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A spatial analysis of race, local health-promoting resources and preventable hospitalizations

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ABSTRACT

Introduction: Preventable hospitalizations (PHs) for chronic conditions could have been avoided if treated with primary healthcare. PH rates are higher among African Americans, and in areas with less healthcare. Little is known about the effects of non-healthcare local health-promoting resources (LHPRs). The objective of this study is to determine associations between LHPRs and chronic PH rates in Maryland, and to assess spatial clustering of areas with high PH rates.

Methods: Hospitalizations in 2010 were obtained from the Maryland Health Services Cost Review Commission by zip code of residence. Negative binomial regressions were used to determine associations between PH rates and LHPRs by race. Clusters of zip codes with high PH rates were assessed using the spatial Scan Statistic.

Results: PH rates were associated with family practitioners (IRR = 0.98, 95% CI = 0.97–0.99), physicians' assistants (IRR = 0.98, 95% CI = 0.96–0.99), internists (IRR = 1.02, 95% CI = 1.01–1.03), teaching hospitals (IRR = 1.21, 95% CI = 1.04–1.40), and local health departments (IRR = 1.19, 95% CI = 1.03–1.37). No LHPRs were associated with PHs among whites, but African American PH rates were associated with family practitioners (IRR = 0.97, 95% CI = 0.94–0.99), nurse practitioners (IRR = 1.03, 95% CI = 1.01–1.06), teaching hospitals (IRR = 1.37, 95% CI = 1.08–1.75) and gyms/recreational centers (IRR = 0.85, 95% CI = 0.73–0.99). Clusters of areas with high PH rates varied by race. African American PH clusters had fewer family practitioners and more federally qualified health centers and teaching hospitals.

Conclusions: Public health practitioners should look to LHPRs beyond physician supply or public clinics to address PHs, particularly among African Americans. Specific LHPRs could be used to target African American PH rates and clusters.

1. Introduction

Preventable hospitalizations (PHs) are inpatient hospital visits that could have been precluded with effective and timely primary care (U.S. Department of Health and Human Services, 2014). These are hospitalizations for ambulatory care-sensitive conditions which include both acute and chronic conditions (Agency for Healthcare Research and Quality, 2012). PHs account for one in ten hospitalizations (Stranges and Stocks, 2010), cost $30 billion annually (Jiang et al., 2009), and are considered a proxy for deficits in the local primary healthcare system (U.S. Department of Health and Human Services, 2014; Stranges and Stocks, 2010; Bindman et al., 1995).

In general, studies find that more primary healthcare access is associated with lower PH rates (Bindman et al., 1995; Epstein, 2001; Probst et al., 2009; Rosano et al., 2013; Parchman and Culler, 1994). Many of these studies have examined demographic and other predisposing factors (Rosano et al., 2013; Basu and Mobley, 2010). The role of local healthcare resources has been examined as well (Epstein, 2001; Probst et al., 2009; Rosano et al., 2013; Parchman and Culler, 1994; Basu and Mobley, 2010; Derose, 2008; Mobley et al., 2006; Hossain and Laditka, 2009; Rothkopf et al., 2011; Rust et al., 2009; Zhang et al., 2006). In a review of primary health care and PHs, seven of 11 studies found an inverse association between physician supply and PHs (Rosano et al., 2013). Rosano et al. also found that all eight studies that examined the presence of community health centers reported an inverse association with PHs (Rosano et al., 2013).

Non-healthcare resources could potentially reduce PHs for chronic conditions, which account for a larger percentage of the overall PH rate

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(Stranges and Stocks, 2010). The management of conditions like hypertension or diabetes can include improvement in diet and physical activity (American Diabetes Association, 2006; Hayes and Kriska, 2008), which can be associated with local access to healthy foods and recreational facilities or spaces (Casagrande et al., 2009). These types of resources have not been addressed in the PH literature.

The objective of this study was to examine the associations between various (healthcare and non-healthcare) local health-promoting resources (LHPRs) and chronic PH rates. Because PHs are highly associated with spatial access to healthcare resources (Fishman et al., 2016; Lin et al., 2016), a secondary aim was to determine if chronic PHs cluster spatially, and whether spatial clusters had fewer LHPRs. It was hypothesized that areas with more LHPRs would have lower chronic PH rates, and that spatial clusters of areas with high PH rates would have fewer LHPRs.

2. Methods

2.1. Data sources

Preventable hospitalizations (PHs) were measured using data obtained primarily from the Maryland Health Services Cost Review Commission. This independent agency sets rates for services provided in Maryland hospitals and collects patient-level data (Health Services Cost Review Commission, 2012). Inpatient visits of Maryland residents hospitalized in the District of Columbia, Virginia, and Pennsylvania were obtained from the Maryland Health Care Commission, Virginia Health Information and the Pennsylvania Health Care Cost Containment Council, respectively. This resulted in a final dataset of 803,441 hospitalizations.

