Is "Walkability" A Useful Concept for Gerontology?

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The study tested two hypotheses: that in a walkable neighborhood, residents will exercise more, eat healthier, and suffer from less obesity and that relation between environment and health outcomes will be stronger for the elderly. Health was measured by physical activity, the number of portions of fruits and vegetables eaten daily, and body mass index. Walkability was measured by three distinct environmental factors—distress, amenities, and residential. The three health outcomes were related to the three environmental factors. Age was not a significant predictor of health outcomes. Although the environment does contribute to health outcomes, the ways that contribution is expressed and its relation to age is complex.

KEYWORDS walkability, environment, GIS

INTRODUCTION

Walkability is an idea becoming increasingly popular with public health officials, government agencies, and advocates for "smart growth" and sustainability. The term is often used to identify and measure features of the built environment that either enhance or impede an individual’s willingness and ability to walk to local amenities, especially those amenities that are thought to encourage healthy lifestyles. Research has tied measures of walkability to

The work was supported by NINR grant #1R21NR012541-01.
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health outcomes, such as reduced obesity (Brown et al., 2009), lower rates of depressive symptoms (Berke, Gotlieb, Oudon, Vernez, & Larson, 2007), and greater longevity (Tkano, Nakamura, & Watanabe, 2002). Other studies have associated walkability with healthy behaviors, such as walking to food markets where fresh fruits and vegetables can be purchased (Rundle et al., 2009). Walkability is also becoming an important concept in the field of aging, especially among advocates for programs that encourage active aging and helping older adults remain in their homes and communities.

This study was designed to test two hypotheses regarding the relation of walkable neighborhoods to health outcomes based on commonly accepted definitions of walkability. Although there is no universally accepted definition for the concept of walkability, much of the literature is based on the assumption that there are three aspects to declaring a neighborhood walkable: high population density, land use mix, and street connectivity (measured by intersection density) (Van Dyck et al., 2010). All three items refer to characteristics of the general built environment and do not take into account the presence or absence of specific amenities or risk factors that might encourage or inhibit walking. Taken together, these items seem to provide a workable definition of what is walkable and set a standard for measuring all neighborhoods on a single set of characteristics (Cutts, Darby, Boone, & Brewis, 2009; Sundquist et al., 2011). Although some researchers add a measure of socioeconomic status to their definition of a walkable neighborhood (Lovasi, Neckerman, Quinn, Christopher, & Rundle, 2000; Owen et al., 2007), the idea that a single item or set of items can measure walkability is assumed in much of the scientific literature. A second assumption often made is that people living in more walkable neighborhoods are more likely to walk than residents of less walkable neighborhoods.

There are two limitations about the common definitions of walkability described above. First, the construct assumes that the characteristics associated with walkability, such as high population density, always encourage walkable neighborhoods. We questioned that assumption; for example, an area with a high population density that has a high crime rate may not encourage walking. Second, we did not assume that residents would walk just because the physical environment meets the requirements for walkability as described above. We felt that these assumptions needed to be tested by adding additional environmental items to the definition of walkability and by testing the assumption that people are more physically active in walkable neighborhoods.

PROJECT WISH

In February 2011, the National Institute of Nursing Research of the National Institutes of Health awarded a 2-year exploratory study entitled "Walkability's Impact on Senior Health" (WISH) to the Philadelphia Corporation for
Aging. The authors of this article are respectively the Principal Investigator, Geographic Information Systems (GIS) Specialist, Statistical Consultant, and Research Analyst on that study. The primary goal of the study was to test two hypotheses regarding walkability and older adults. The hypotheses and the methods used to study them were guided by the first assumption above—that walkability was a single domain with positive and negative elements that was applicable in all neighborhoods and age groups.

- Hypothesis one. In a walkable neighborhood, residents will exercise more, eat healthier, and report from less obesity. A neighborhood is walkable when a person in reasonably good health can walk to neighborhood amenities, such as a grocery store, senior center, or park, and take public transportation. It is also a neighborhood where barriers to walking, such as high crime rates and physical barriers or obstacles, are minimized.

