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Use of GIS to identify optimal settings for cancer prevention and control in African American communities

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Abstract

Objective—Rarely have Geographic Information Systems (GIS) been used to inform community-based outreach and intervention planning. This study sought to identify community settings most likely to reach individuals from geographically localized areas.

Method—An observational study conducted in an urban city in Missouri during 2003–2007 placed computerized breast cancer education kiosks in seven types of community settings: beauty salons, churches, health fairs, neighborhood health centers, Laundromats, public libraries and social service agencies. We used GIS to measure distance between kiosk users' (n=7,297) home ZIP codes and the location where they used the kiosk. Mean distances were compared across settings.

Results—Mean distance between individuals' home ZIP codes and the location where they used the kiosk varied significantly ($p<0.001$) across settings. The distance was shortest among kiosk users in Laundromats (2.3 miles) and public libraries (2.8 miles) and greatest among kiosk users at health fairs (7.6 miles).

Conclusion—Some community settings are more likely than others to reach highly localized populations. A better understanding of how and where to reach specific populations can complement the progress already being made in identifying populations at increased disease risk.

Keywords

community health planning; minority health; Geographic Information Systems; health education; breast neoplasms; prevention and control; health status disparities; African Americans

Introduction

Geographic Information Systems (GIS) have been widely used to map disease rates, understand relationships between environmental risk factors and disease, and determine accessibility to and utilization of healthcare services. However, use of GIS to inform the design and delivery of disease prevention programs has been uncommon. National public health objectives call for increased use of GIS to make interventions more cost-effective by targeting health promotion efforts to specific geographic areas (U.S. Department of Health and Human Services, 2000).

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GIS can improve community-based health promotion and disease prevention efforts in at least seven ways: (1) helping decision makers visualize patterns of disease and disparity; (2) elucidating contextual risk factors; (3) fostering local collaboration and data-sharing; (4) conveying geo-specific intervention outcomes; (5) evaluating how well target populations are being served; (6) planning interventions to maximize reach, effectiveness and efficiency; and (7) selecting the most promising settings for prevention efforts (Caley, 2004; McLafferty, 2003; Renger et al., 2002; Richards et al., 1999). This paper reports findings from a study exploring the last two of these opportunities.

The National Cancer Institute emphasizes the importance of community-based cancer prevention and control in underserved areas (National Cancer Institute, 2006). However, cancer prevention and control in urban, African American communities may be hindered by structural barriers such as availability and quality of health resources as well as individual barriers such as competing priorities and lack of transportation (Russell et al., 2008; Lacey, 1993). Consideration of location and proximity when selecting settings for outreach and research recruitment in these communities may overcome some of these barriers (Russell et al., 2008).

This observational study examined whether distance from individuals' area of residence to the location where they used a cancer education kiosk varied across seven types of community settings. We hypothesized that mean home-to-kiosk distance would vary significantly across settings. Such a finding could help inform outreach and intervention planning for community-based cancer prevention and control.

Methods

The Saint Louis University Institutional Review Board approved this study.

This study utilized GIS to measure distance between individuals' area of residence and the location where each person used a computerized breast cancer education kiosk, using data collected June 2003-March 2007. The kiosk, called *Reflections of You*, is an interactive program adapted from a tailored intervention found to be effective at increasing mammography use among African American women (Kreuter et al., 2008; Kreuter et al., 2006; Kreuter et al., 2005).

Study setting

Kiosks were placed in north St. Louis, Missouri, where the population is predominantly African American and rates of late-stage breast cancer diagnosis are disproportionately high.

Community settings

Kiosks were placed in 13 beauty salons, 14 churches, 17 neighborhood health centers, 6 Laundromats, 16 social service agencies, 11 public libraries and at 14 health fairs. Selection criteria included size and composition of the population reached by the setting, suitability of the setting for the intervention (e.g., waiting time inherent to the setting), and prior evidence that the setting had been used effectively in delivering health promotion interventions (see Kreuter et al., 2006 for details). One kiosk was placed at each location for an average of 3–4 weeks, except at health fairs where a kiosk only stayed for the event duration.

