Preventive Medicine 73 (2015) 30–36

Contents lists available at ScienceDirect

Preventive Medicine

journal homepage: www.elsevier.com/locate/ypmed

The geographic distribution of eye care providers in the United States: Implications for a national strategy to improve vision health

Diane M. Gibson *

School of Public Affairs, Baruch College — City University of New York, 17 Lexington Avenue, Box D-901, New York, NY 10010, United States

ARTICLE INFO

Available online 22 January 2015

Keywords:
Vision
Ophthalmology
Optometry
Public health
United States

ABSTRACT

Objective. To describe the patterns of local eye care provider availability in the US.

Methods. Data from 2011 on the number of ophthalmologists and optometrists in each of the 3143 counties in the US were drawn from the Area Health Resources File. Population-weighted quartiles of the county-level number of ophthalmologists per capita and the county-level number of optometrists per capita were defined. Descriptive statistics were calculated and a cross tabulation of quartiles of ophthalmologist availability and quartiles of optometrist availability was conducted for all the counties in the US and for the set of counties in each region of the US.

Results. 24.0% of US counties had no ophthalmologists or optometrists. 60.7% of counties in the US were in one of the lower two quartiles of both ophthalmologist availability and optometrist availability, and 24.1% of counties were in one of the lower two quartiles of ophthalmologist availability but in one of the upper two quartiles of optometrist availability.

Conclusions. Public health interventions that are effective in a context of limited local eye care provider availability or that are able to leverage optometrist availability effectively in areas with limited ophthalmologist availability could be of widespread use in the US.

Introduction

More than 4 million Americans aged 40 years and older are either blind or visually impaired (Prevent Blindness America, 2012). Among Americans aged 40 years and older, 25.4 million have cataracts, 7.7 million have diabetic retinopathy, 2.7 million have glaucoma, and 1.8 million have age-related macular degeneration (Eye Diseases Prevalence Research Group, 2004; Prevent Blindness America, 2012). On the basis of these numbers, projected demographic trends in the US, the availability of effective treatments for many eye conditions, and the large financial and quality of life burden of vision loss, it has been argued widely that vision loss in the US is a public health problem (Gohdes et al., 2005; Lee et al., 2012; Prevent Blindness America and National Association of Chronic Disease Directors, 2005; Saadine et al., 2003; US Centers for Disease Control, 2009; Zhang et al., 2008). The Vision Health Initiative (VHI) of the US Centers for Disease Control and Prevention has developed a national public health strategy for improving vision health in the US. Since community characteristics such as the local availability of health care providers influence the use of health care services and the effectiveness of public health interventions, one of the recommendations in the VHI strategy is to determine the patterns of local eye care provider availability in the US in order to develop and disseminate public health interventions that are effective in these contexts (Gohdes et al., 2005; Layde et al., 2012; Prevent Blindness America and National Association of Chronic Disease Directors, 2005; Prevent Blindness America, 2004; US Centers for Disease Control, 2009; Zhang et al., 2007, 2008).

There is a small amount of previous research considering the geographic distribution of eye care providers in the US (Gamble et al., 1983; Lee et al., 2005). Gamble et al. (1983) described the number of ophthalmologists per capita in 1983 in the US and in each of the 532 ZIP Code sectional areas in the US. ZIP Code sectional areas usually cover multiple counties. They drew their information on ophthalmologists from the American Academy of Ophthalmology's (AAO) list of member and non-member ophthalmologists. They reported there were 11,210 ophthalmologists and 4.8 ophthalmologists per 100,000 residents of the US in 1983. They found that the number of ophthalmologists per capita varied widely across ZIP Code sectional areas, with the number of ophthalmologists per 100,000 residents ranging from 0 to 14.5. They also determined that 37 ZIP Code sectional areas, containing 0.8% of the total population of the US, did not have an ophthalmologist.

Lee et al. (2005) estimated the combined number of full-time equivalent (FTE) ophthalmologists and optometrists in 1994 in the US and in each of the four Census Regions of the US. They also drew their

Abbreviations: AAO, American Academy of Ophthalmology; AMA, American Medical Association; AMD, age-related macular degeneration; AHRF, Area Health Resources Files; FTE, full-time equivalent; VHI, Vision Health Initiative

* Fax: +1 646 660 6831.
E-mail address: diane.gibson@baruch.cuny.edu.

http://dx.doi.org/10.1016/j.ypmed.2015.01.008
0091-7435/

information on ophthalmologists from the AAO's list of member and non-member ophthalmologists. They estimated the number of optometrists using data from the 1990 Census Public Use Microdata Sample. They estimated there were 41,738 eye care provider FTEs in the US and their estimates by region ranged from 9065 eye care provider FTEs in the Northeast to 11,890 eye care provider FTEs in the South.

This paper provides updated information on the geographic distribution of ophthalmologists and optometrists in the US using data from 2011. The county-level analysis considers eye care provider availability in a smaller geographic area than in previous research. Additionally, the county-level availability of ophthalmologists and optometrists per capita are considered both separately and combined into the category of "eye care providers." While some types of vision care can be delivered by either ophthalmologists or optometrists, these two types of providers differ in training and in the range of vision care services they provide (Lee et al., 2005). The paper also adds to previous research by examining how county characteristics differ with the availability of eye care providers.

Methods

Sample

All of the 3143 counties and "county-equivalents" in the US in 2011 were included in the analysis. "County equivalents" are defined by the US Census Bureau and include the District of Columbia, the parishes of Louisiana, the boroughs of Alaska, and "independent cities" in Maryland, Missouri, Nevada, and Virginia. Hereafter, county equivalents are referred to as counties for ease of explanation.

