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ORIGINAL RESEARCH

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Analysis of socioeconomic factors in laryngology clinic utilization for treatment of dysphonia

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Abstract

Objective: To evaluate the association between patient socioeconomic and demographic factors and tertiary care utilization for dysphonia in a localized metropolitan area of the American Midwest.

Methods: Multivariate regression analysis was used to correlate patient demographics and population level data (e.g., age, gender, race, insurance, median income, education level) with tertiary laryngology utilization for dysphonia care at our institution between 2000 and 2019. Initial analyses characterized tertiary laryngology utilization rates for all regional ZIP codes and correlated these data with census information for household income and education. Dysphonia patient demographics were compared among populations cared for in our entire academic Otolaryngology department, our health system, and the regional population.

Results: Among 1,365,021 patients in our health system, there were 7066 tertiary laryngology visits with a diagnosis of dysphonia. Dysphonia patients as compared to the overall health system were older (62.0 vs. 50.8 years), more likely to be female (63.7 vs. 50.2%) and more likely to have insurance (98.4 vs. 87.5%, all $p < .001$). Patient and population-level factors including insurance status, education, and black race showed positive correlation with laryngology utilization while median income did not.

Conclusions and Relevance: Insurance status, education level, and race correlated with utilization of tertiary laryngology services for the evaluation of dysphonia in our community, while median income did not. Black patients utilized tertiary laryngology care at higher rates compared to departmental and regional population utilization data. These results underscore important demographic and disease-specific factors that may affect utilization of subspecialty care in Otolaryngology.

Level of Evidence: IV

Shane W. White and Jonathan M. Bock should be considered as joint first authors for this work.

KEYWORDS
disparity, dysphonia, laryngology, social determinants, utilization

1 | INTRODUCTION

Dysphonia is an impairment of vocal production which affects nearly one-third of the population of the United States during their lifetime.[1] Rates have been shown to increase in women, the elderly, and those in professions which demand frequent vocal overuse.[2,3] The annual cost of treatment for this condition has been estimated to be 11.9–13.4 billion dollars, which is roughly two-thirds the annual cost of asthma treatment.[4] Beyond cost, dysphonia is associated with overall decreased quality of life, increased depression and anxiety, and decreased work productivity comparable to that of asthma, depression, and COPD.[2,5,6] Finally, dysphonia may be a heralding symptom of underlying diseases, including head and neck cancers. In this population, delays in evaluation may result in higher cancer staging upon diagnosis, resulting in a treatment plan with increased morbidity and lower survival rates.[7] As such, access to quality laryngology care has significant medical and socioeconomic implications.

Recent studies have revealed disparities in the diagnosis and treatment of multiple otolaryngologic conditions.[8–12] However, little data currently exist regarding health care utilization disparities in dysphonia care, with only a single prior published study examining disparities related to this disease process. Hur et al. found that individuals with public health insurance, low income, or members of a racial minority were less likely to seek care for voice problems for a variety of reasons.[13] We hypothesized that socioeconomic factors could have significant effects on disease-specific delivery of care within our network. The aim of this current study is to confirm prior disparity assessments and identify new care utilization correlates by examining the association between known socioeconomic determinants of health—specifically income, insurance status, race, and education—and laryngology clinic utilization for dysphonia. It is for this purpose that we have developed the OTO Clinomics database, a department-wide data mining tool specifically designed for acquiring and measuring clinical parameters and their associations with socioeconomic and demographic factors of otolaryngology patients. The OTO Clinomics platform also utilizes population-level data from southeast Wisconsin to identify disparities in local healthcare utilization patterns for specific otolaryngologic disease states.

