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Thank you, Senator Bailey, Representative Mathieson, and committee members, for allowing me to testify in favor of LD1803.

My name is Ian Jones, and I have been a Doctor of Optometry practice for 28 years. I am a private practice owner with offices in Newport and Waterville. I would like to address the access of care issue for Maine people especially in rural Maine.

Optometrists provide services to 92% of Maine's population across 15 of Maine's 16 counties. Meanwhile, three counties lack ophthalmologists entirely, and two have just one. My testimony includes a map highlighting the distribution of optometrists compared to ophthalmologists. Certain regions lack specialty care services. With an upcoming ophthalmologist practice closure in the Lewiston/Auburn area and other practices not accepting new referrals, optometrists often refer patients to out-of-state ophthalmologists, necessitating travel to New Hampshire or Boston.

Requiring patients to see ophthalmologists for procedures that Doctors of Optometry are educated, trained and certified to perform leads to delays, lengthy travel times, and additional travel expenses. Patients are frustrated with waiting for an appointment and the need to travel out of their local areas to see an ophthalmologist for procedures that should be done by their optometrist.

Last summer, one of my patients, a school bus driver of 20 years, came to me after failing her vision exam during a driver's license test. She had cataract surgery six years ago. During the exam, I discovered she had an opacified capsule- a film covering the back of the intraocular lens that had been implanted. She required a YAG capsulotomy laser procedure to remove this film. This non-invasive, in office procedure was necessary for her to continue working. However, we could not get her an ophthalmology consult appointment for many months. The delay affected her ability to work, get paid and had an impact on the school system, which already had a bus driver shortage. If I had the authority to perform this laser procedure as I am educated, trained and certified to do, my patient would not have faced this delay. She would have had the procedure in my office and returned driving her school bus without delay.

A recent article in the Journal of the American Medical Association examined the geographic distribution of ophthalmologists and evaluated factors associated with practicing in rural areas. The study "suggests a concerning geographic disparity in rural ophthalmic surgeons available to serve the needs of rural patients." It went on to state, "It has been established that limited access to ophthalmic care generates negative outcomes among rural or patients in underserved communities, including increased prevalence of visual impairment, diabetic retinopathy, and macular degeneration.

Access to care should never come with a compromise in quality of care. This legislation will allow our patients to receive care when and where they need it from highly trained professionals without having to wait or travel for additional appointments. Travel creates barriers in the form of missed work, additional costs, and delays in care. By passing this legislation Maine can join other states in taking proactive measures to address health equity and access.

Thank you for the opportunity to speak today, I urge your support for this bill and would be happy to answer any questions.

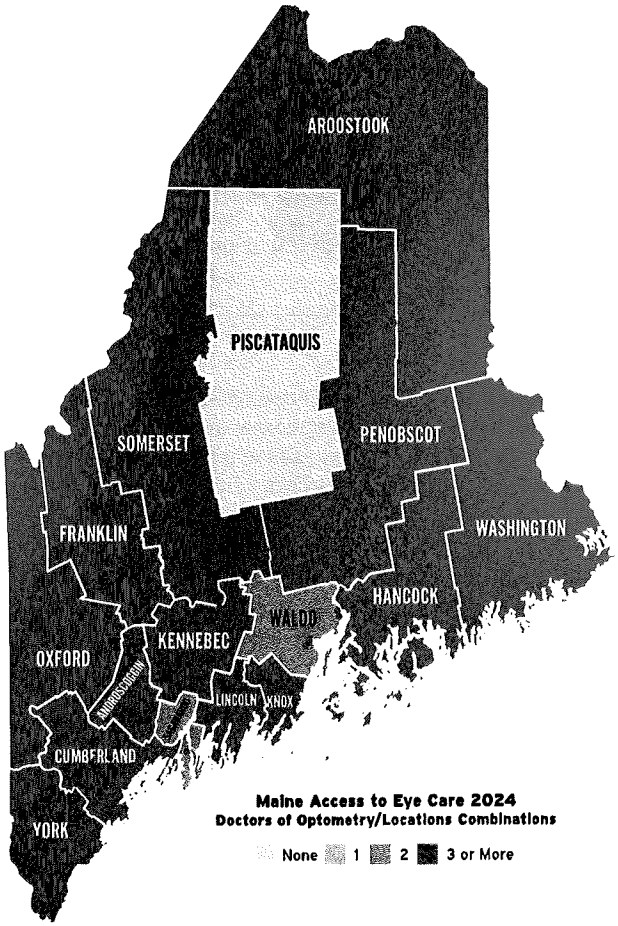
Ian Jones O.D.

(Included with written testimony state maps and JAMA article of access to care)

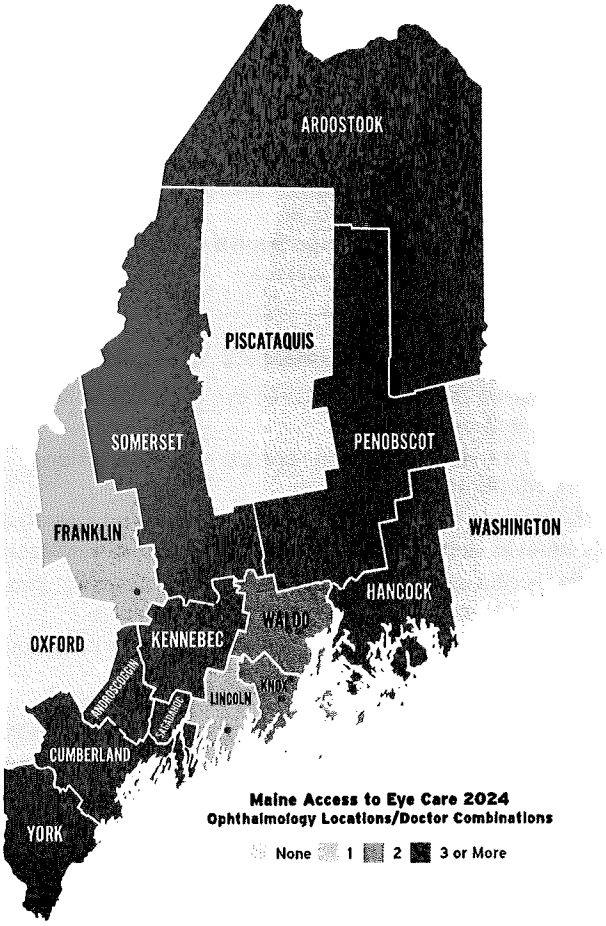
DOCTORS OF OPTOMETRY ARE GEOGRAPHICALLY ACCESSIBLE AND UNIQUELY AVAILABLE TO FURNISH PRIMARY EYE CARE SERVICES.

