville were the only two neighborhoods whose self-perceived health was statistically significantly worse than that of West Rock (Table 6). Hill North was borderline significant with a p-value of 0.0876 (Note: The 95% CI does not include 1, this is due to a small sample size). The global tests for age, neighborhood and education in table 6 are also significant which means that there is evidence that these variables affect self-perceived health.

Characteristic	Adjusted OR (95% CI)	p
High URI Greenspace	1.130 (0.845, 1.511)	0.4110
Age		
Less than 25	1.000	
25-44	1.988 (1.255, 3.148)	0.0034
45-64	3.506 (2.233, 5.504)	<.0001
65 or greater	2.548 (1.160, 5.598)	0.0199
Global Test for Age	X^2= 14.73 DF=2	0.0006
Education		
Less than High School	1.00	
High School Graduate	0.657 (0.449, 0.962)	0.0307
At least some College	0.404 (0.273, 0.599)	<.0001
Global Test for Education	X^2=10.51 DF=1	0.0012

Table 5: Logistic regression model of green space associated with self-perceived health adjusted for age and education level (N=1,197).

Characteristics	Adjusted OR (95% CI)	p
Neighborhood		
Dixwell	1.479 (0.852, 2.567)	0.4161
Fair Haven	2.315 (1.361, 3.940)	0.0280
Hill North	2.156 (1.267, 3.668)	0.0876
Newhallville	2.328 (1.363, 3.975)	0.0299
West River/ Dwight	1.326 (0.763, 2.305)	0.1335
West Rock	1.000	
Global Test for Neighborhood	X^2=17.81 DF=5	0.0032
Age		
Less than 25	1.000	
25-44	1.939 (1.221, 3.080)	0.0050
45-64	3.462 (2.199, 5.451)	<.0001
65 or greater	2.519 (1.128, 5.642)	0.0242
Global Test for Age	X^2= 15.12 DF=2	0.0005
Education		
Less than High School	1.000	
High School Graduate	0.696 (0.474, 1.024)	0.0659
At least some College	0.463 (0.309, 0.694)	0.0002
Global Test for Education	X^2=7.11 DF=1	0.0077

Table 6: Logistic regression model of neighborhood associated with self-perceived health adjusted for age and education (N=1,197).

The likelihood ratio test statistic for the relationship between self-perceived health and neighborhood after adjustment for age and education yielded a Chi-square value of 82.23 (DF=10) with a p-value of <.0001 (Table 7). The same test performed on the model between health and high URI Greenspace activity, adjusted for the same covariates, resulted in a Chi-square value of 64.36 (DF=6) and a p-value of <.0001. Subtracting the Chi-square values to determine how much of the difference in neighborhood self-perceived health could be accounted for by the difference in amount of active URI Greenspace sites after controlling for age and education level yielded a Chi-square value of 17.87 (DF=4) and a p-value of 0.0013.

	X^2	Degrees of Freedom (DF)	P-value
Neighborhood	82.23	10	<.0001
+High URI Greenspace	64.36	6	<.0001
	17.87	4	0.0013

Table 7: Adjusted likelihood ratio test results

DISCUSSION

Based on this data, the hypothesis that more active URI Greenspace groups results in a better overall self-perceived health in neighborhood residents has not been confirmed. No statistically significant results were realized through data analysis.

The likelihood ratio test statistic indicates that the surveyed neighborhoods are very different from one another in their self-perceived health. Adjusting for age and education levels explained some of the difference between overall self-perceived health in each neighborhood but was unable to explain all of the differences. Adding the green space variable to the model helped to explain some of the differences but the differences were still significant after adding this to the model. This means that another variable that was not included in the model plays a role in perceived health.

The formulation of this study examines the neighborhood-level effects of URI Community Greenspace groups on perceived health of all residents. While those who participate directly in the projects are likely to experience the greatest health benefits, examining health at a larger, neighborhood-level scale allows us to see how far-reaching the effects of these green spaces can be. Based on this, it would be assumed that having more community-run green spaces would result in a better overall perceived health in the neighborhood because more spaces mean that more people are likely to live in close proximity to a site and therefore experience the physical and aesthetic benefits of its presence.

However, data used in this study could only identify residents as belonging to one of the six neighborhoods and not their address. Neighborhood-level data does not permit the examination of proximity to one of these community green space sites and the associated health effects. It is likely that those living closer to these community Greenspace sites are more likely to

participate or utilize the space and therefore have better overall health. However, residents are identified by their neighborhood and therefore any effects of living near a URI Community Greenspace and participating in its upkeep or utilizing the space, are diluted by residents who do not live near one and are less likely to experience health benefits. As the maps of the neighborhoods demonstrate, green space locations are clustered together rather than spread evenly throughout the neighborhood. This clustering likely resulted in fewer residents experiencing benefits. If sites were more evenly spread and if benefits can reach farther than a 50m radius, more residents are likely to benefit from the presence of such groups. However, without this even spread, the benefits are less widespread and thus undetectable in this analysis. While it is important to see how the health of the overall neighborhood might be affected by the presence of active groups as we sought to do, the effect was not strong enough to exemplify this relationship. Instead, the effects were likely diluted to an extent that they were not at all detectable at the scale of the neighborhood.

