

Utilizing Data Mining Algorithms and Geospatial Analysis to Study Cataract Surgeries in Florida

Mahmood Khan¹, Amritha Kanakamedala², Zaina Al-Mohtaseb³

¹Department of Ophthalmology, Weill Cornell Medical College, New York, New York, USA, ²Department of Ophthalmology and Visual Sciences, Washington University in St. Louis, St. Louis, Missouri, USA, ³Department of Ophthalmology, Cullen Eye Institute, Baylor College of Medicine, Houston, Texas, USA

Abstract

Purpose: To determine statewide cataract surgery rates with cataract extraction with intraocular lens implantation (CEIOL) in Florida from 2005 to 2014 among Caucasians, African–Americans, Hispanics, and Asian/Pacific Islanders.

Methods: This is a retrospective database study analyzing ambulatory surgical data in Florida from 2005 to 2014. Using the Agency for Healthcare Research and Quality’s Healthcare Cost and Utilization Project (HCUP) and State Ambulatory Surgery and Services Databases (SASD), the authors utilized data mining algorithms to analyze and graphically represent disparities in the delivery of cataract surgery, changes in surgery volume, and demographic characteristics in patients 65 years and older in all Florida counties from 2005 to 2014.

Results: Cataract surgeries performed in patients ≥ 65 years of age represented 1,892,132 (14.90%) of the 12,695,932 total ambulatory surgical procedures from 2005 to 2014 in the HCUP-SASD Florida database. More surgeries were performed in females versus males, $P < 0.001$. Caucasians, African–Americans, and Hispanics represented 82.23%, 4.95%, and 10.69% of the utilization rate of all CEIOLs, respectively. From 2005 to 2014, the average surgery volume increased by an average rate of change of 1.29%. Cataract surgery penetration in the general population observed a steady decrease from 18.82% in 2005 to 16.66% in 2014.

Conclusions: Cataract surgery in Florida exhibited an unequal distribution with respect to gender and race, and select counties exhibited marked changes in surgical volume over the past 11 years. This study establishes a method for data mining and geospatial analysis to study surgical and epidemiological trends and identify disparities in delivery of healthcare.

Keywords: Cataract, Data mining, Epidemiology, Public health

Address for correspondence: Zaina Al-Mohtaseb, Department of Ophthalmology, Baylor College of Medicine, 6565 Fannin, NC205, Houston, Texas 77030, USA.

E-mail: zaina@bcm.edu

Submitted: 11-Apr-2021; **Revised:** 06-Jul-2021; **Accepted:** 07-Jul-2021; **Published:** 16-Apr-2022

INTRODUCTION

Cataract is one of the leading causes of blindness worldwide. It is estimated that 25.4 million Americans 40 years and older in the United States suffer from this condition.¹ Moreover, recent studies in the literature estimate that 13.5 million people in the year 2020 were blind secondary to cataract.^{2,3}

Given the increasing aging population, the number of individuals with cataract is estimated to increase to 30 million by 2020.³ Cataract impair vision and can negatively affect

quality of life, making it a growing public health concern.⁴ Cataract continue to be a target of epidemiologic and genetic research that serves to provide insight into causative factors and develop novel treatment options aimed at reducing disease burden.⁵

Cataract extraction and intraocular lens (CEIOL) placement is the mainstay treatment. Currently, 18 million cataract surgeries are performed worldwide annually, and it is estimated that the number of operations will increase to 24 million in years

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: WKHLRPMedknow_reprints@wolterskluwer.com

How to cite this article: Khan M, Kanakamedala A, Al-Mohtaseb Z. Utilizing data mining algorithms and geospatial analysis to study cataract surgeries in Florida. *J Curr Ophthalmol* 2022;34:37-43.