Optometry is a regulated profession and scope of practice varies between states. Practice rights should not be a political issue that is inconsistent across states but an issue of patient access to quality eye health and vision care. By allowing all doctors of optometry to practice to the full extent of their training, patients enjoy greater access to the latest procedures and better preventive care as many medical conditions will be caught earlier. If appropriate preventive steps are not taken, costs will burgeon as the population ages and life expectancy increases.

MAINE OPTOMETRY PRACTICE LOCATIONS



MAINE OPHTHALMOLOGY PRACTICE LOCATIONS



[1] American Optometric Association (AOA) Doctor of Optometry Master Data File. St. Louis, Missouri. January 9, 2024.

AMERICAN OPTOMETRIC ASSOCIATION

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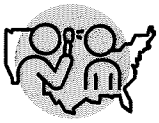
DOCTORS OF OPTOMETRY ARE A CRITICAL KEY TO PRIMARY EYE HEALTH IN THE U.S.

Up to 16 million Americans struggle with undiagnosed or untreated vision impairments.[1] Combined with the fact that eye diseases, vision loss, and eye disorders create an estimated $139 billion economic burden demonstrates the importance of care delivered by doctors of optometry. Doctors of optometry are geographically accessible and uniquely available to furnish Americans' primary eye care services.

Doctors of optometry, also recognized as physicians, deliver an essential component of patients' overall primary health that goes well beyond examining vision acuity to prescribe glasses or contact lenses. An in-person, comprehensive eye exam includes diagnosis and management of eye diseases and treatment of systemic diseases, including diabetes, high blood pressure and even cancer. They prescribe medication to treat eye diseases, treat glaucoma, perform pre- and post-operative evaluations and perform follow-up care.



Doctors of optometry provide more than **two-thirds of primary eye health care in America**

More than **99 percent of the U.S. population** lives in counties with a doctor of optometry

5,800 communities nationwide, doctors of optometry are the only primary eye and vision care providers

DOCTORS OF OPTOMETRY CAN ALSO:

- Prescribe medication to treat eye diseases in drop, ointment or pill form.
- Evaluate visual acuity for corrective prescriptions (refraction).
- Determine the patient's ability to focus and coordinate the eyes and to judge depth and see colors accurately.
- Prescribe eyeglasses, contact lenses, low vision aids, and deliver rehabilitation and vision therapy.
- Perform minor surgical procedures such as removing foreign objects from the eye and cornea.
- Evaluate patients with diseases such as cataract, macular degeneration, glaucoma, and diabetes. They will co-manage these diseases when further care is necessary by referring patients to the appropriate surgical eye specialty and routinely provide post-op care when their patients are returned to them.
- Treat eye trauma and acute eye infections including corneal abrasions, chemical burns, foreign bodies on the surface of the eye or eyelids, thermal burns, conjunctivitis, and inflammation of the iris.

DOCTORS OF OPTOMETRY HAVE EXTENSIVE EDUCATION AND TRAINING TO DELIVER THE MEDICALLY RECOGNIZED STANDARD OF CARE

The doctor of optometry program is comprised of additional years of extensive classroom study and clinical training, through intensive, hands-on clinical experience and concentrated disease exposure. Professional education of doctors of optometry includes general medicine with a concentration on the study of eye health and vision care.

Doctors of optometry are licensed by each state, the District of Columbia and Puerto Rico. While requirements may differ from state to state, optometry school graduates must pass a comprehensive examination to prove competence and skill before a license to practice is granted.

These licenses must be renewed annually or biannually. In all states, renewal requires a specified number of hours of continuing education. Throughout their careers, doctors of optometry complete ongoing professional training and education.

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JAMA Ophthalmology | Original Investigation

Geographic Distribution of US Ophthalmic Surgical Subspecialists

Aishah Ahmed, BA; Muhammad Ali, MBBS; Chen Dun, MHS; Cindy X. Cai, MD, MS; Martin A. Makary, MD, MPH; Fasika A. Woreta, MD, MPH

IMPORTANCE While urban counties maintain higher densities of ophthalmologists than rural counties, the geographic distribution of ophthalmic surgical subspecialists has not yet been elucidated. A potential workforce discrepancy may impact the burden of care faced by rural surgeons.

OBJECTIVE To assess the geographic distribution of the ophthalmic subspecialist surgeon workforce and evaluate factors associated with practicing in rural areas.