2 | MATERIALS AND METHODS

The processes used in this study have been approved by our Children's Hospital system IRB (PRO 1538127) with reliance agreements by the academic center, adult hospital, and regional state university. The Froedtert and Medical College health system is the only academic medical center serving Southeastern (SE) Wisconsin. Then, 1.3 million individual patient records are contained in the health system electronic record for the data evaluation period of 2000–2019. The Clinical and Translational Science Institute of Southeast Wisconsin (UL1TR001436) provides monthly mirroring of the entire electronic medical record through the Clinical Research Data Warehouse (CRDW) and uploads this to a JupyterHub allowing for data queries.

2.1 | Patient demographics

Selected ICD codes used to extract patients seen in our laryngology clinic for dysphonia care via the JupyterHub included the following: ICD10: R49.0, J38, R49.8, R49.9 D14.1, J38.1, and ICD9: 784.42, 478.5, 212.1, and 478.4. These codes were cross-correlated with the two fellowship-trained laryngologists who were primary providers for dysphonia during the study period. Demographic variables extracted included encounter diagnosis, provider, encounter date (shifted for privacy), age, race, ZIP code of primary residence, and insurance status at, or nearest to, the date of encounter. If a patient had another appointment near to the laryngology assessment, their insurance may not have been entered and we thus used the most proximal entry of insurance as most likely status. We included patients from across the entire state of Wisconsin in this analysis with specific attention toward the eight counties comprising Southeast Wisconsin (Milwaukee, Waukesha, Washington, Ozaukee, Jefferson, Walworth, Racine, and Kenosha). We also examined the highest utilization area surrounding the medical center, largely Milwaukee and Waukesha counties.

Comparison group data were generated in a similar fashion for all patients seen in our otolaryngology clinic, a subset of patients with chronic rhinosinusitis (CRS), our entire health system, and all of SE Wisconsin. Patients with CRS were used as a comparator as this is a prevalent condition with no known racial or ethnic susceptibility. We defined the overall laryngology utilization rate as the total number of patients seen with dysphonia from each local ZIP code during the study period divided by each ZIP code's population as found in the 2014 US Census Bureau American Community Survey statistics.

2.2 | Regional demographic and socioeconomic data

Here, 2010–2014 US Census Bureau data allowed us to assess population-level socioeconomic characteristics (median income, education, and insurance rate) by ZIP code for adult residents of the 126 ZIP codes of SE Wisconsin. ZIP codes were stratified by median

TABLE 1 Comparison of adult patient characteristics among those utilizing laryngology services for evaluation of dysphonia, Meniere's disease, and rhinology services compared to the Otolaryngology clinic, the Froedtert Health Network, and Southeast Wisconsin as a whole

	ALL ENT ($n = 95,559$)	Dysphonia ($n = 7066$)	Meniere's disease ($n = 1091$)	Rhinology ($n = 8325$)	Froedtert Health ($n = 1,365,021$)	SE Wisconsin ($n = 2,083,474$)
Age, median (years)	58.8	62	65	58.9	50.8	47.1
Women, % (no.)	52.9 (50,597)	63.7 (4499)	55.8 (609)	57.6 (4799)	50.2 (685,240)	50.7 (1,056,113)
Race, % (no.)						
White	80.9 (77,330)	79.7 (5635)	92.0 (1004)	85.0 (7079)	72.0 (982,471)	77.9 (1,622,691)
Black	12.0 (11,478)	14.9 (1053)	2.7 (29)	9.3 (778)	15.6 (213,399)	13.8 (288,362)
Asian	1.7 (1603)	1.1 (75)	0.5 (5)	1.3 (109)	2.2 (29,474)	2.4 (49,721)
Other	3.2 (3021)	2.6 (185)	1.6 (17)	2.5 (205)	6.0 (82,403)	4.3 (89,264)
Unknown	2.2 (2127)	1.7 (118)	3.3 (36)	1.8 (154)	0.7 (9751)	1.6 (33,436)
Insurance, % (no.)						
Private	52.0 (49,647)	47.7 (3368)	57.1 (623)	60.0 (4994)	49.8 (680,346)	56.1 (1,169,000)
Public	44.9 (42,872)	50.2 (3545)	40.8 (445)	38.1 (3168)	36.5 (497,872)	30.9 (643,000)
Other	0.8 (792)	0.6 (42)	0.5 (5)	0.9 (75)	1.2 (16,357)	3.6 (74,000)
Self-pay	1.3 (1201)	0.5 (34)	0.3 (3)	0.6 (54)	3.8 (52,065)	7.5 (157,000)
No insurance record	1.1 (1038)	1.1 (77)	1.4 (15)	0.4 (34)	8.7 (118,381)	