Access this article online

Quick Response Code:



Website:
www.jcurrophthalmol.org

DOI:
10.4103/joco.joco_119_21

to come as the aging population increases.⁶ Furthermore, treatment for cataract comprises a substantial portion of Medicare costs.³ Americans spend approximately \$6.8 billion annually on medical costs and services related to cataract treatments, which account for approximately 5% of the total Medicare budget.^{3,7}

Existing population-based studies on cataract surgery in the United States are limited in power and number of years studied.^{3,8} Existing studies have found that cataract disproportionately affect the elderly and females more than males.⁹ There is a disparity not only in the incidence of cataract but also in access to cataract surgery for racial and ethnic minorities. In one study analyzing racial differences in blindness among Caucasians and African-Americans in Baltimore, results showed that un-operated cataract accounted for 27% of all blindness among African-Americans. Furthermore, un-operated cataract were four times more prevalent among African-Americans than Caucasians. In fact, Caucasians were almost 50% more likely than African-Americans to have undergone cataract extraction before the age of 80.¹⁰

Recently, policy reform has focused on attempting to reduce racial disparities in healthcare utilization. Race, one's geographic location, and other socioeconomic factors play a major role in healthcare utilization, access, and outcomes.¹¹ While a number of studies have analyzed the influence of geography and race on access to healthcare treatments, only one study published in 2015 used geospatial analysis to analyze the effect of racial residential segregation on access to cataract extraction by African-Americans and Caucasians.⁸ In that study, researchers used the national prevalence data from the National Institute of Eye Health and the 2010 Healthcare Cost and Utilization Project (HCUP)-Florida State Ambulatory Surgery Database (SASD) to estimate the number of cataract cases and the actual number of cataract procedures performed on four race/gender-determined groups aged 65 and over in the state of Florida in 2010. Our work expands on this study by analyzing data in Florida from 2005 to 2014 in addition to analyzing several other factors, explained below. Geospatial analysis can provide a visual representation of access to healthcare and demonstrate patterns across regions. This type of analysis can help policy makers, researchers, and healthcare providers in identifying underserved areas.¹²

Given the increasing volume of cataract surgeries and other ophthalmological procedures, there will be a growing demand for ophthalmologists to meet patient care needs.³ Studies are needed to analyze the increasing volume of cataract surgery and the regional differences in availability of ophthalmologists in order to assess and predict access to cataract surgery by geographic region.

The purpose of this study is five fold: (1) To determine the statewide cataract surgery rates in Florida from 2005 to 2014 among Caucasians, African-Americans, Hispanics, and Asian/Pacific Islanders; (2) To examine the county-level racial and geographic variations in receiving cataract surgery

amongst gender and these four populations; (3) To assess and predict future case volumes for cataract surgery; (4) To predict physician needs for the future; (5) To apply geospatial analysis to graphically represent health disparities and surgical volume by county.

METHODS

All research activities adhered to the tenets of the Declaration of Helsinki. Data for the state of Florida from 2005 to 2014 was used for this study.

Data for this study were obtained from the Agency for Healthcare Research and Quality's (AHRQ) (U.S. Department of Health and Human Services, Washington D.C., USA) HCUP-SASD which captures all ambulatory procedures performed on the same day in which patients are treated and discharged from an ambulatory surgical center. This database captures data from all hospital-owned ambulatory surgery facilities. All data contained in this database are de-identified and publicly available.¹³

Florida was selected for this study due to its large and diverse population and high concentration of individuals ≥ 65 years of age.¹⁴ Primary analysis was restricted to persons ≥ 65 years who underwent a CEIOL placement. Surgeries were queried using Current Procedural Terminology codes for extra capsular cataract removal with insertion of intraocular lens prosthesis (66982, 66983, 66984). Using the five-digit Federal Information Processing Standards (FIPS) codes associated with each surgical encounter, state and county-level data were obtained from this database. Surgical volume for Caucasian, African-American, Hispanic, and Asian/Pacific Islander races are coded within this database and were included in this study.

Data mining and processing were performed using R (The R Foundation, Vienna, Austria), an open-source programming language. All data acquisition, processing, and mapping were performed in accordance with the U.S. Health and Human Services terms of use. Census data from the Florida Office of Economic and Demographic Research (Tallahassee, USA) was used to obtain state and county-level population data from 2005 to 2014.¹⁵ Using national population data statistics from The World Bank Group (Washington, D.C., USA), percentage rates for persons ≥ 65 years of age in the United States were estimated.¹⁶ Using the National Eye Institute (Bethesda, USA) U.S. age-specific prevalence for cataract by age, the number of persons affected by cataract in the state of Florida from 2005 to 2014 was estimated by multiplying national prevalence to the total number of adults ≥ 65 years of age.¹⁷

The number of cataract surgeries performed by year was obtained for each of the 67 counties in Florida. The number of cataract surgeries for each race within each county and payer status, gender, and setting of surgery (urban or rural) for each surgery were also obtained. Similarly, the total number of ambulatory surgeries including cataract surgeries performed by race and county were obtained. The percent change in each

county from 2005 to 2014 was calculated. Using the average percent change from 2005 to 2014, predicted cataract surgery volume till 2024 was projected.