DESIGN, SETTING, AND PARTICIPANTS This cross-sectional population-based study of Medicare patients and surgeons performing subspecialized procedures took place from 2012 through 2022. Medicare Fee-for-Service claims were analyzed in 2023 for patients 65 years or older who underwent subspecialized ophthalmic procedures between 2012 and 2022 using *Current Procedural Terminology* codes (n = 1 619 043). Surgeons were defined as a subspecialist based on *Current Procedural Terminology* codes, indicating performance of at least 1 subspecialty procedure from the following subspecialties: cornea, glaucoma, oculoplastic, retina, or strabismus (n = 13 526).

MAIN OUTCOMES AND MEASURES The primary outcome was the population density of practice for subspecialist surgeons and residence for patients (rural or urban). The secondary outcomes were the characteristics associated with rural practice.

RESULTS Among 13 526 ophthalmic surgical subspecialists, 9823 were male (72.6%), 3235 were female (26.8%), and 4484 (33.2%) practiced in the South. There were 2540 cornea subspecialists (18.5%), 3676 glaucoma subspecialists (26.8%), 1951 oculoplastic subspecialists (14.2%), 4123 retina subspecialists (30.0%), and 1236 strabismus subspecialists (9.0%). Across subspecialties, a higher proportion of patients (17.4%; 95% CI, 16.9%-17.9%) resided in rural areas relative to surgeons (5.6%; 95% CI, 5.3%-5.9%) with differences ranging from 6.2% to 14.8% across subspecialities. Female surgeons (adjusted odds ratio [aOR], 0.63; 95% CI, 0.51-0.79; $P < .001$), surgeons in the Northeast (aOR, 0.62; 95% CI, 0.48-0.78; $P < .001$), surgeons in the West (aOR, 0.63; 95% CI, 0.50-0.79; $P < .001$), and recent graduates relative to those who graduated 11 to 20 years ago (aOR, 1.66; 95% CI, 1.25-2.21; $P < .001$), 21 to 30 years ago (aOR, 1.83; 95% CI, 1.38-2.42; $P < .001$), or 31 years ago or longer (aOR, 1.43; 95% CI, 1.08-1.90; $P = .013$), were less likely to practice rurally.

CONCLUSIONS AND RELEVANCE This cross-sectional study between 2012 and 2022 identified higher proportions of rural patients compared with rural surgeons. Percentages of rural surgeons declined over time, with female surgeons and recent medical school graduates less likely to practice rurally. This suggests a disparity in the number of rural subspecialist surgeons available to serve rural patients.

Invited Commentary

Supplemental content

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Over 90 million Americans older than 40 years have vision problems.[1] As the US population continues to expand and age, the demand for ophthalmic care is expected to rise.[2,3] The most commonly performed ophthalmic surgery in the US is cataract removal, typically considered a general ophthalmology procedure.[4] However, a growing aging population demands an increase in the number of subspecialty-specific ophthalmic surgeries performed as well.[5] Yet, access to these interventions hinges on the accessibility of subspecialist ophthalmic surgeons, which may vary with location.

Physician density is higher in metropolitan counties than in rural counties,[6] with a growing urban-rural gap among primary care physicians.[7] Additionally, general surgeons in rural communities have been shown to perform specialized procedures more frequently than their urban counterparts due to shortages of rural surgical specialists.[8] Among ophthalmologists, there is a larger workforce density in metropolitan and nonmetropolitan counties compared with rural counties.[9] Previous research shows that as the proportion of a county's urban residents increases, the density of ophthalmologists increases,[10] highlighting the scarcity of rural ophthalmologists. It has been established that limited access to ophthalmic care generates negative outcomes among rural or patients in underserved communities, including increased prevalence of visual impairment, diabetic retinopathy, and macular degeneration.[11-14] As such, it is crucial that there is a rural ophthalmic subspecialist workforce available to meet rural patients' ophthalmic needs.

While there are known distribution discrepancies in the physician and general ophthalmologist workforce,[15] the geographic distribution of ophthalmic surgical subspecialists has not been elucidated. Furthermore, rurality practice patterns of ophthalmic surgical subspecialists have not been analyzed over time, limiting insight on trends in the rural ophthalmic subspecialist-surgeon workforce.[16] In this study, we aimed to determine the geographic and urban-rural distribution of ophthalmic surgical subspecialists, including cornea, glaucoma, oculoplastic, retina, and strabismus specialists, across the US and assess surgeon characteristics associated with rural practice from 2012 to 2022.

Key Points

Question What is the geographic distribution of ophthalmic surgical subspecialist surgeons in the US and what surgeon demographics are associated with rural practice?

Findings This cross-sectional study between 2012 and 2022 identified higher proportions of rural patients compared with rural surgeons. The percentage of rural surgeons declined over time; furthermore, female surgeons and more recent medical school graduates were less likely to practice rurally.

Meaning These results suggest that the rural US faces increasing ophthalmic subspecialty surgeon shortages.

Methods

Study Population

We conducted a retrospective, cross-sectional analysis using 100% Medicare Fee-For-Service claims data for traditional Medicare obtained from the US Centers for Medicare and Medicaid Services virtual research data center. For this reason, informed consent was not needed. This study received approval from the institutional review board of the Johns Hopkins University School of Medicine and adhered to the principles of the Declaration of Helsinki. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

We identified patients 65 years or older who underwent a subspecialized ophthalmic surgery between January 1, 2012, and December 31, 2022, using *Current Procedural Terminology* codes (eTable 1 in the Supplement). Our criteria to define ophthalmic subspecialists, based on Cai et al,[17] incorporated procedural minimums from the Accreditation Council for Graduate Medical Education, fellowship training requirements, credentialing guidelines, and expert consensus to construct a list of subspecialty-specific operations. A surgeon's subspecialty was defined via *Current Procedural Terminology* code if they performed at least 1 of the following subspecialty operations: cornea (corneal transplant), glaucoma (trabeculectomy, aqueous shunt implant), oculoplastic (lacrimal gland procedure, enucleation, exenteration, orbitotomy, ocular implant procedure), retina (repair of retinal detachment, pars plana vitrectomy), or strabismus (strabismus surgery). Surgeons who performed procedures across multiple subspecialties were defined based on the plurality of procedures performed.