- Hypothesis two. The relationship between walkable neighborhoods and health outcomes will be stronger for individuals aged 60 years and older than for younger individuals. We expected this result because older individuals are more likely to spend the majority of their day in the neighborhood in which they reside, and therefore they will shop for food and engage in recreational activities in close proximity to their homes.

We planned to test our hypotheses by creating a Philadelphia Walkability Score through the development of a single scale that included items that would encourage walking (such as the presence of desirable destinations) and those that would discourage walking (such as crime and vacant properties). The study team assumed, based on the published literature, that a scale could be created that would then be used to measure walkability in terms of the relative presence of the positive items and absence of the negative items. That scale could then be associated with health behaviors in the city's neighborhoods to test our hypotheses.

Since 2009, the Philadelphia Corporation for Aging has pursued an integrated research/policy agenda called Age-friendly Philadelphia. The WISH study was designed, in part, to extend these efforts (Clark & Glicksman, 2012). The goal of Age-friendly Philadelphia is to create an “age-friendly city committed to improving both the physical and social environments that surround the city’s elders to facilitate independence and neighborhood cohesion” (Clark, 2011, p. 5). Much of the Age-friendly Philadelphia effort has focused on modifying the physical environment. Age-friendly Philadelphia has taken the lead on efforts to include aging related issues into the new city zoning code, encourage better bus shelters that make it easier for older adults to use public transportation, increase access to city parks, and develop more gardening opportunities for seniors.
ANALYSIS AND RESULTS

To complete the analyses, we needed information about the health status and behaviors of adults in the City of Philadelphia, Pennsylvania, as well as information on their social and physical environments. The data file used to identify the health status of adults (those aged 18 years and older) was the 2008 Public Health Management Corporation (2010) Household Health Survey, which has been conducted in 1983, 1987, 1991, and every 2 years since 1994 and covers the city/county of Philadelphia and the four surrounding Pennsylvania counties (Bucks, Chester, Delaware, and Montgomery). In 2008, 10,007 individuals were interviewed by phone, and of those, 4,394 (3,051 aged 18–59 years and 1,343 aged 60 years and older) lived in Philadelphia. Topics covered in the survey included health status, sources of care and use of services, personal health behaviors, disease prevention and health promotion, social capital, hunger and access to food, housing repair, transportation, and demographic characteristics. The survey has also included questions about income, years of education, living arrangements, and minority status. In addition, geographic locators including county, zip code, and Census Tract were included for each case. Interviews were conducted in English and Spanish.

We selected three outcome measures for the tests of our hypotheses: body mass index (BMI), which was calculated by Public Health Management Corporation for all individuals in the sample; a measure of the number of servings of fruits and vegetables consumed each day (scale ranging from 0 to 11+); and whether the respondent was physically active, which was measured using a dichotomous yes-no scale asking “In general, would you say that you are physically active on a regular basis?” Stata version 12 software was used for statistical analyses, and ArcGIS version 10 software was used for spatial analyses.

To analyze the environmental effect on health, we used variables that measured the frequency of each environmental factor, such as vacant properties, book stores, bus stops, and the number of murders in each Census Tract represented in the data set. The staff at Azavea (our GIS consultants) took responsibility for identifying and assembling data sets related to walkability for the city of Philadelphia. These data sets were selected from a range of sources, including city agencies, the State of Pennsylvania’s data clearinghouse, and Azavea’s data archives. In addition, Philadelphia Corporation for Aging’s GIS Specialist acquired data sets from other sources, including the Philadelphia Police Department and the Pennsylvania Horticultural Society. As a first step to preparing the GIS files for analysis, Azavea organized the data sets so that they shared a common coordinate and projection system. As in traditional cartography, the projection of a map refers to the way in which the naturally curved surface of the earth is distorted to produce geographic information on a flat surface, such as a paper map or computer screen.
Both the projection and coordinate system (the x-y grid used to pinpoint locations on a map, typically based on longitude and latitude) are used to provide consistent representation of geographical information, and it is important to standardize both of these in ArcGIS before any data is analyzed to assure that relative location of the items is not skewed. The original GIS files were provided in a manner conducive to representation on a visual map, with single/smaller locations (such as a bus stop or the physical location of a crime) represented as points, and locations that cover larger areas (such as major parks) as polygons that show the entire area covered. Using the GIS software and a data layer representing the boundaries of each Census Tract in Philadelphia, we were able to quantify the number of items that fell inside the boundary of each Census Tract. Point data was counted if it fell inside these boundaries for a particular tract and polygon data if it was found to intersect with the boundaries. The Census Tract was used as the level of study because it was the smallest geographic unit represented in the Household Health Survey.