The penetration rate of cataract surgeries in the general population ≥ 65 years of age was calculated for each of the 67 counties in Florida. This calculation was performed by using the number of cataract surgeries as the numerator and dividing that into the estimated number for the incidence of cataracts in the general population. The utilization rate was calculated for each of the 67 counties and also for both males and females by dividing the total number of cataract surgeries into the total number of ambulatory surgeries performed. Next, the total difference in cataract surgery volume by state and each county was calculated from 2005 to 2014. The codes used to perform the above analyses can be provided at the request of other researchers.

Statistical analysis

The Kruskal–Wallis test was used to compare mean differences between racial and gender groups. Excel (Microsoft, Redmond, USA) and R were used for all statistical analyses. $P \leq 0.05$ was considered statistically significant.

Using county names, FIPS codes, and the software Tableau Public (Tableau Software, Seattle, USA), differences in case volume, percentage changes, and disparities in cataract surgery were mapped. Disparities in cataract surgery were mapped by calculating the percentage of non-Caucasians undergoing cataract surgery with intraocular lens implantation in each county.

RESULTS

Detailed information on total ambulatory surgeries, CEIOL surgeries, race, and gender are presented in Table 1 and graphically in Figure 1. The cataract surgeries performed in individuals ≥ 65 years of age represent 1,892,132 (14.90%) of the 12,695,932 total ambulatory surgical procedures from 2005 to 2014 in the HCUP-SASD Florida database. Furthermore, the number of surgeries performed in females was found to be statistically different, $P < 0.001$. All races and genders observed steady growth in surgical volume from 2005 to 2014.

Caucasians, African–Americans, and Hispanics represented 82.15% (95% confidence interval [CI] [83.10%, 83.21%]), 4.95% (95% CI [4.89%, 4.95%]), and 10.63% (95% CI [10.59, 10.67]) of the utilization rates of all CEIOLs, respectively. In Table 2, a total of 1,892,132 surgeries were performed on 1,076,848 patients. Females outnumbered males by approximately 3:2 in terms of cataract surgery volume. Furthermore, the most frequent payers were Medicare and private insurances [Table 2]. From 2005 to 2014, the average rate of change in surgical volume increased 1.29% per year [Table 3]. From 2009 to 2010, the surgical volume decreased by 5.41%, but from 2011 to 2012, the surgical volume increased by 5.09%. In 2009, the rate of CEIOL implantation observed a noticeable decrease for the Hispanic

race [Figure 1]. Past and predicted future surgical volumes in all 67 counties in Florida were also represented in Figures 2 and 3. CEIOL penetration in the general population observed a steady decrease from 18.82% in 2005 to 16.66% in 2014 [Table 3].

Figure 2 shows a graphical representation of the percent change in cataract surgery from 2005 to 2014. Figure 2 shows a graphical representation of the percentage of CEIOLs performed in non-Caucasians over the 11 years. Sumter county observed a 196% increase in surgical volume [Figure 2]. Figure 3 depicts predicted cataract surgery volume changes from 2014 to 2024. Our results support the existence of gender differences with Caucasian females having the highest likelihood of receiving cataract surgery [Table 1]. At the county level, Miami-Dade and Sumter counties observed the greatest increase in surgical volume from 2005 to 2014 and predicted surgical volume in 2024 [Figures 2 and 3].

DISCUSSION

Cataract is the leading cause of blindness in the world, primarily affecting the elderly.¹⁸ Timely surgical intervention for cataract not only serves as a curative treatment but also acts as a preventative measure for overall mortality risk and injuries secondary to compromised visual acuity.¹⁹ Despite breakthrough developments in surgical technology, instrumentation, and research, the delivery and access to quality surgical care continues to benefit only a select population in the U.S. Often, preexisting medical conditions, age, gender, and payer status serve as surrogates for the prediction of surgical outcomes in most patient populations. This study intends to show that in addition to these variables, race is an additional factor that can increase disparities in access to quality surgical care, specifically cataract surgery.⁸ The resulting unequal rates of surgery and limited access to healthcare can negatively affect the clinical outcomes of millions of patients every year.¹⁰