For surgeons performing equal numbers of operations across more than 1 subspecialty domain (n = 233), we reviewed practice website information and virtual physician profiles to determine if they held a fellowship[17]; based on this method, 30 surgeons were sorted into cornea (12.9%), 9 into glaucoma (3.9%), 1 into oculoplastic (0.4%), 8 into retina (3.4%), and 7 into strabismus (3.0%). The remaining surgeons were determined to be general ophthalmologists, and thus were excluded from the data. Patients were excluded from the study population if they were younger than 65 years and/or did not have demographic information (eFigure 1 in Supplement 1).

Outcomes: Surgeon and Patient Characteristics

Each procedural claim was linked to a National Provider Identifier to extract surgeon characteristics from the Medicare Data on Provider Practice and Specialty and Physician Compare National Downloadable file. Characteristics collected were sex (male, female, unknown), census region (Midwest, Northeast, South, West, other, or unknown), rurality (urban, rural, not available), and years since medical school graduation (0 to 10, 11 to 20, 21 to 30, 31 or more, or unknown). We defined an urban area of practice as a metropolitan or micropolitan core-based statistical area (CBSA) and a rural area of practice as a non-CBSA. The CBSA or non-CBSA that contained the most line items for that surgeon was used to identify the census region and rurality of practice for that surgeon. Years since graduation were calculated from graduation until the last operation in the study period.

Table 1. Ophthalmic Surgeon Characteristics By Subspecialty Type Between 2012 and 2022

Characteristic	No. (%)					P value
	Cornea (n = 2540)	Glaucoma (n = 3676)	Oculoplastic (n = 1951)	Retina (n = 4123)	Strabismus (n = 1236)	
Surgeon sex						
Male	1791 (70.51)	2659 (72.33)	1384 (70.94)	3276 (79.46)	713 (57.69)	
Female	639 (25.16)	888 (24.16)	531 (27.22)	669 (16.23)	508 (41.10)	
Unknown	110 (4.33)	129 (3.51)	36 (1.85)	178 (4.32)	5 (1.21)	<.001
Difference between male-female, % (95% CI)	45.35 (41.39-49.31)	48.17 (44.88-51.46)	43.72 (39.25-48.19)	63.23 (60.11-66.35)	16.59 (10.90-22.19)	
Census region of practice location						
Midwest	477 (18.78)	691 (18.80)	355 (18.20)	753 (18.26)	282 (22.82)	
Northeast	518 (20.39)	806 (21.93)	368 (18.86)	889 (21.56)	250 (20.23)	
South	857 (33.74)	1171 (31.86)	690 (35.37)	1349 (32.72)	417 (33.74)	
West	567 (22.32)	846 (23.01)	490 (25.12)	915 (22.19)	265 (21.44)	<.001
Other or unknown	121 (4.76)	162 (4.41)	48 (2.46)	217 (5.26)	22 (1.78)	
Difference across regions, % (95% CI)	28.89 (25.50-32.46)	27.45 (24.16-30.74)	32.91 (28.95-36.87)	27.46 (24.17-30.75)	21.04 (17.63-24.45)	
Rurality of practice location						
Urban	2319 (91.30)	3270 (88.96)	1780 (91.24)	3745 (90.83)	1169 (94.58)	
Rural	110 (4.33)	277 (7.54)	135 (6.92)	200 (4.85)	52 (4.21)	
NA	111 (4.37)	129 (3.51)	36 (1.85)	178 (4.32)	15 (1.21)	<.001
Difference between urban-rural, % (95% CI)	86.97 (82.9-90.95)	81.42 (78.13-84.71)	84.32 (79.85-88.79)	85.98 (82.86-89.10)	90.37 (84.77-95.97)	
Years since medical school graduation						
0-10	545 (21.46)	588 (16.00)	278 (14.25)	679 (16.47)	132 (10.68)	
11-20	678 (26.69)	712 (19.37)	468 (23.99)	1038 (25.18)	253 (20.47)	
21-30	488 (19.21)	740 (20.13)	392 (20.09)	868 (21.05)	251 (20.31)	
≥31	551 (21.69)	1037 (28.21)	476 (24.40)	1004 (24.35)	328 (26.54)	<.001
Unknown	278 (10.94)	599 (16.29)	337 (17.27)	534 (12.95)	272 (22.01)	
Difference among years, % (95% CI)	7.48 (5.62-9.34)	12.21 (9.43-15.00)	10.15 (7.93-12.37)	8.88 (7.01-10.7%)	15.86 (12.77-18.95)	

Abbreviation: NA, not available.