Two Stata data files were created: one with the Public Health Management Corporation survey data and one with the items provided by Azavea. Each was sorted by Census Tract. The two files were combined using the Stata routine, matching each case in the survey data with information on their Census Tracts from the GIS data. A single analytic file was then created combining this information with the Public Health Management Corporation survey data, using the Census Tract number as the common identifier to match the files.

RESULTS

We computed the proposed Walkability Score by summing the scores on the environmental items. We included both positive and negative items in the analysis because we assumed that a single scale would emerge that would include both positive and negative elements. The scale showed a weak alpha (.72) even after removing several items from the analysis. The initial attempt at completing the analyses by testing the relation of this scale to our three outcome variables showed no statistically significant relation between our walkability measure and any of the three health outcomes. We then rethought our assumptions and decided to complete a factor analysis to determine whether there was only one domain as assumed or if there were several domains being measured by this set of items.

Factor Analysis of Neighborhood Characteristics

Fourteen neighborhood characteristics (variables listed in Table 1) were factor analyzed using a principal axes method based on 4,394 data points. The
TABLE 1 Items in the Three Walkability Factors

<table>
<thead>
<tr>
<th>Items</th>
<th>Amenities</th>
<th>Distressed Neighborhoods</th>
<th>Residential</th>
<th>Uniqueness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murder</td>
<td>0.53</td>
<td></td>
<td></td>
<td>0.70</td>
</tr>
<tr>
<td>Proportion of vacant</td>
<td>0.64</td>
<td></td>
<td></td>
<td>0.52</td>
</tr>
<tr>
<td>properties</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corner stores</td>
<td>0.61</td>
<td></td>
<td></td>
<td>0.62</td>
</tr>
<tr>
<td>Coffee/tea shops</td>
<td>0.88</td>
<td></td>
<td></td>
<td>0.30</td>
</tr>
<tr>
<td>Book stores</td>
<td>0.63</td>
<td></td>
<td></td>
<td>0.60</td>
</tr>
<tr>
<td>Bus stops</td>
<td></td>
<td></td>
<td>0.50</td>
<td>0.68</td>
</tr>
<tr>
<td>Murals</td>
<td></td>
<td></td>
<td>0.61</td>
<td>0.56</td>
</tr>
<tr>
<td>Restaurants</td>
<td>0.88</td>
<td></td>
<td></td>
<td>0.14</td>
</tr>
<tr>
<td>Pharmacies</td>
<td>0.41</td>
<td></td>
<td></td>
<td>0.67</td>
</tr>
<tr>
<td>Groceries</td>
<td>0.37</td>
<td></td>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td>Fitness centers</td>
<td>0.77</td>
<td></td>
<td></td>
<td>0.43</td>
</tr>
<tr>
<td>Land reclamation</td>
<td></td>
<td></td>
<td>0.51</td>
<td>0.72</td>
</tr>
<tr>
<td>projects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owner occupied</td>
<td></td>
<td></td>
<td>0.60</td>
<td>0.58</td>
</tr>
<tr>
<td>dwellings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renter occupied</td>
<td></td>
<td></td>
<td>0.46</td>
<td>0.58</td>
</tr>
<tr>
<td>dwellings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