Measures

Demographics—The kiosk assessment collected users' age, health insurance status, and 5-digit ZIP code for their home address.

Community setting—At each kiosk site, the kiosk was initialized to a setting type (e.g., church) with a distinct street address.

Data management

Kiosk users' responses were automatically stored within each kiosk computer. Project staff downloaded data weekly from each kiosk for transfer to a master database.

Analyses

Geographic analyses—A total of 7,297 kiosk users provided a home ZIP code. Each ZIP code was geocoded to determine whether it was within the St. Louis Metropolitan Statistical Area (MSA). User ZIP codes outside the MSA (n=292; 4.0%), invalid (n=308; 4.2%), or within the MSA but associated with a PO Box (n=36; 0.5%) were excluded. Two kiosk addresses (n=13 kiosk users; 0.2%) could not be geocoded, leaving a final sample of 6,648.

The street address of each kiosk location and the centroid (geographic center) of each user's home ZIP code were geocoded using the U.S. Census Bureau's ZIP Code Tabulation Areas and TIGER shape files for 2000 (U.S. Census Bureau, 2000). Straight-line (Euclidean) distances between each kiosk location and the centroid for each kiosk user at that location were calculated. Geographic analyses were conducted using ArcGIS 9.2 (ESRI, 2006).

Statistical analyses—The primary analytic goal was to determine whether mean distance between kiosk users' area of residence and the kiosk location varied across settings. Distance and age are continuous variables reported as means, and insurance status is a categorical variable reported in terms of proportions. Chi-square analyses compared proportions across settings, and one-way ANOVA with a Scheffé post hoc analysis compared means. P-values at the 0.05 alpha level and 95% confidence intervals are provided. Statistical analyses were conducted using SPSS 15.0 (SPSS, 2006).

Results

User characteristics

Kiosk user characteristics are shown in Table 1.

Distance

On average, kiosk users lived 3.8 miles from the kiosk location. Mean distance between individuals' home ZIP codes and the kiosk location varied ($p<0.001$) across settings (Table 1). Individuals who used the kiosk in Laundromats lived closest to the location where they used the kiosk, and individuals who used the kiosk at health fairs lived farthest from the kiosk location. Post hoc analysis identified four subsets of settings with varying population reach (Figure 1).

Secondary analyses

To explore the possibility that certain settings are more likely to be located near poor people who are less likely to have transportation (and thus favor nearby settings), the distance analysis was replicated among ZIP codes (n=3) containing at least five of the seven settings (n=1,892 kiosk users). To examine a possible temporal effect, the distance analysis was also replicated among sites with kiosks available during the same 4-week period. Five such time periods were analyzed, and each included at least three of the seven settings (n=1,390 kiosk users). Lastly, population density (U.S. Census Bureau, 2000) was calculated for each ZIP code in which kiosks were placed and a median split was used to compare distance across settings in low-

and high-density ZIP codes. In each of these analyses, Laundromats and libraries consistently had the most localized reach among all settings.

Discussion

As population health data are increasingly available at small geographic levels of analysis, it is not only possible but relatively easy to identify census tracts, neighborhoods and communities with disproportionate cancer burden, elevated levels of cancer risk or low cancer screening rates. Such information is useful in identifying *where* to intervene but provides little guidance about *how* to intervene. Study findings begin to address this gap by suggesting that some settings are more likely than others to serve residents living in their immediate surroundings. The study found clear differences in the population reach of different types of settings, with Laundromats and libraries reaching the most proximal populations, followed by social service agencies and neighborhood health centers, beauty salons and churches, and finally health fairs. Intuitively, these patterns make sense. Individuals may travel a greater distance to stay with a particular faith leader or favorite hairdresser if either party relocates, but probably don't feel the same sense of loyalty to a library or coin laundry.