The Medicare Master Beneficiary Summary File was used to extract patient characteristics per claim, including age (65 to 74 years, 75 to 84 years, 85 years or older), sex (male, female), race and ethnicity (White, Black, Hispanic, Asian, other or unknown, North American native), census region of zip code (Midwest, Northeast, South, West, other, or unknown), Charlson Comorbidity Index (0, 1 to 6, or 7 or more), zip code rurality (urban, rural), and zip code median income ($0 to 45 999, $46 000 to 60 999, $61 000 to 81 999, $82 000 or more, or unknown). To determine Charlson Comorbidity Index, we reviewed patients' inpatient, outpatient, and carrier claims up to 1 year before their procedure. At least 1 diagnosis from inpatient claims or at least 2 diagnoses recorded more than 30 days apart from outpatient and carrier claims was required for comorbidity.[18]

Statistical Analysis

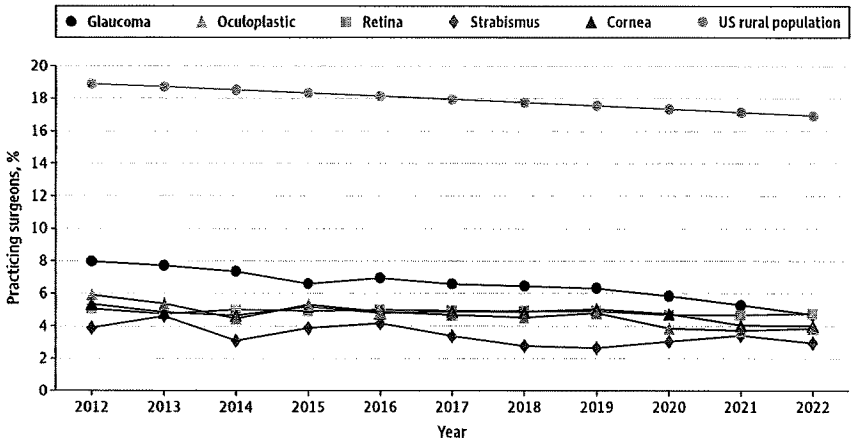
Continuous variables were presented as mean with SD or median with IQR. Categorical data were expressed as numbers and percentages. Two-sample *t* tests were used to compare continuous variables, while Pearson χ^2 tests were used for comparing categorical variables. Cochran-Mantel-Haenszel test was used to evaluate trends in surgeon data over time. Multivariable logistic regression model, adjusted for surgeon sex, census region of practice, years since medical school graduation, and surgical volume by quartile, was used to evaluate surgeon characteristics associated with rural practice. The statistical analyses were executed using SAS Enterprise version 7.1 (SAS Institute). All *P* values were 2-sided but not adjusted for multiple analyses.

Results

Surgeon and Patient Demographics With Trends Over Time

Table 1 summarizes surgeon demographics by subspecialty type. There was a total of 2540 cornea, 3676 glaucoma, 1951 oculoplastic, 4123 retina, and 1236 strabismus surgical subspecialists in the US who performed subspecialty operations between 2012 and 2022 in the Medicare database. There was a difference in the number of operations performed between male and female surgeons, with male surgeons completing

Figure 1. Percentage of Subspecialist Surgeons Who Practice in Rural Areas by Year, 2012 to 2022



	Total surgeons, No.										
Subspecialty	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Cornea	1446	1494	1489	1466	1527	1514	1547	1573	1481	1465	1389
Glaucoma	2222	2167	2111	2081	2032	2024	1940	1884	1762	1783	1752
Oculoplastic	984	949	922	963	948	941	976	962	887	890	887
Retina	2491	2528	2566	2607	2634	2695	2728	2745	2746	2762	2802
Strabismus	672	696	683	675	699	685	691	718	626	644	631

Between 2012 and 2022, the percentage of surgeons practicing in rural settings declined, with cornea surgeons declining by 1.3% (95% CI, 0.9%-1.7%), glaucoma declining by 3.3% (95% CI, 2.6%-4.0%), oculoplastic declining by 2.1% (95% CI, 1.3%-2.9%), retina declining by 0.4% (95% CI, −0.2% to 1%), and strabismus declining by 1.0% (95% CI, 0.4%-1.6%) (Cochran-Mantel-Haenszel test; $P < .001$). This is occurring alongside a 2.0% decline in the US rural population (95% CI, 1.5%-2.4%), values for which were obtained from the World Bank Open DataBank.

more procedures than female surgeons across all subspecialties (cornea difference, 45.4%; 95% CI, 41.4%-49.3%; glaucoma difference, 48.2%; 95% CI, 44.9%-51.5%; oculoplastic difference, 43.7%; 95% CI, 39.3%-48.2%; retina difference, 63.2%; 95% CI, 60.1%-66.4%; and strabismus difference, 16.6%; 95% CI, 11.0%-22.2%) ($P < .001$). A higher proportion of ophthalmic subspecialist surgeons practiced in the South (857 cornea [33.7%], 1171 glaucoma [31.9%], 690 oculoplastic [35.4%], 1349 retina [32.7%], and 417 strabismus [33.7]) relative to other census regions ($P < .001$). The Midwest had the lowest proportion of cornea (477 [18.8%]), glaucoma (691 [18.8%]), oculoplastic (355 [18.2%]), and retina (753 [18.3%]) surgeons and the Northeast had the lowest proportion of strabismus surgeons (250 [20.2%]) ($P < .001$).

Across all surgical subspecialties, there was a difference in the number of surgeons practicing in urban settings compared with rural settings, with most surgeons practicing in urban settings compared with rural settings (cornea difference, 87.0%; 95% CI, 83.0%-91.0%; glaucoma difference, 81.4%; 95% CI, 78.1%-84.7%; oculoplastic difference, 84.3%; 95% CI, 79.9%-88.8%; retina difference, 86.0%; 95% CI, 82.9%-89.1%; and strabismus difference, 90.4%; 95% CI, 84.8%-96.0%) ($P < .001$). Between 2012 and 2022, the percentage of surgeons practicing in rural settings declined with cornea surgeons declining by 1.3% (95% CI, 0.9%-1.7%), glaucoma declining by 3.3% (95% CI, 2.6%-4.0%), oculoplastic declining by 2.1% (95% CI, 1.3%-2.9%), retina declining by 0.4% (95% CI, −0.2% to 1%), and strabismus declining by 1.0% (95% CI, 0.4%-1.6%). This is occurring alongside a 2.0% decline in the US rural population (95% CI, 1.5%-2.4%) (Figure 1) (eTable 2 in Supplement 1).