An important limitation of this study is that the total green space area was not accounted for in the analysis. In only including data on green spaces being developed and maintained by community groups, existing green spaces such as parks and fields were not accounted for. It is likely that these spaces are utilized by community members for physical activities and that community-building takes place here. These sites also provide aesthetics. Moreover, the ecosystem services provided contribute to an overall improvement in the environment, which therefore influences health (e.g. cleaner air). One example of this is the existence of West Rock Park in the West Rock Neighborhood. This park comprises a large portion of the neighborhood but there is no URI community group associated with it. This may explain why the West Rock Neighborhood has the best self-perceived health amongst all included neighborhoods despite

having only a single active URI Greenspace group at the time of the survey. Without controlling for these spaces, it is likely that their presence confounds the results of the association between perceived health and URI Community Greenspace groups because these other green spaces are likely to be associated with both neighborhood and health.

It is also important to consider that different URI Greenspace groups have different histories. Some are active for only short periods of time and some have been active since the program was introduced to New Haven. Therefore, in choosing a two-year window in which to include or exclude green spaces, some short-lived green space groups may have been included. They may have come together as late as 2008 and may have disbanded following 2009. These groups are likely to exert weaker influences within their neighborhood. Perhaps choosing such a small window of time contributed to the weak associations seen.

Conversely, those sites that have been around for nearly a decade are more likely to have contributed to more community building and environmental change within their neighborhoods. These spaces may have much greater impacts on the self-perceived health of residents.

Another important contributor to the association that was not considered is income. There was no data available on the income levels of those completing the survey and research has shown that those in poverty are more likely to have poorer health than their more wealthy counterparts. This has to do with access to care and the ability to pay for insurance or medical bills (4, 14). Some of this may have been controlled for because income is related to socioeconomic status that is influenced by things like education, which was included in the model. Therefore, it is unlikely that lack of data on income significantly influenced the results of this study.

A final limitation of this study is the inability to control for air pollution. Air pollution may significantly influence the results of this study because poorer air quality can exacerbate symptoms of existing illnesses and cause other illnesses. Therefore, neighborhoods with greater air pollution levels are likely to perceive their health to be worse than those areas with cleaner air. This is important to this study because of the major arteries of Interstates 91 and 95 that run through the city. Some neighborhoods are much closer to these highways than others meaning that air quality is likely to differ between neighborhoods. Without data on pollution for each neighborhood, this variable could not be controlled for and confounding probably exists.

Since 2009, the URI Community Greenspace program has continued to run every summer with new groups forming, some groups fading away, and some groups continuing to flourish. Additionally, CARE has recently completed a second round of adult surveying. It would be interesting to plot the progression of community group development throughout each neighborhood. The 2012 CARE data could also be used to determine how perceptions of health have changed and compare this to the changes that have occurred in the URI green spaces for each neighborhood.

Future research should aim to address these limitations. Address-level data should be obtained so that a resident's proximity to an active URI Community Greenspace site can be identified. Alternatively, block group-level data would allow comparisons of perceived health in blocks between those closest to or containing a green space site as compared to blocks devoid of green space or farther away from an active site. This would help to determine how far-reaching the effects of these groups can be on self-perceived health. Moreover, information on air pollution and existing green spaces that are not community-maintained should be gathered to control for potential confounding by these variables.

The URI Community Greenspace program should consider strategic targeting of areas throughout neighborhoods so that a greater percentage of residents are located within 50m of an active group and a more even spread of sites is developed. Moreover, neighborhoods with the fewest sites should be targeted to attempt to cultivate the growth of more community groups. While there is no convincing evidence that the presence of these groups improves the self-perceived health of the greater community, there is also no convincing evidence that they result in poorer health. These sites bring neighbors together and bring something beautiful to their homes. Residents who participate directly in projects like these have been noted to experience health benefits (2). These projects plant trees that provide invaluable ecosystem services like cleaner air, a cooler environment, and less run off which, if continued, will positively impact the health of all residents. This combination of environmental restoration and community building has the potential to result in so many positive things for a neighborhood. A group coming together can help drive out unwanted loiters and help change the atmosphere of the environment. While improvements in health could not be measured here, it is likely that they exist and the URI Community Greenspace program should continue to grow to help create a beautiful New Haven.

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