Measurement of the county-level availability of eye care providers

The number of "patient care" ophthalmologists and the number of optometrists in each county in the US in 2011 were drawn from the Area Health Resources File (AHRF) of the US Health Resources and Services Administration (US Department of Health and Human Services, 2013a). This is the most recent data on ophthalmologists currently available in the AHRF. The source of the ophthalmologist data in the AHRF is the American Medical Association's (AMA) Physician Masterfile (US Department of Health and Human Services, 2013b). Lee et al. (2005) found that there were similar numbers of ophthalmologists in the AMA Physician Masterfile and the AAO's list of member and non-member ophthalmologists. The source of the optometrist data in the AHRF is the Centers for Medicare and Medicaid Services National Provider Identification File (US Department of Health and Human Services, 2013b). In the AHRF, a health care provider is assigned to a county on the basis of the provider's office address if it was provided and on the basis of the provider's mailing address if it was not.

Data on county population in 2011 was drawn from the AHRF. Separate county-level variables were created for the number of ophthalmologists per 100,000 county residents, the number of optometrists per 100,000 county residents, and the combined number of ophthalmologists and optometrists per 100,000 county residents ("eye care providers").

Previous research on the US found that greater county-level availability of ophthalmologists, with availability measured using population-weighted quartiles of the county-level number of ophthalmologists per capita, was associated with increased use of eye care services and better visual health outcomes (Gibson, 2014). These findings motivate the decision to describe eye care provider availability in a similar fashion in this paper. The definitions of the population-weighted quartiles of the number of ophthalmologists per 100,000 county residents are: low, $<= 2.95$; medium-low, >2.95 and $<= 5.39$; medium-high, >5.39 and $<= 7.63$; high, >7.63. The definitions of the population-weighted quartiles of the number of optometrists per 100,000 county residents are: $<= 10.96$ "low"; >10.96 and $<= 14.09$ "medium-low"; >14.09 and $<= 16.80$ "medium-high"; >16.80 "high." Each quartile contains approximately the same total population but the number of counties in each quartile differs.

County characteristics

Additional county-level variables drawn from the AHRF were the number of "patient care" physicians, population density, median household income, percentage of county residents who were poor, and percentage of county residents who were aged 65 years and older (all measured in 2011) and the percentage of county residents living in an urban area in 2010. The US Census Bureau is the source of AHRF demographic variables. A county's region was defined based on US Census Bureau Regions. The states in each region are listed in the footnotes in Table 4.

Statistical analysis

Descriptive statistics were calculated for the full set of counties and for the set of counties in each ophthalmologist and optometrist availability quartile. A cross tabulation of quartiles of ophthalmologist availability and quartiles of optometrist availability was conducted for all the counties in the US and for the set of counties in each region of the US. Linear tests of trend were conducted using bivariate linear regressions of each continuous county characteristic on a categorical ophthalmologist availability variable defined based on a county's ophthalmologist availability quartile (1 = lowest availability quartile, 4 = highest availability quartile). Similarly, linear tests of trend were conducted using bivariate linear regressions of each continuous county characteristic on a categorical optometrist availability variable defined based on a county's optometrist availability quartile. All tests were 2-sided with a significance level of $P < .05$. All analyses were performed with Stata Version 13.1 (StataCorp, College Station, Texas).

Results

There were 17,793 ophthalmologists and 44,402 optometrists in the US in 2011 and there were 5.7 ophthalmologists and 14.3 optometrists per 100,000 residents of the US in 2011. The county-level means were 2.1 ophthalmologists per 100,000 county residents, 11.2 optometrists per 100,000 county residents, and 13.2 eye care providers per 100,000 county residents (Tables 1 and 2). In 2011, 61% of counties had no ophthalmologists, 24.2% of counties had no optometrists, and 24.0% of counties had neither an ophthalmologist nor an optometrist. 11.7% of the US population lived in a county without an ophthalmologist; 2.2% of the US population lived in a county without an optometrist; and 2.1% of the US population lived in a county without an ophthalmologist or an optometrist.

Table 3 presents the cross tabulation of county ophthalmologist availability quartile by county optometrist availability quartile for all of the counties in the US. 44.7% of counties in the US were in the lowest quartile of both ophthalmologist and optometrist availability and 12.9% of the US population lived in these counties. 60.7% of counties in the US were in one of the lower two quartiles of both ophthalmologist availability and optometrist availability and 34.3% of the US population lived in these counties. 24.1% of counties were in one of the lower two quartiles of ophthalmologist availability but in one of the top two quartiles of optometrist availability and 15.7% of the US population lived in these counties.

The county-level availability of ophthalmologists and optometrists in the US is depicted in Figs. 1 and 2 respectively. The figures show that there was substantial variation between and within states in the county-level availability of ophthalmologists per capita and in the availability of optometrists per capita.

At the regional-level, the South had the highest total number of eye care providers (20,417) but the lowest number of providers per capita (17.6 per 100,000 residents). The Northeast had the lowest total number of eye care providers (13,323) but the highest number of eye care providers per capita (22.2 per 100,000 residents) and the highest number of ophthalmologists per capita (7.6 per 100,000 residents). The Midwest had the highest number of optometrists per capita (16.1 per 100,000 residents). Table 4 shows that 71.1% of counties in the South were in one of the lower two quartiles of both ophthalmologist and optometrist availability in comparison with 46.1% of counties in the Northeast, 51.6% of counties in the Midwest, and 56.8% of counties in the West. Table 4 also shows that 36.3% of counties in the Midwest were in one of the lower two quartiles of ophthalmologist availability but in one of the top two quartiles of optometrist availability in comparison