eTable 3 in Supplement 1 summarizes patient demographics by subspecialty surgery received. There was a difference between the number of patients residing in urban areas compared with rural areas across all subspecialties, with most patients who underwent subspecialty surgery residing in urban areas (cornea difference, 63.7%; 95% CI, 63.2%-64.1%; glaucoma difference, 69.2%; 95% CI, 68.8%-69.6%; oculoplastic difference, 73.8%; 95% CI, 73.1%-74.5%; retina difference, 60.6%; 95% CI, 60.5%-60.8%; strabismus difference, 65.1%; 95% CI, 64.3%-66.0%; combined 2 or more subspecialty surgeries difference, 68.0%; 95% CI, 65.2%-70.8%) ($P < .001$). eTable 4 in Supplement 1 shows the number of each subspecialty's rurally residing patients by year from 2012 to 2022.

Geographic and Rural Distribution of Ophthalmic Subspecialty Surgeons vs Patients

Figure 2 shows the geographic distribution of subspecialty surgeons per 10 000 patients by census region. The West had the highest number of surgeons per 10 000 patients for cornea (158) and glaucoma (156), while the Midwest and South had the lowest for cornea (102) and glaucoma (110), respectively. The West also led in oculoplastic surgeons per 10 000 patients (300) with the fewest in the South (196). The Northeast had the highest number of retina surgeons per 10 000 patients (54) and the South had the lowest (33). The Northeast also had the most strabismus surgeons per 10 000 patients (332), with the South having the least (208).

Across all subspecialties, a greater proportion of patients resided rurally (cornea, 18.2%; glaucoma, 15.4%; oculoplastic, 13.1%; retina, 19.7%; strabismus, 16.0%) compared with the proportion of rurally practicing surgeons (cornea, 4.3%; glaucoma, 7.5%; oculoplastic, 6.9%; retina, 4.9%; strabismus, 4.2%) ($P < .001$). The cornea patient-surgeon difference was 13.8% (95% CI, 13.2%-14.5%). The glaucoma patient-surgeon difference was 7.9% (95% CI, 7.3%-8.4%). The oculoplastic patient-

Figure 2. Number of Surgeons Per 10 000 Patients Per Subspecialty by US Census Region (Northeast, South, Midwest, West) Between 2012 and 2022

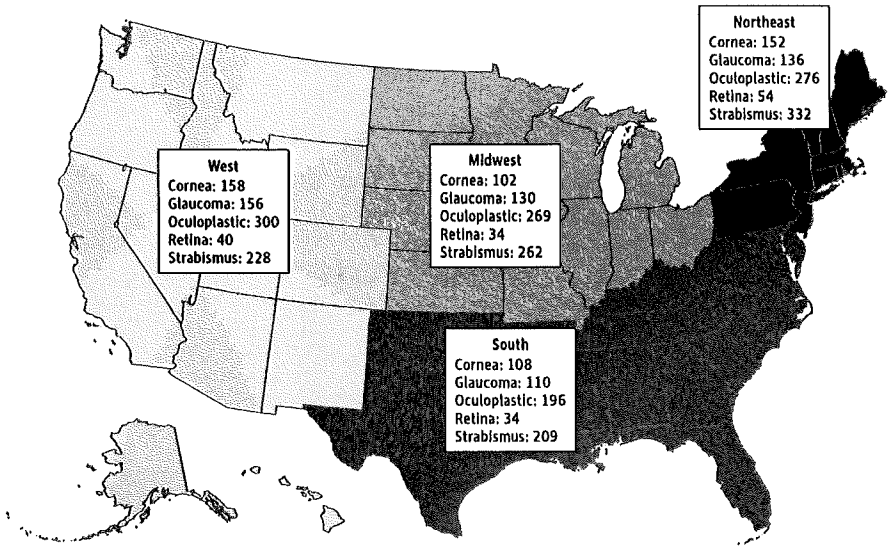
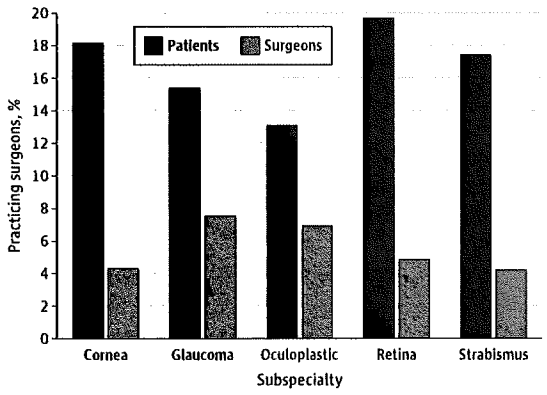


Figure 3. Percentage of Patients Undergoing Cornea, Glaucoma, Oculoplastic, Retina, and Strabismus Procedures and Surgeons Residing in Rural Areas



	Subspecialty				
	Cornea	Glaucoma	Oculoplastic	Retina	Strabismus
Patients	196496	274691	78117	1015231	49940
Surgeons	2540	3676	1951	4123	1236

The cornea patient-surgeon difference was 13.8% (95% CI, 13.2%-14.5%). The glaucoma patient-surgeon difference was 7.9% (95% CI, 7.3%-8.4%). The oculoplastic patient-surgeon difference was 6.2% (95% CI, 5.6%-6.8%). The retina patient-surgeon difference was 14.8% (95% CI, 14.2%-15.5%). The strabismus patient-surgeon difference was 13.2% (95% CI, 12.6%-13.9%).

surgeon difference was 6.2% (95% CI, 5.6%-6.8%). The retina patient-surgeon difference was 14.8% (95% CI, 14.2%-15.5%). The strabismus patient-surgeon difference was 13.2% (95% CI, 12.6%-13.9%) (**Figure 3**).