likelihood ratio test indicated that the correlation matrix was significant ($\chi^2$ [91] = 22000, $P = .0000$). The factor analysis was a principal axes method, with the number of factors for rotation obtained through the use of the examination of eigenvalues and the scree diagram. The eigenvalues and scree diagram of the unrotated factor pattern matrix suggested that three or four factors would be appropriate for rotation. An oblique, oblimin factor pattern rotation was used to test the three- and four-factor solutions. Because we had more than 4,000 individuals in the factor analysis, the minimum factor pattern loading that we required for inclusion of a neighborhood variable in a factor was .30. The four-factor solution was less efficient because it produced a poorly defined fourth factor and disturbed the other three factors. The three-factor solution generated usable, defined rotated factors, without any double loadings (Table 1). The first factor was labeled "amenities" and contained the variables coffee/tea shops, book stores, restaurants, pharmacies, grocery stores, and fitness centers. The second factor was labeled "distressed neighborhoods" and contained the variables murder, proportion of vacant properties, corner stores, murals, and land reclamation sites. The third factor was labeled "residential" and contained the variables bus stops and owner and renter dwellings. Factor scores were calculated for the individuals in each of the three factors. Dummy variables were then generated from these factor scores for subsequent use in the multivariate analysis of variance (MANOVA) and analysis of variance (ANOVA). The factor score variables were median split, and 0 was applied to the lower values and 1
TABLE 2 Correlation Matrix of Oblimin Rotated Common Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Amenities</th>
<th>Distressed Neighborhoods</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amenities</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distressed</td>
<td>0.1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>0.27</td>
<td>-0.05</td>
<td>1</td>
</tr>
</tbody>
</table>

The correlations among the factors are shown in Table 2. The amenities and distressed neighborhoods factors were positively correlated (.10). Thus, there were some individuals who lived in minimum amenity neighborhoods who were not living in distressed neighborhoods; conversely, some neighborhoods were distressed but had amenities. The factor structure matrix combined the information in both the factor pattern loadings and the factor correlations. It provided no useful information with respect to double loadings between the amenities and distressed neighborhoods factors (i.e., both factors having loadings ≥ .30). The amenities and residential factors had the highest correlation (.27). Thus, there was a distribution of individuals who lived in neighborhoods with low amenities and low residential scores and individuals who lived in neighborhoods with high amenities and high residential scores. The factor structure matrix with its doubly loaded variables suggested that bus stops, restaurants, pharmacies, grocery stores, and renters in particular were located primarily in high amenities and high residential neighborhoods. These neighborhood characteristics were substantially absent in low amenities and low residential neighborhoods. Finally, an inconsequential negative correlation was found between distressed neighborhoods and residential (−.05), and double loadings in the factor structure matrix were absent based on the above ±.30 correlation criterion.

MANOVA and ANOVA Analyses

Three participant criteria—physical activity, BMI, and availability of vegetables and fruit in daily diets (fruit)—were regressed on the amenities, distressed neighborhoods, and residential factors. There was no missing data in the environmental variables, but there was a minimum amount of missing
data (≤3%) in the physical activity, BMI, and fruit criteria. In physical activity, BMI, and fruit, there were missing values for 21 (0.48%), 89 (2.03%), and 149 (3.35%) cases, respectively. Missing values were imputed using Stata’s regression algorithm so that all the variables had legitimate values for the analyses. As indicated, the factor scores of the derived factors were transformed into dummy variables for use in ANOVA by median splits, assigning 0 to the low and 1 to the high factor scores. The individual MANOVA models were two-factor, multivariate regressions of the three criteria (physical activity, BMI, and fruit) on each of the derived factors (amenities, distressed neighborhoods, or residential), a dummy age variable (the variable is age 60; 0 = <59; 1 = >60), and the interaction of a particular factor with age 60.

The first MANOVA model was physical activity, BMI, and fruit regressed on the factors of amenities, age 60, and amenities*age 60. The analysis contained 4,394 individuals and the Wilks' lambda (W) = .9953 (df = 3) for the model, with an F = 2.32 (df = 9, 10679.4), P = .0134. The significance of this finding is founded entirely on the large sample size because the Wilks' lambda itself is minimal. The individual MANOVA factors of age 60 and amenities*age 60 were not significant, but amenities had a W = .9961 (df = 1), with an F = 5.70 (df = 3, 4388), P = .0007.