Secondary analyses found kiosk users in Laundromats and libraries to live closer to these two settings than other kiosk locations, ruling out the influence of geographic distribution of settings, time period of kiosk use and neighborhood population density. These findings suggest that even if a Laundromat and church are adjacently located, Laundromat visitors (at least those who would use a kiosk) are more likely to live in the immediate vicinity than are church visitors. Thus if the objective of a given outreach effort is to reach a localized population, some settings may be more likely to provide such access.

Low-income populations are more limited than others in their daily travel, which is typically across distances of 3 miles or less (Pucher and Renne, 2003; Murakami and Young, 1995). Kiosk users in Laundromats and libraries not only live nearby, but also are more likely to be uninsured and more likely to have not received a provider recommendation for mammography (Kreuter et al., 2008). An earlier finding of the *Reflections of You* kiosk study was that both reach (kiosk uses per *kiosk day*, i.e., each day that a kiosk was available) and specificity (as indicated by high uninsured rates, low mammography utilization rates and low breast cancer knowledge) were highest in Laundromats (Kreuter et al., 2008; Kreuter et al., 2006). Additional research is needed examining Laundromats as promising kiosk venues.

Further research is also needed to examine the relative contribution of distance compared to other factors, as travel distance is only one factor that should inform community-based outreach (see Kreuter et al, 2008 for a discussion of other factors). Nevertheless, GIS can elucidate patterns/limits of mobility and proximity to/from a destination (e.g., grocery, clinic, intervention site), and can enhance existing audience segmentation strategies that incorporate some geographic variables (CACI, 2004; Claritas, 1985).

Study limitations and strengths

First, kiosk users in Laundromats were more likely than users in other settings to provide invalid home ZIP codes, however the difference in proportions is small (7% in Laundromats versus 4% in other settings). Second, the use of ZIP code centroids makes distance estimates imprecise. Third, analyses may include data from repeat kiosk users. Lastly, data did not include additional factors that may explain differences in distance traveled to kiosk sites such as income, preference for specific locations, transportation accessibility, mode of transportation and nature of the trip (e.g., single- or multi-purpose) which may influence travel behavior and route (Pucher and Renne, 2003).

Conclusions

The increasing availability of geo-referenced data and analytic tools like GIS make possible improved reach and efficiency of community-based interventions. This study found Laundromats and public libraries to be optimal settings for targeted breast cancer prevention outreach in low-income African American communities. Just as the locations for stores, hospitals and schools are carefully chosen to maximize convenience and access for those they serve, so too should we identify the best settings for prevention and control efforts.

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Figure 1.

Average geographic reach of different types of community settings

This study was conducted in north St. Louis, MO during 2003–2007.

Table 1

Kiosk user characteristics, by type of community setting

	Beauty salons (n=475)	Churches (n=259)	Health fairs (n=284)	Laundromats (n=923)	Neighborhood health centers (n=2023)	Public libraries (n=1589)	Social service agencies (n=1095)	p-value
Age in years								
Mean	34.7	42.3	44.9	34.0	34.5	33.1	35.3	<0.001
(SD)	(13.7)	(19.0)	(14.0)	(14.1)	(14.6)	(14.1)	(13.4)	
Insurance ^a								
% Medicare	10.3	23.6	12.0	16.6	13.3	19.1	11.6	<0.001
% Medicaid	21.7	16.6	8.5	39.7	48.3	32.5	44.5	<0.001
% private	50.3	46.7	69.0	23.1	19.6	28.3	30.0	<0.001
% other	9.5	13.9	9.9	7.9	4.6	7.6	6.7	<0.001
% none	15.4	15.1	6.7	21.6	20.3	25.0	16.0	<0.001
Mean distance (miles)^b	5.1	5.8	7.6	2.3	4.4	2.8	3.6	<0.001

This study was conducted in north St. Louis, MO during 2003–2007.

^a Individuals could indicate more than one type of health insurance.

^b Distance between kiosk users' home ZIP code and kiosk location