Characteristics of Surgeons Associated With Rural Practice

On multivariable analysis (**Table 2**), female surgeons were less likely to practice rurally (adjusted odds ratio [aOR], 0.634; 95% CI, 0.511-0.787; $P < .001$) than male surgeons. Surgeons practicing in the Midwest were more likely to practice rurally (aOR, 1.459; 95% CI, 1.195-1.780; $P < .001$) compared with the South, while surgeons practicing in the Northeast (aOR, 0.615; 95% CI, 0.482-0.783; $P < .001$) and the West (aOR, 0.627; 95% CI, 0.497-0.792; $P < .001$) were less likely to practice rurally relative to the South. Cornea surgeons (aOR, 0.737; 95% CI, 0.545-0.988; $P < .05$), retina surgeons (aOR, 0.911; 95% CI, 0.692-1.200; $P = .51$), and strabismus surgeons (aOR, 0.665; 95% CI, 0.456-0.970; $P = .03$) were less likely to practice rurally, while glaucoma surgeons (aOR, 1.182; 95% CI, 0.923-1.513; $P = .18$) were more likely to practice rurally relative to oculoplastic surgeons. Compared with surgeons who recently graduated medical school (0 to 10 years ago), more experienced surgeons who graduated 11 to 20 years ago (aOR, 1.662; 95% CI, 1.253-2.205; $P < .001$), 21 to 30 years ago (aOR, 1.828; 95% CI, 1.380-2.421; $P < .001$), and 31 years ago or longer (aOR, 1.432; 95% CI, 1.079-1.902; $P < .05$) were more likely to practice rurally. Surgeons with higher surgical volume (2nd quartile: aOR, 0.633; 95% CI, 0.504-0.794; $P < .001$; 3rd quartile: aOR, 0.534; 95% CI, 0.425-0.671; $P < .001$; 4th quartile: aOR, 0.465; 95% CI, 0.364-0.593; $P < .001$) were less likely to practice rurally than surgeons with the lowest quartile surgical volume.

Discussion

While the broad geographic practice patterns of ophthalmologists are well researched, the rural distribution of subspecialists, like cornea, glaucoma, oculoplastic, retina, and strabismus surgeons, to our knowledge, has not been studied previously. Existing literature focuses on individual practices[19] or compares general ophthalmologists to subspecialists.[17,20]

Table 2. Multivariable Analysis Assessing Ophthalmologist Characteristics Associated With Practicing in a Rural Area From 2012 to 2022 in the US Centers for Medicare and Medicaid Database

Characteristic	Unadjusted odds		Adjusted odds	
	Odds ratio (95% CI)	*P* value	Odds ratio (95% CI)	*P* value
Surgeon sex				
Male	Reference	NA	Reference	NA
Female	0.616 (0.501-0.758)	<.001	0.634 (0.511-0.787)	<.001
Census region of practice location				
Midwest	1.435 (1.178-1.748)	<.001	1.459 (1.195-1.780)	<.001
Northeast	0.623 (0.490-0.792)	<.001	0.615 (0.482-0.783)	<.001
South	Reference	NA	Reference	NA
West	0.644 (0.511-0.812)	<.001	0.627 (0.497-0.792)	<.001
Subspecialty				
Cornea	0.622 (0.467-0.828)	.001	0.737 (0.549-0.988)	.04
Glaucoma	1.063 (0.834-1.354)	.62	1.182 (0.923-1.513)	.18
Oculoplastic	Reference	NA	Reference	NA
Retina	0.744 (0.580-0.955)	.02	0.911 (0.692-1.200)	.51
Strabismus	0.610 (0.420-0.886)	.01	0.665 (0.456-0.970)	.03
Other/none	1.900 (1.118-3.230)	.02	1.397 (0.812-2.402)	.23
Years since medical school graduation				
0-10	Reference	NA	Reference	NA
11-20	1.478 (1.120-1.950)	.01	1.662 (1.253-2.205)	<.001
21-30	1.827 (1.388-2.405)	<.001	1.828 (1.380-2.421)	<.001
≥31	1.474 (1.121-1.938)	.01	1.432 (1.079-1.902)	.01
Surgeon's volume (surgeries), quartile				
1st	Reference	NA	Reference	NA
2nd	0.594 (0.476-0.740)	<.001	0.633 (0.504-0.794)	<.001
3rd	0.515 (0.413-0.643)	<.001	0.534 (0.425-0.671)	<.001
4th	0.515 (0.415-0.640)	<.001	0.465 (0.364-0.593)	<.001

Abbreviation: NA, not applicable.

Given that fewer eye care professionals have been linked to an increase in visual impairment prevalence,[12,13] our study provides evidence to suggest that there are fewer rural ophthalmic surgical subspecialists available. Furthermore, these data suggest that there has been a decline in the percentage of rural subspecialists over time. Our study reveals regional variations in subspecialty distribution, with characteristics like being female, practicing in the Northeast or West, being a recent graduate, and having a higher patient volume being less associated with practicing in rural settings. Notably, these findings do not determine if clinically relevant outcomes of care within these subspecialties have declined.