Studies using single-year data with fewer surgical procedures have shown increased cataract rates in Caucasians and females, and a lower utilization rate of cataract surgery amongst African–Americans.^{8,20} In this study, the authors report that Caucasians observed the highest utilization rate at 82.23% followed by Hispanics at 10.69%. Consistent with previous studies, African–Americans had a lower rate of utilization, 4.95%, of cataract surgery than Caucasians despite comprising 13.4% of the population of Florida greater than age 65 in the most recent census.^{21–23} Although Hispanics and African–Americans comprise 18.3% and 13.4% of the Florida population greater than age 65, respectively, there exists a disproportionate difference in the rate of cataract surgery utilization between the two groups.^{21,24} Alternatively, this difference is visualized in Figure 1, where the rate of change in cataract surgery from 2005 to 2014 is lower in African–Americans than in Hispanics and Asian/Pacific Islanders. This observed disparity toward African–Americans could be due to

Table 1: Cataract surgery volume, by race and gender, ≥65 years, Florida 2005-2014

Year	Total surgeries	Total CEIOL	Caucasian male	Caucasian female	African-American male	African-American female	Hispanic male	Hispanic female	Asian-Pacific Islander male	Asian-Pacific Islander female
2005	1,140,317	179,673	64,772	90,944	2644	4809	5922	9320	343	525
2006	1,182,974	180,400	64,961	90,353	2695	4896	6349	9537	395	659
2007	1,262,775	187,011	66,747	90,921	2873	5385	7233	10,667	428	701
2008	1,316,736	188,463	67,164	90,962	3071	5466	7512	11,167	372	722
2009	1,306,748	195,944	69,627	95,652	3412	6327	7192	10,714	469	781
2010	1,289,273	185,352	66,153	87,610	3511	5932	8610	12,356	706	1087
2011	1,263,370	182,183	63,677	85,263	3511	6125	8706	12,678	644	1070
2012	1,298,307	191,465	66,619	88,073	3892	6389	9312	13,322	651	1073
2013	1,316,107	200,946	69,326	93,055	3978	6799	9932	15,129	767	1137
2014	1,319,325	200,695	69,518	91,975	4288	7066	10,212	15,275	755	1205
<i>P</i> *	-	-	<0.001		<0.001		<0.001		<0.001	
Total	12,695,932	1,892,132	668,564	904,808	33,875	59,194	80,980	120,165	5530	8960

There was noted a significant difference in cataract surgery volume between genders in each race.*Kruskal–Wallis test. CEIOL: Cataract extraction with intraocular lens implantation

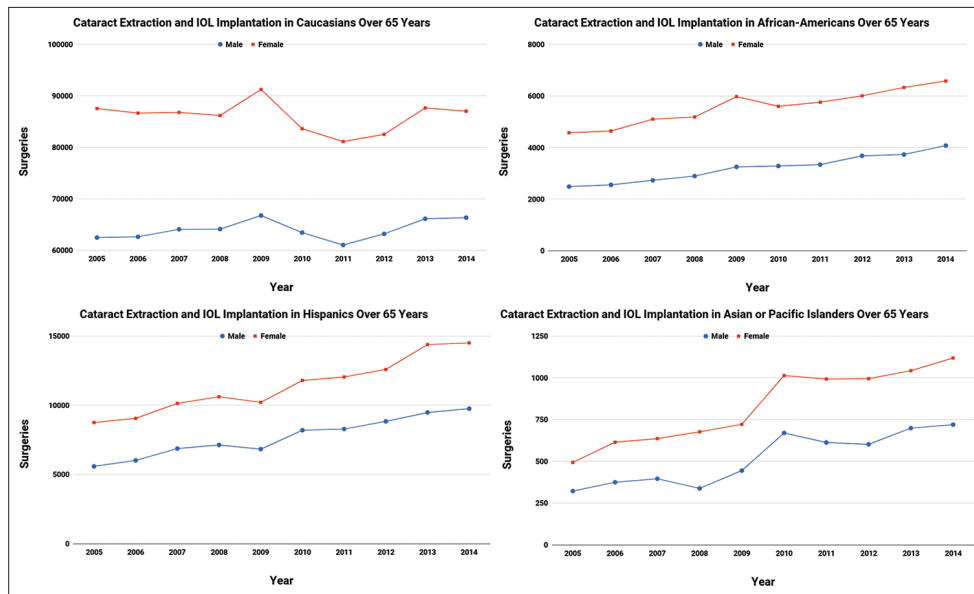


Figure 1: Cataract surgery by race and gender, Florida 2005-2014. (Top left) Caucasians, (top right) African–Americans, (bottom left) Hispanics, (bottom right) Asian or Pacific Islanders