Three individual ANOVAs were then calculated to determine the significant basis of the MANOVA model. For example, physical activity was regressed on amenities, age 60, and amenities*age 60, which is a 2-factor ANOVA. The ANOVA factor for age 60 was not significant, but it was significant for amenities (F = 9.45 [df = 1, 4390], P = .0021) and for amenities*age 60 (F = 5.95 [df = 1, 4390], P = .0147). The adjusted means for physical activity were 1.21 for amenities = 0 and 1.19 for amenities = 1, indicating that greater physical activity could be found in some individuals who lived in low amenities neighborhoods. With respect to the interaction term, the adjusted mean was 1.20 for the low amenities, younger individuals, and the adjusted mean was 1.24 for the low amenities, older individuals, resulting in a relative mean difference of .04 in physical activity for some older individuals in the low amenities neighborhoods. This was contrasted in the interaction with a relative difference in adjusted means for high amenities, older individuals (1.17) compared with high amenities, younger individuals (1.19), an opposite mean difference of .02. This implied that there were some older individuals who were more physically active than some younger individuals in low amenities neighborhoods. Likewise, some younger people were more physically active than their older counterparts in the high amenities neighborhoods. Next, the physically active criterion was regressed on BMI, age 60, and BMI*age 60. Only the BMI factor was significant (F = 7.95 [df = 1, 4390], P = .0048). The adjusted mean physical activity for individuals with low BMI scores was 28.44, and the adjusted mean physical activity for those with high BMI scores was 27.92. To reiterate, individuals with lower BMI scores tended to be more physically active. Moreover, there were only
nonsignificant relationships found in the regression of physical activity on fruit, age 60, and fruit*age 60.

The second MANOVA regressed the same criteria (physical activity, BMI, and fruit) on the ANOVA factors of distressed neighborhoods, age 60, and distressed neighborhoods*age 60. The overall model was significant ($W = .9934 \ [df = 3]$ and $F = 3.23 \ [df = 9, 10679.4], P = .0006$). Although significant, $W$ was at a minimum level. Only the distressed neighborhoods factor was significant ($W = .9966 \ [df = 1]$ and $F = 5.04 \ [df = 3, 4388], P = .0017$); both the main effects of age 60 and distressed neighborhoods*age 60 were non-significant. Once again, the two factor ANOVAs were repeated on the three criteria. The physically active criterion was regressed on distressed neighborhoods, age 60 and distressed neighborhoods*age 60. There was only one significant result, the interaction of distressed neighborhoods*age 60 ($F = 4.12 \ [df = 1, 4390], P = .0425$). The adjusted mean for physical activity in the low distressed neighborhoods, low age 60 group was 1.22, and the adjusted mean was 1.20 for the low distressed neighborhoods, high age 60 group. For the younger, high distressed neighborhoods group, the physical activity adjusted mean was 1.18, and for the older, high distressed neighborhoods group the physical activity mean was 1.22. Some older individuals in the high distressed neighborhoods group tended to be more physically active than their younger counterparts; inversely, in the low distressed neighborhoods groups, some of the younger individuals were more physically active than their elders. The ANOVA of BMI regressed on distressed neighborhoods, age 60, and distressed neighborhoods*age 60 produced a significant main effect only for the distressed neighborhoods factor ($F = 9.94 \ [df = 1, 4390], P = .0016$). The adjusted means for BMI were lower for the low distressed neighborhoods group (27.82) and higher for the high distressed neighborhoods group (28.52). Some individuals in the low distressed neighborhoods group had better BMI measurements than some other individuals found in the high distressed neighborhoods group. Finally, the regression of fruits on distressed neighborhoods, age 60, and distressed neighborhoods*age 60 had no significant main effects.

