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Major article

Relationship between local family physician supply and influenza vaccination after controlling for individual and neighborhood effects

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Background: Family physicians (FPs) play an important role in influenza vaccination. We investigated how local FP supply is associated with influenza vaccination, controlling for both individual-level and county-level characteristics.

Methods: The 2008-2010 individual-level data from the Behavioral Risk Factor Surveillance System were merged with county-level data from the Area Resource File (n = 985,157). Multivariate logistic analyses were performed to predict influenza vaccination using the number of FPs per 1000 population as the key predictor, adjusting for individual-level demographic, socioeconomic, and health information, as well as county-level racial composition and income level. Additional analyses were performed across racial/ethnic and employment status categories.

Results: Increasing local FP supply was associated with higher odds (adjusted odds ratio [aOR], 1.58; 95% confidence interval [CI], 1.49-1.67) and varied across racial/ethnic groups (Hispanic: aOR, 2.05, 95% CI, 1.55-2.72; non-Hispanic white: aOR, 1.57, 95% CI, 1.48-1.66; non-Hispanic black: aOR, 1.49, 95% CI, 1.18-1.89), employment status categories, and county types.

Conclusions: FP supply was significantly associated with influenza vaccination. The association was greatest among those who were Hispanic, residing in a rural area, or out of work. Our findings lend support to initiatives aimed at increasing the FP supply, particularly among disadvantaged populations.

Influenza vaccination is a cost-effective preventive service[1-3] and a core component of any preventive service packages.[3,4] Maciosek et al[1] found that approximately 275,000 quality-adjusted life years (QALYs) would be saved if influenza vaccination were offered annually to all persons age 50 years and older. After considering the cost-effectiveness and serious health and cost consequences of influenza vaccination, in 2010 the Advisory Committee on Immunization Practices (ACIP) recommended annual influenza vaccination for all persons age 6 months and older in the United States. The 2010 Patient Protection and Affordable Care Act (PPACA) required insurance policies beginning on or after September 23, 2010, to provide full coverage of influenza vaccination with no copayment or coinsurance.

Despite its effectiveness and low costs, however, influenza vaccination rates remain low in the United States. The *Healthy People 2020* targets include achieving influenza vaccination rates of 90% in adults aged 65 years and older and 80% in adults aged 18-64 years,[4] but the actual rates during the 2012-2013 influenza season were only 66.2% and 35.7%, respectively.[5] Large racial/ethnic disparities also remain. During the 2012-2013 season, among adults aged 65 and older, 67.9% of non-Hispanic whites were vaccinated, compared with 54.5% of non-Hispanic blacks.[5] Of note, the low vaccination rates and racial/ethnic disparities exist in other years as well.

Numerous studies have explored possible predictors and causes of low influenza vaccination rates. This area of research is critical for understanding differing prevalence rates and for designing sound public health policies to promote preventive care. In addition to individual-level factors, including socioeconomic and demographic characteristics, general health status, and perceived risks and benefits of influenza vaccination, recent studies have identified contextual/neighborhood characteristics, such as racial/ethnic composition and neighborhood socioeconomic status, as important factors affecting individual decisions as well. They exert this influence by affecting individuals' knowledge of health, belief in the

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benefits of prevention, trust of the health care system and providers, and allocation of public health resources.[6-9]

Among various contextual factors, local family practitioner (FP) supply is important, for several reasons. First, FPs play a significant role in assessing and treating victims of new influenza viruses.[10] Second, FPs not only directly influence individual vaccination decisions,[11] but also help change a community's attitude toward the effectiveness of influenza vaccination. Finally, although many health care professionals can administer the vaccine, FPs still may play an important role in vaccine delivery, especially in rural areas and among minority populations. Despite the known importance of FPs, however, there remains a gap in empirical studies based on nationally representative data to quantify the impact of local FP supply. Most previous studies examined primary care physicians in general,[12-14] making it difficult to measure the impact of FPs. Several studies were based on regional data, and thus their findings might not be representative at the national level.[7,12,15]

To fill this gap in the literature, we use a nationally representative dataset to examine the association between the local supply of FPs and the rate of influenza vaccination while including other individual and neighborhood factors in the model. This approach helps tease out the effects of other factors, providing a "cleaner" estimate of the effect of local FP supply.[16]

We hypothesized that the density of FPs should be positively and significantly associated with individual use of the influenza vaccination. We further hypothesized that the magnitude of the association varies by racial/ethnic groups and areas; that is, local FP supply should have a larger association among nonwhite population and in rural regions. Our findings are a valuable contribution toward understanding and quantifying the correlation between local FP supply and rate of influenza vaccination, which is a necessary step in addressing the low influenza vaccination rates and disparities.