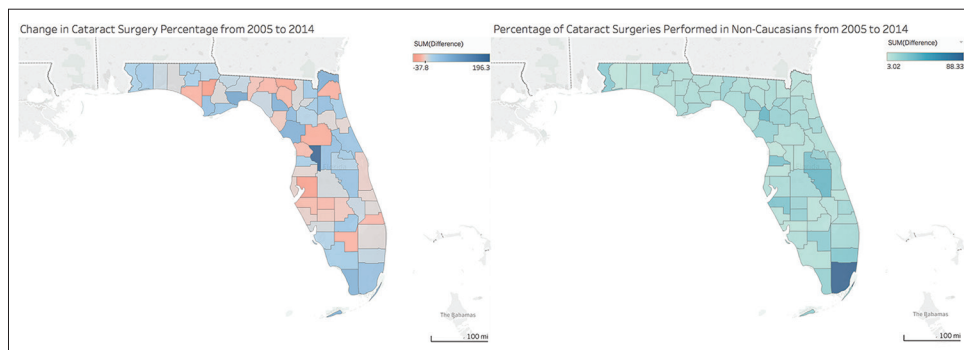


Figure 2: (Left) Change in cataract surgery percentage from 2005 to 2014. (Right) Percentage of cataract surgeries within counties performed in non-Caucasians from 2005 to 2014

two reasons. First, their residential clustering apart from other races may result in and continue to reinforce disparities in their

access to healthcare and economic opportunities.¹⁰ Second, the geographical proximity of Florida relative to US territories and

Table 2: Demographic, race, setting, and payer status in patients ≥65 years, Florida 2005-2014

Demographics	All surgeries
Patients	1,076,848
Surgeries	1,892,132
Gender (%)*	
Male (surgeries)	814,209 (42.0)
Female (surgeries)	1,126,506 (58.0)
Race	
Caucasian	1,573,372
African-American	93,069
Hispanic	201,145
Asian/Pacific Islander	14,490
Native American	1520
Other	30,588
Setting (%)	
Urban	1,426,797 (91.8)
Rural	126,726 (8.2)
Payer (%)	
Medicare	1,577,442 (81.5)
Medicaid	19,300 (1.0)
Private	307,129 (16.0)
Self-pay	23,548 (1.41)
No charge	793 (0.04)
Other	12,201 (0.063)

*Not all surgeries include gender, race, setting, or payer codes due to hospital coding practices

South American countries that observe high rates of emigration to this state may artificially increase the difference in rates of cataract surgeries between the different racial groups. In certain counties such as Miami-Dade County, there is a high concentration of immigrant populations that may artificially inflate the number of cataract surgeries being performed on Hispanics [Figure 2].

In this study, females underwent more cataract surgeries than their male counterparts in all racial groups, $P < 0.001$. Recent epidemiologic data have shown that cataract is more prevalent in women than men, with this study showing a 30% difference between genders of all races.²⁵ Published data on the role of endogenous versus exogenous estrogen in formation of cataract lacks consensus; however, several studies state that the decrease of estrogen in females during menopause may increase the risk of cataract formation and that hormone replacement therapy may counteract this.²⁵⁻²⁷ Studies by Skiljic *et al.* and Abraham *et al.* have hypothesized that it is not necessarily the concentration of estrogen but rather its withdrawal during menopause that may increase the risk of cataract formation.^{5,27} Estrogen, estradiol, and other derivatives are known to exert anti-aging effects such as preservation of telomeres, increased bone mineral density, and reduction in damage from oxidative stress.²⁶ It is possible that this increase of oxidative stress during estrogen withdrawal during menopause may accelerate the formation of cataract in females.