Data on the number of ophthalmic surgical subspecialists within the US per year vary: between 338 and 840 cornea surgeons,[17,20] 378 and 457 glaucoma surgeons,[17,20] 329 and 1238 oculoplastic surgeons,[17,20-22] 1084 and 2591 retina surgeons,[17,20,23] and 382 and 1056 strabismus surgeons.[20,24,25] More ophthalmology residents are matching into a subspecialty fellowship program, with 73.7% of applicants accepted into fellowship programs between 2010 and 2017.[26] Moreover, general ophthalmologists may gain experience in various subspecialist-specific procedures, via Accreditation Council for Graduate Medical Education residency graduation requirements. This enables general ophthalmologists to perform subspecialized operations, potentially increasing rural care availability. Our methodology for defining subspecialists based on procedures performed accounts for potentially broader availability of care than indicated by solely examining fellowship.

Patients were more likely than surgeons to be located rurally. Furthermore, we observed that between 2012 and 2022, there was a decline in the percentage of ophthalmic subspecialist surgeons practicing in rural areas. Previous work showed that between 1995 and 2017, the density of ophthalmologists decreased from 6.3 to 5.68 ophthalmologists per 100 000 individuals, with rural counties exhibited the lower mean density (0.58 ophthalmologists per 100 000 individuals).[9] These findings collectively underscore a potential concern regarding an increasing burden for rural subspecialists.

Our results suggest that 18.2% of patients undergoing cornea transplants are rurally located. Previous research indicated that only 3.5% of transplants occur in a rural area,[27] suggesting that many rural patients do not receive care locally. As of 2016, 90% of contiguous US Medicare beneficiaries resided within a 30-minute drive of an ophthalmologist.[28] However, this includes both general and subspecialized ophthalmologists. Our findings suggest that there is a disparity in ophthalmic subspecialist surgeon availability between rural and urban areas; this may be concerning for older rural patients, who may face impairments hindering their ability to drive to a subspecialist surgeon. Alternative transportation

modes, such as buses or shuttles, also may not be readily available in rural settings.

Our results also suggested that the census region—Northeast, South, Midwest, or West—exhibiting the most surgeons per 10 000 patients was subspecialty dependent. Retina specialists preferentially practice in the Mid-Atlantic and Pacific subregions[23]; our analysis corroborated this, revealing the most retina surgeons per 10 000 patients in the Northeast and the West. Regarding oculoplastic surgeons, we observed more surgeons per 10 000 patients in the West and Northeast. This aligns with findings showing Los Angeles county and New York county having the most oculoplastic surgeons.[22] Trabeculectomies, performed by glaucoma specialists, are preferentially performed in the Northeast[29]; our results indicated that the West and the Northeast possess the most surgeons per 10 000 patients. In 2021, 89% of US counties lacked an oculoplastic surgeon[22]; in 2023, 90% of counties did not have a pediatric/strabismus ophthalmologist.[25] This underscores geographic disparities in the distribution of subspecialist surgeons, even within census regions.

We found that female ophthalmic surgeons were less likely to practice in rural areas, a trend also noted by Webb et al[27] for female cornea surgeons. The preference for urban settings may stem from lifestyle factors or a lack of female mentors in rural areas, discouraging recent female graduates from practicing there.[30] Additionally, we discovered that rural subspecialist surgeons were less likely to practice in the West and Northeast, indicating that rural residents within these regions may face less access. Our findings also revealed that newer medical school graduates (0 to 10 years out) were less likely to practice rurally than more experienced surgeons. This aligns with the decreasing percentage of medical students who are interested in rural practice[31] but may be troubling for the ophthalmic subspecialist workforce considering the projected increase in demand for rural physicians.[15] Understanding the demographics of subspecialist surgeons who choose to practice in rural areas may help develop incentives for rural practice. This could include financial compensation, debt forgiveness, research stipends, predefined service obligations, and enhanced work-life balance.[32]

Strengths and Limitations

A strength of our study is that it is large and nationally representative, due to Medicare data. In 2023, approximately 65 million Americans were enrolled in Medicare,[33] with 94% of Americans aged 65 years or older enrolled in Medicare.[34] Another strength is that we included multiple ophthalmic surgeries as subspecialized practice markers.

Limitations include that the Medicare Fee-For-Service dataset used in our analysis does not encompass data from Medicare Advantage insurance plans, which accounted for 51% of patients in 2023.[33] We did not include these plans due to lack of associated surgeon data. Therefore, the surgeons analyzed in this study were only those participating in traditional Medicare, and thus, may not be representative of the total subspecialty surgeon workforce. Our findings are also in Medicare patients 65 years or older, and thus, may not be generalizable to younger patients possessing commercial insurance plans; this may be particularly relevant to pediatric strabismus patients. Additionally, our study defined a subspecialist as a surgeon who has performed a subspecialist-specific procedure; this means that a subspecialist may not be fellowship-trained, and therefore, may perform more general ophthalmology procedures than subspecialty-specific procedures. Furthermore, while this work characterized the urban-rural subspecialist workforce discrepancy, we did not directly quantify rural patient access to subspecialist care through specific measurements, such as driving distance. Lastly, these findings do not necessarily determine if clinically relevant outcomes of care within these subspecialities have declined in rural settings, with evidence being mixed as to whether increased medical specialist presence leads to improved care.[12,13,35,36]

Conclusions

In summary, our work suggests a concerning geographic disparity in rural ophthalmic surgeons available to serve the needs of rural patients across cornea, glaucoma, oculoplastic, retina, and strabismus subspecialties. Despite a decrease in both the rural US population and the proportion of rural subspecialty surgeons over time, we discovered that rural patients still disproportionately outnumber rural surgeons. We also identified factors associated with a lower likelihood of practicing in rural areas, including being female, practicing in the Northeast and the West, being recently graduated, and having a high patient volume. While our findings underscore the potentially pressing issue of a dwindling rural ophthalmic subspecialist workforce, this study may also inform policy interventions aimed at increasing access to ophthalmic subspecialist surgeons and incentivizing rural practice among ophthalmic subspecialist surgeons.

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