The final MANOVA regressed the criteria (physical activity, BMI, and fruits) on the predictors of neighborhood residential, age 60, and residential*age 60. The overall model was significant ($W = .9950 \ [df = 3]$ and $F = 2.43 \ [df = 9, 10678.4], P = .0095$). Once again, although significant, $W$ was at a minimum level. Only the residential factor was significant ($W = .9958 \ [df = 3]$ and $F = 6.15 \ [df = 1, 4388], P = .0004$). The individual ANOVAs for physical activity and BMI both had nonsignificant main effects. However, the fruits criteria had a significant main effect for the residential factor ($F = 15.09 \ [df = 1, 4590], P = .0001$). The adjusted means for fruit were higher for some individuals in the lower residential neighborhoods (2.61) than for individuals living in the higher residential neighborhoods (2.40).
Developing a Third Hypothesis

The distressed neighborhoods factor contains items that identify sources of distress (i.e., vacant lots, murder) and items that measure interventions in distressed neighborhoods designed to make them more livable, such as murals and land reclamation. This led our GIS Analyst to propose a third hypothesis—that health outcomes would differ in the distressed neighborhoods that were receiving significant intervention compared with those that were not receiving such interventions. To test the hypothesis, we selected the Census Tracts with the highest number of vacant properties by splitting the sample into high and low and then testing whether the presence of murals (part of the city's effort to change the physical environment of neighborhoods) made a difference in health behaviors. We dichotomized the variable using a median split. We discovered that for older adults (aged 60 years and older) who lived in areas with high rates of vacant properties, the presence of murals meant that they were more physically active (83% of elders living in areas with high rates of vacant properties and high numbers of murals report being physically active versus 73% of elders in areas with high rates of vacant properties and with few or no murals, with $\chi^2 = 19.7$, $P = .02$). Although we cannot directly tie the presence of the murals to the increased physical activity of older adults, the correlation between these items suggest that it is worth investigating the effect of these types of interventions on health outcomes. When we repeated this analysis in areas with lower rates of abandoned properties, there were no health differences between areas with high numbers of murals and those without, suggesting that the effect of murals is more pronounced in the most distressed areas of the city.

DISCUSSION

We confirmed that there is a relationship between the physical and social environment and health outcomes (hypothesis one). However, we did not confirm that there was a reliable single measure of walkability or that the combination of fewer negative environmental features with more positive environmental features leads to all predicted health outcomes. Rather, we found that specific elements in the social and physical environment are related to specific health outcomes. Thus, our findings have led us to question some of the assumptions on which the first hypothesis was based.

In regard to hypothesis two, we found that although age has some effect on the relationship between environment and health outcomes, the relationship is more nuanced than expected. Age did not affect all relationships between the three environmental factors we created and the three outcomes variables. This finding makes sense. Neighborhood environment, both social and physical, affects all residents, although in some cases it may have a greater effect on the trailer residents.
The results of these analyses point to five important lessons. First, we may require a rethinking of the concept of walkability. The assumption in much of the literature that walkability is a one-dimensional item was not confirmed by our analyses. Rather, we discovered that walkability (if that is the correct term at all) is composed of different dimensions (amenities, distressed neighborhoods, and residential factors), and that each of these dimensions interacts differently with the selected outcome measures of health behaviors and risks. For example, some middle class neighborhoods may not be very distressed but may be so residential in character that it is impossible to get to a store that sells fresh fruits and vegetables without needing to drive or having adequate public transportation, so an intervention in such a neighborhood would need to be designed to deal with the lack of access to healthier foods. That there are complex interactions between type of neighborhood and health outcomes was further confirmed by the finding from the third hypothesis, which seems to suggest that an intervention that has a positive health effect in certain types of neighborhoods (in this case, the most distressed) may not have the same effect in other types of neighborhoods. This has tremendous implications for designing interventions at the neighborhood level to increase walkability. A neighborhood with little mixed land use that also has a low crime rate and few vacant properties will require a different type of intervention than one with a high level of distress but many amenities.