Table 3: Incidence and cataract surgery penetration

Year	Population ≥65	Cataract incidence*	Surgery	Percentage penetration	95% confidence lower limit	95% confidence upper limit
2005	2,133,734	954,846	179,673	18.82	18.74	18.90
2006	2,215,209	991,306	180,400	18.20	18.12	18.27
2007	2,287,768	1,023,776	187,011	18.27	18.19	18.34
2008	2,345,724	1,049,712	188,463	17.95	17.88	18.03
2009	2,392,364	1,070,583	195,944	18.30	18.23	18.38
2010	2,444,549	1,093,936	185,352	16.94	16.87	17.01
2011	2,495,847	1,116,892	182,183	16.31	16.24	16.38
2012	2,556,356	1,143,969	191,465	16.74	16.67	16.81
2013	2,619,683	1,172,308	200,946	17.14	17.07	17.21
2014	2,692,407	1,204,852	200,695	16.66	16.59	16.72

*Estimated values based on data from the U.S. Census Bureau and National Eye Institute

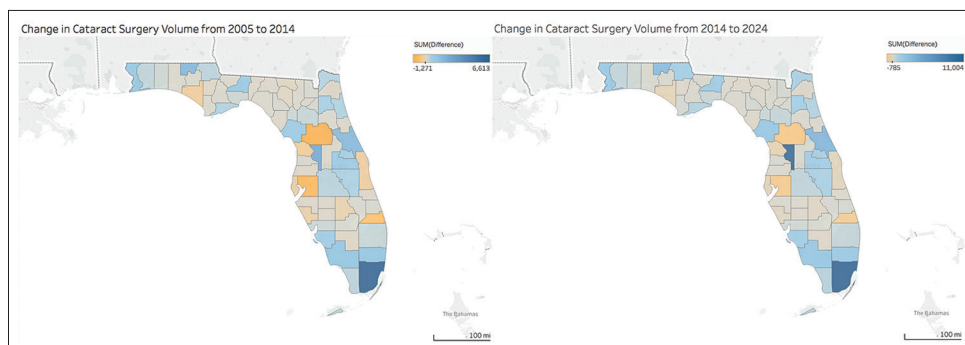


Figure 3: (Left) Change in cataract surgery volume from 2005 to 2014. (Right) Projected change from 2014 to 2024

Consistent with the high concentration of elderly individuals in Florida, Medicare covers 81.5% of cataract surgeries [Table 2].²⁴ From 2005 to 2014 and based on our estimations, the incidence of cataract in the general population grew at a rate faster than that of CEIOL implantation. This difference is appreciated in the penetration of CEIOLs in the general population ≥ 65 years with a diagnosis of a cataract. Reaching its peak in 2005, the rate of cataract surgeries reached its lowest penetration in the population in 2011. This is mirrored in Figure 1, which shows the concurrent decrease in cataract surgeries in Caucasians in 2011. Given that Caucasians comprise the majority of cataract surgeries in this study, it is likely that the drop in this racial group was sufficient to affect the overall percent penetration of cataract surgeries in the general population.

From 2005 to 2014, the county with the greatest percentage change in cataract surgery volume was Sumter County [Figure 2]. According to the most recent data published by the United States Census Bureau, Sumter County boasts the oldest median age, 62.7 years, of any US county.¹⁴ Similarly, Figure 3 depicts surgical volume changes over the same period. Using past surgical trends, the authors of this study were able to extrapolate and predict future surgical volumes at the county level. Counties with the greatest expected increase in surgical volume were Miami-Dade, Sumter, Broward, and Collier County [Figure 3]. Large tertiary referral centers such as Bascom Palmer Eye Institute in Miami-Dade County coupled with the high population density can account for the high surgical volume observed in Figures 2 and 3. Furthermore, Sumter County with its high density of the elderly population can also account for the increased predicted surgical volume.