METHODS

Data

Data for this study were obtained from 2 sources. Individual-level attributes and influenza vaccination status were collected from the 2008, 2009, and 2010 Behavioral Risk Factor Surveillance System (BRFSS) database. The BRFSS data have been collected annually since 1984 to monitor health risk, prevention, and access related to chronic diseases and injuries across the United States. Each year, the BRFSS collects information from more than 400,000 respondents across all 50 states and the District of Columbia, Puerto Rico, the US Virgin Islands, and Guam. We restricted observations to adults age 18 years and older in this study.

Data on county-level attributes and local FP supply were obtained from the Area Resource File (ARF) published by the Health Resources and Services Administration for 2011-2012. The ARF database contains data on more than 6000 variables for every US county, including information on health facilities, health professions, and socioeconomic and environmental characteristics at the county level. It collects data from more than 50 sources, including the American Medical Association, American Hospital Association, and National Center for Health Statistics.

We merged 2 datasets based on the state and county of each respondent. The sample for analysis included 985,157 observations with complete individual- and county-level information.

Individual-level variables

The dependent variable in our analysis was derived from a survey question in the BRFSS that asked whether the respondent had received the influenza vaccination within the previous 12 months. Based on the response, we created a binary variable equal to 1 if the respondent reported receiving the vaccination within the previous 12 months and 0 otherwise.

Individual-level independent variables obtained from the BRFSS included socioeconomic characteristics, demographic data, and general health status. Socioeconomic characteristics included education (high school or less than high school [reference group in the logistic model], some college, and college or postbaccalaureate education), household income (less than $10,000 [reference group], $10,000-$14,999, $15,000-$19,999, $20,000-$24,999, $25,000-$34,999, $35,000-$49,999, $50,000-$74,999, and $75,000 and above), employment status (out of work [reference group], wage employment, self-employment, homemaker, student, retired and unable to work), insurance coverage, and access to health care providers. A dummy variable for insurance status was equal to 1 the respondent indicated that he or she had health care coverage, including health insurance, a prepaid plan such as an HMO, or a government plan such as Medicare. Access to health care providers was measured by a dummy variable that took the value of 1 if the respondent had 1 or more persons as personal doctors or health care providers. Demographic characteristics included sex (with male as the reference group), race/ethnicity (5 categories: non-Hispanic white [reference], non-Hispanic black, non-Hispanic Asian, Hispanic, and other), age (5 categories: age 18-29 years [reference], 30-39 years, 40-49 years, 50-64 years, and 65 years and older), and marital status (4 categories: single/never married [reference], married, unmarried couple, widowed/divorced/separated). General health status was classified as excellent/very good (reference group), good, and fair/poor.

County-level variables

Our key independent variable, county-level FPs per 1000 population, was derived by dividing the number of FPs reported in the ARF by the population. The number of FPs in the ARF was obtained from the 2010 American Medical Association's physician master files, aggregated to county levels. The 2010 FP supply was collected at the end of 2009, approximately the midpoint between 2008 and 2010. This is the period (ie, 2008-2010) during which we collected the individual-level data from the BRFSS. In robustness tests, we used the 2008 FP supply instead of the 2010 FP supply, and found similar results.

The ARF rural/urban codes were based on the Core-Based Statistical Area from the Economic Research Service. We used these codes to create 3 rural/urban categories: metropolitan counties (reference), urban but nonmetropolitan counties, and counties that were completely rural or with an urban population <2500. To capture local health care resources, we created 3 dummy variables to indicate whether a county was in 1 of the 3 Health Professional Shortage Areas (HPSAs) for primary care: (1) none of the county was designated as a shortage area (reference); (2) at least 1 part of the county was designated as a shortage area; or (3) the entire county was designated as a shortage area. We included in the model percentages of non-Hispanic black and Hispanic in a county, and median household income level as additional control variables in the analysis.

Statistical analysis

The BRFSS uses a multistage survey design to allow researchers to make nationally representative inferences. Stata 12 (StataCorp, College Station, TX) commands "svy: logit" and "svy: mean" were used to generate nationally representative results adjusted by the survey weights in the BRFSS. Multivariate logistic models were estimated