Second, we also discovered that the relation of age to walkability is more complex than we first hypothesized. Although age is a significant element in some of our analyses, it is not as central to defining the relationship between walkability and health outcomes as we first hypothesized. This is an important finding in itself because it suggests that neighborhoods have similar effects on individuals of all ages and that the frailty of the neighborhood may be as big a factor in whether a neighborhood is walkable as the frailty of the individual.

Third, we learned the importance of using GIS in examining the effect of the environment on health. Current methods, which often rely only on survey research samples, need to be expanded to include spatially based analyses to take into account the often overlooked effects of a populations' physical (and social) environment. The use of GIS data for theory design, data analysis, and interpretation should be considered in any future study of the effect of the environment on health outcomes.

In addition to providing the location-based data used to measure environmental factors in the study, GIS is also useful as a tool for understanding initial results and creating further hypotheses. By viewing these results as a map in ArcView (or other GIS software), we can visually compare them with other known data (e.g., income levels or minority status from the Census Bureau), see where the highest and lowest concentrations of different items and factors are located, and use our knowledge of local communities
(and where they are situated) to draw further conclusions about why these concentrations exist as they do. For example, when we looked at the residential factor distributed over a map of the city, we could see that it seemed strongest in neighborhoods that had few commercial areas, and therefore could hypothesize that the reason for low fruit and vegetable consumption was a lack of mixed-use or commercial properties. This is a theory we will be testing with new data. We can also take the distressed neighborhoods factor that was created from physical attributes (e.g., vacant land) and compare it visually and in statistical analysis to poverty levels taken from the Public Health Management Corporation data set or from Census data. This type of analysis is critical because it can help us better understand the effect of distressed neighborhoods on individuals of all ages by linking low income to distressed physical environments and help us begin to examine how each of these factors affect health outcomes. In the future, we hope to add other measures of the environment to our analyses, such as the slope of the land, to improve our understanding of the relationship of the physical environment to health and aging.

Fourth, we discovered the need to rediscover theoretical approaches to the study of environment and aging, whether from sociology (human ecology) or gerontology (Lawton’s theory of environmental press). For example, Lawton’s (1982) theory of environmental press can help us understand why interventions in more distressed environments may have a greater effect on health than interventions in less distressed environments. Lawton proposed that there was a dynamic relationship between the individual and the environment, and each has an effect on the other. However, when an individual becomes frail, the effect of the environment, whether for good or bad, becomes greater because the individual has less ability to modify the environment and reduce or enhance its effect. If his hypothesis that the environment has a greater effect on frailer adults than on the less frail is correct, then perhaps the same is true for neighborhoods. As the application of these theories regarding the relationship between environment and health could have important real-world consequences, a next step in research should be to formally test these theories in the neighborhood environment.

Fifth, we determined that researchers must work closely with policy makers to help incorporate these findings into new efforts to help older adults remain in their homes. Although the findings reported here need further study before they can be practically implemented, only by working closely with policy makers as the research progresses can we hope to eventually turn these research findings into practice. Changes to the physical environment are usually the work of government, regional planning authorities, and community organizations. The ability to integrate research findings into the plans of these groups requires an understanding of the ways in which they accomplish their goals and the ability to translate research findings into language that is meaningful to them. This would require
understanding of complex policy issues including zoning, land reclamation, etc. The policy work needed is not something that the scientific community can undertake by itself – there needs to be collaboration between scientists and policy makers for any of this to be useful in the real world. The Age-friendly Philadelphia effort, of which this study is part, has already created real change by influencing the revised City Zoning Code (Clark, 2011). This is just one example of what can be accomplished when policy planners and researchers work together on a common goal.

CONCLUSION

The results of this research are only a beginning and the findings need to be confirmed, a task we have already begun. However, they contribute to a trend in some of the literature that argues for the need to go beyond traditional notions of health and look at environmental factors (both social and physical) in understanding health status and health changes for both older and younger adults. Finally, we need to determine where there is a domain called walkability or whether that term actually includes multiple aspects of the environment that affect health. Rather than walkability being a concept that is familiar to us, it seems that it is a concept that we are only beginning to understand.

REFERENCES