To understand geographic and racial disparities in access to cataract surgery, it is important to examine the distribution of ophthalmologists in the United States. In 2011, there were 17,793 ophthalmologists and 5.7 ophthalmologists per 100,000 county residents. At that time, 61% of counties did not have ophthalmologists, and 11.7% of the US population lived in a county without an ophthalmologist.²¹

Large data sets providing ample longitudinal data are valuable to both clinicians and officials that oversee health policies. By analyzing past trends in healthcare utilization, researchers, and physicians can accurately identify utilization rates of surgeries, gain a greater understanding of racial and ethnic disparities in healthcare, and strategically plan healthcare policies to preemptively address issues before they become public health concerns. Predictions of future case volume can help foreshadow future shortages of physicians and also serve as a tool for academic institutions when deciding on satellite campuses or training programs. With respect to African-American and Hispanic populations, increasing the rate of cataract extraction and decreasing time to surgery has benefits that extend beyond the individual patient. Furthermore, by avoiding visual complications associated with delayed cataract surgery, the risk of overall mortality risk is decreased.^{19,28}

This study has several limitations. First, the reliability of the SASD is dependent on the accuracy of coding for surgical procedures and the ability of the AHRQ to capture every ambulatory surgical procedure performed from 2005 to 2014 in Florida. Second, given the paucity of published population data and cataract prevalence data, this study relies on estimated figures to calculate the number of individuals ≥ 65 years old and the prevalence of cataract. Though our calculations were based on previous data and estimations, the accuracy of calculations is dependent on the reliability of formulas utilized. Third, there is year-to-year variation in surgical volume in our data set, which we attribute to changes in the economy. We would encourage future studies that utilize multi-year data sets to examine the potential variability. Finally, the projected cataract surgery volume is dependent on the accuracy of the data derived from the HCUP database.

Ophthalmological studies on longitudinal, population-based data for cataract surgeries and other ophthalmic procedures are limited. As mentioned previously, few studies have used geospatial analysis to examine cataract surgery rates and utilization. A study conducted by Shahbazi *et al.* utilized geospatial analysis and calculated disparity ratios in each county in Florida in 2010 to analyze whether there was an association between racial composition and these disparity ratios. Overall, the study found no overall differences between the disparity ratios and racial composition of the communities, though they did find that African-Americans are least likely to receive necessary cataract surgery, as stated above.⁷ Our study expands on this study because we analyze cataract surgery rates in Florida from 2005 to 2014. Furthermore, the study by Shahbazi *et al.* was restricted to non-Hispanic persons 65 years and older. Given that Hispanic individuals comprised 18.3% of the population >65 years of age in Florida, we included Hispanic individuals in our study, in addition to Caucasians, African-Americans, and Asian/Pacific Islanders.²⁴