Data on LHPRs were obtained from several sources. Data on healthcare providers in Maryland in 2010 were obtained from SK & A, a company that obtains data on practicing healthcare providers from various sources. SK & A estimates that their data includes up to 97% of all office-based doctors in the U.S., and data is verified every six months. Federally qualified health centers (FQHCs) in each Maryland zip code were obtained from the Health Resources and Services Administration. The zip code in which every hospital and local health department in Maryland is located was obtained from the Maryland Department of Health and Mental Hygiene. Data for state and local parks were obtained from the Maryland Department of Natural Resources and local parks and recreation departments. Data for other LHPRs variables were collected from the 2010 Zip Code Business Patterns dataset (U.S. Census Bureau, 2017).

Population-based data were obtained from the U.S. Census Bureau by zip code tabulation area (ZCTA). The number of non-Hispanic blacks and non-Hispanic white residents (hereafter referred to as African Americans and whites), median income, education attainment, insurance status and rural residents in each ZCTA was obtained from the 2010 Census and 2008–2012 American Community Survey.

2.2. Variables

Chronic PHs were defined as a hospitalization where the primary diagnosis was for: angina, asthma, chronic obstructive pulmonary disease, congestive heart failure, diabetes or hypertension. This set of conditions was derived from a list frequently used to broadly define preventable hospitalizations in the literature (Bindman et al., 1995; Billings et al., 1996; McCall et al., 2004). Each hospitalization record included the patient's race, ethnicity and zip code of residence. Hospitalizations where the race was recorded as “Black/African American” or “White” and the ethnicity was recorded as “Not Hispanic” were included in these analyses. An algorithm was used to match patients' reported zip code of residence with the corresponding ZCTA (American Academy of Family Physicians, 2015). From this, a dataset was created with the number of chronic PHs by race in each Maryland ZCTA in 2010. The dataset also included the total population, and the number of white and African American residents in each ZCTA.

Continuous variables to represent the number of family physicians, internists, nurse practitioners' and physicians' assistants per 10,000 ZCTA population were created. Internist supply also included physicians who identify as general practitioners. Dummy variables were used to represent whether no hospital, a teaching or non-teaching hospital was located in a ZCTA. A dichotomous variable representing whether a local health department was located in a ZCTA was created. Similar variables for FQHCs, commercial urgent care centers, pharmacies, grocery stores, commercial gyms/recreational centers and parks were created. Commercial urgent care centers, pharmacies, grocery stores and commercial gyms/recreational centers were those with the North American Industry Classification Code System (NAICS) code of 621493, 446110, 445110 and 713940, respectively. Only those grocery stores with > 20 employees were included (Hendrickson et al., 2006).

ZCTA demographics were included as covariates and measured continuously. Racial composition was measured as the percentage of African American ZCTA residents. Rurality was calculated as the percentage of ZCTA residents who did not live in an urban cluster or urbanized area. Insurance status was measured as the percentage of ZCTA residents who did not have any health insurance. ZCTA median income was included and measured in tens of thousands ($10,000). Educational attainment was measured as the percentage of ZCTA residents with more than a high school education.

2.3. Statistical analyses

The mean and proportional differences between ZCTAs included in PH spatial clusters and non-cluster ZCTAs for demographics and LHPRs were evaluated using Student's *t* and chi-square tests for continuous and categorical variables. Due to overdispersion (Cameron and Trivedi, 1998), negative binomial regressions were used to determine the associations between LHPRs and chronic PH rates in Maryland ZCTAs adjusting for covariates. Models were repeated for PHs among whites and African Americans using a race-specific population count as an offset. All analyses were stratified by race because PHs are more prevalent among African Americans compared to whites (Derose, 2008; Chang et al., 2008; Gaskin and Hoffman, 2000; Laditka et al., 2003; O'Neil et al., 2010), and areas with more African American residents have less access to healthcare (White et al., 2012), fewer grocery stores (Kwate, 2008), and recreational facilities such as parks (Hughey et al., 2016).

Spatial clusters of ZCTAs with high chronic PH rates were assessed by race/ethnicity using the spatial Scan Statistic. Described in depth elsewhere (Kulldorff, 1997), this identifies clusters of ZCTAs that have greater than the expected number of PHs based on population and the overall PH rate. Using Poisson models, several Monte Carlo simulations are replicated to determine whether each cluster supports or rejects the null hypothesis that PH rates are spatially random. The primary PH cluster was considered as the PH cluster that has the greatest observed-to-expected ratio. Once smaller clusters are identified, the simulations are repeated to determine if adjacent clusters should be combined into larger clusters. White and African American spatial clusters were determined from the race-specific mean chronic PH rate. Only PH clusters with > 20 PHs were reported.

Dichotomous variables were created to indicate whether a ZCTA was included in a chronic PH cluster for the total, white or African American population. Analysis of covariance analyses were used to detect differences in LHPRs between PH clusters. These analyses were adjusted for covariates.

Software.

Regression and analysis of covariance analyses were performed using Stata Version 14 (StataCorp LP, College Station, TX). SatScan Version 9.4 (SatScanTM, New York, NY) was the statistical software package used to detect PH clusters with the spatial scan statistic