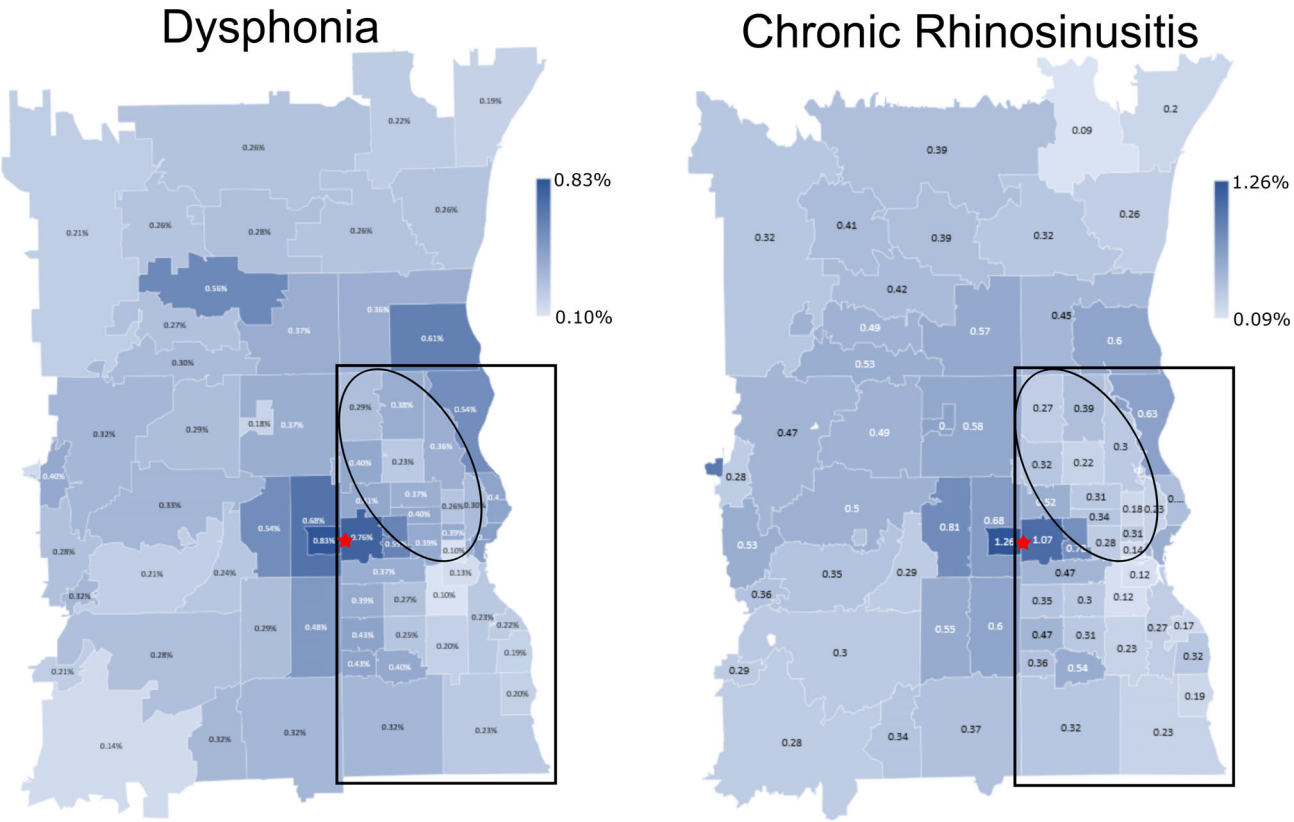

FIGURE 1 Geographic variation in tertiary laryngology clinic utilization rates for evaluation of dysphonia. Geographic heat map of Wisconsin ZIP codes showing rates of utilization within each ZIP code. The academic medical center is noted with the red star. The oval indicates the central city area of highest black population in Milwaukee County