With the use of the AHRQ's HCUP database, the authors of this study were able to analyze trends in cataract surgery volume, utilization, racial disparities, and penetration from 2005 to 2014 and predict future case volumes at the county and state level in Florida. In this study, we found that African-Americans were underserved when compared to their racial counterparts. Given that racial disparities and gender differences exist in the limited scope of our study, the utility of larger database studies to further characterize racial and ethnic populations is extremely valuable. Our hope is that this study will serve as a foundation for future database studies and allow for more robust analyses of other surgical procedures and diseases in the rest of the United States.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Prevent Blindness America. Prevent Blindness America: Vision Problems in the US. Schaumburg, IL: Prevent Blindness America; 2012.
2. Hashemi H, Pakzad R, Yekta A, Aghamirsalim M, Pakbin M, Ramin S, *et al.* Global and regional prevalence of age-related cataract: A comprehensive systematic review and meta-analysis. *Eye (Lond)* 2020;34:1357-70.
3. Flaxman SR, Bourne RR, Resnikoff S, Ackland P, Braithwaite T, Cicinelli MV, *et al.* Global causes of blindness and distance vision impairment 1990-2020: A systematic review and meta-analysis. *Lancet Glob Health* 2017;5:e1221-34.
4. Congdon N, Vingerling JR, Klein BE, West S, Friedman DS, Kempen J, *et al.* Eye diseases prevalence research group. *Arch Ophthalmol* 2004;122:487-94.
5. Abraham AG, Condon NG, West Gower E. The new epidemiology of cataract. *Ophthalmol Clin North Am* 2006;19:415-25.
6. Brunin G, Khan K, Biggerstaff KS, Wang L, Koch DD, Khandelwal SS. Outcomes of femtosecond laser-assisted cataract surgery performed by surgeons-in-training. *Graefes Arch Clin Exp Ophthalmol* 2017;255:805-9.
7. Shahbazi S, Studnicki J, Warner-Hillard CW. A cross-sectional retrospective analysis of the racial and geographic variations in cataract surgery. *PloS One* 2015;10:e0142459.
8. Lundqvist B, Mönestam E. Gender-related differences in cataract surgery outcome: A 5-year follow-up. *Acta Ophthalmol* 2008;86:543-8.
9. Sommer A, Tielsch JM, Katz J, Quigley HA, Gottsch JD, Javitt JC, *et al.* Racial differences in the cause-specific prevalence of blindness in east Baltimore. *N Engl J Med* 1991;325:1412-7.
10. Institute of Medicine (US) Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care. Unequal treatment: confronting racial and ethnic disparities in health care. Smedley BD, Stith AY, Nelson AR, editors. Washington (DC): National Academies Press (US); 2003. PMID: 25032386.
11. Graves BA. A model for assessment of potential geographical accessibility: A case for GIS. *Online J Rural Nurs Health Care* 2009;9:46-55.
12. Agency for Healthcare Research. SASD Database Documentation. Available from: <https://www.hcup-us.ahrq.gov/db/state/sasddbdocumentation.jsp>. [Last accessed on 2018 May 24]
13. Bureau UC. The Nation's Older Population Is Still Growing, Census Bureau Reports. <https://www.census.gov/newsroom/press-releases/2017/cb17-100.html>. [Last accessed on 2018 May 24].
14. Office of Economic and Demographic Research. Population and Demographic Data. The Florida Legislature. Available from: <http://edr.state.fl.us/content/population-demographics/data/index-floridaproducts.cfm>. [Last accessed on 2019 Jul 14; Last updated on 2017 May 31].
15. The World Bank Group. Population Ages 65 and above (% of Total Population) | Data. The World Bank Group. Available from: <https://data.worldbank.org/indicator/SP.POP.65UP.TO.ZS>. [Last accessed on 2019 May 20].
16. Institute NE. Cataract. National Eye Institute; 2019. Available from: <https://www.nei.nih.gov/learn-about-eye-health/outreach-campaigns-and-resources/eye-health-data-and-statistics/ataract-data-and-statistics/ataract-tables>. [Last accessed on 2019 Jul 14].
17. Hodge WG, Whitchee JP, Satariano W. Risk factors for age-related cataract. *Epidemiol Rev* 1995;17:336-46.
18. Dang S. Cataract Surgery Infographic. Available from: <https://www.aao.org/eye-health/news/ataract-surgery-infographic>. [Last accessed on 2018 May 24].
19. Broman AT. Cataract and barriers to cataract surgery in a US Hispanic population. *Arch Ophthalmol* 2005;123:1231.
20. Baicker K, Chandra A, Skinner JS. Geographic variation in health care and the problem of measuring racial disparities. *Perspect Biol Med* 2005;48:S42-53.
21. West SK, Muñoz B, Schein OD, Duncan DD, Rubin GS. Racial differences in lens opacities: The Salisbury Eye Evaluation (SEE) project. *Am J Epidemiol* 1998;148:1033-9.
22. Zhang X, Cotch MF, Ryskulova A, Primo SA, Nair P, Chou CF, *et al.* Vision health disparities in the United States by race/ethnicity, education, and economic status: Findings from two nationally representative surveys. *Am J Ophthalmol* 2012;154 Suppl 6:S53-62.e1.
23. U.S. Census Bureau Quick Facts: Florida. Available from: <https://www.census.gov/quickfacts/fact/table/US/PST045217>. [Last accessed on 2019 Jul 14].
24. Zetterberg M, Celojevic D. Gender and cataract – The role of estrogen. *Curr Eye Res* 2015;40:176-90.
25. Lai K, Cui J, Ni S, Zhang Y, He J, Yao K. The effects of postmenopausal hormone use on cataract: A meta-analysis. *PLoS One* 2013;8:e78647.
26. Hales AM, Chamberlain CG, Murphy CR, McAvoy JW. Estrogen protects lenses against cataract induced by transforming growth factor-beta (TGFbeta). *J Exp Med* 1997;185:273-80.
27. Škiljić D, Nilsson S, Seibt Palmér M, Tasa G, Juronen E, Behndig A, *et al.* Estrogen-related polymorphisms in Estonian patients with age-related cataract. *Ophthalmic Genet* 2013;36:188-91.
28. Lee DJ, Gómez-Marin O, Lam BL, Zheng DD. Visual acuity impairment and mortality in US adults. *Arch Ophthalmol* 2002;120:1544-50.