income into bins of <$42,000; $42000–53,100; $53100–59,300; $59300–67,500; $67500–77,800; $77800–8700; and >$87,000. This income stratification strategy was used to allow direct comparisons to DATAUSA (datausa.io), a publicly accessible database compiling multiple government sources including the Census Bureau, the Bureau of Labor Statistics, and the Bureau of Economic Analysis.

TABLE 2 Comparison of laryngology utilization, race, insurance status, and education among income categories in SE Wisconsin; rate and 95% confidence intervals

Income categories	<$42 k	$42 k–$53.1 k	$53.1 k–59.3 k	$59.3 k–$67.5 k	$67.5 k–$77.8 k	$77.8 k–$87 k	>$87 k	p*
Utilization rate %	0.256 (0.176, 0.366)	0.259 (0.198, 0.377)	0.177 (0.033, 0.223)	0.21 (0.112, 0.248)	0.258 (0.208, 0.404)	0.262 (0.197, 0.327)	0.322 (0.275, 0.543)	<.001
White population %	0.368 (0.171, 0.602)	0.818 (0.643, 0.861)	0.924 (0.873, 0.947)	0.949 (0.887, 0.957)	0.947 (0.899, 0.961)	0.961 (0.948, 0.968)	0.95 (0.928, 0.964)	<.001
Private insurance %	30.527 (29.08, 33.92)	47.33 (40.48, 50.36)	53.006 (48.77, 55.69)	52.797 (50.88, 55.54)	58.942 (55.26, 61.16)	62.411 (60.04, 64.64)	63.754 (62.83, 66.44)	<.001
College educated %	18 (11.15, 23.75)	21.9 (21.0, 25.7)	22.4 (18.8, 28.1)	30.25 (22.53, 34.30)	31.85 (25.15, 41.7)	33 (30.2, 37.45)	50.5 (39.0, 59.5)	<.001

2.3 | Statistical analyses

Demographic data produced via query of the JupyterHub were compared directly by chi-square test (dysphonia vs. region, dysphonia vs. health system, dysphonia vs. department, dysphonia vs. other ENT diagnoses). Analysis of age between study groups was evaluated by independent two-group *t* test. The Kruskal–Wallis test was used to perform univariate analysis of laryngology utilization rates, race, insurance status, and education within stratified income categories. Data throughout are presented as median values with interquartile ranges. Statistical significance for individual analyses was defined as $p < .05$. The potential effects of race, income, education, and insurance status on laryngology utilization rate were evaluated via multivariate regression analyses ANOVA used to calculate *p*-values. Statistical evaluations were completed within the JupyterHub notebook using R language (3.6.1).

3 | RESULTS

Fellowship trained laryngologists at our institution diagnosed 7066 adult patients with dysphonia during the study period (Table 1). We found a significantly higher mean age of the dysphonic patient as compared to the region, health system, and department (62.0 vs. 47.1 vs. 50.8 vs. 58.8, $p < .001$). Women also made up a larger portion of our patients when compared to these same groups (63.7 vs. 50.7 vs. 50.2 vs. 52.9, $p < .001$).

Laryngology clinic utilization rates for dysphonia care per local ZIP code ranged from 0.10 to 0.83% (Figure 1). Of the 7066 patients seen in our clinic, the majority were either from Milwaukee County (45.46%) or Waukesha County (20.03%), the neighboring suburban county to the west. The surrounding Southeast Wisconsin region provided 83.92% of our patient population, while the state of Wisconsin made up 94.89% of our patient cohort. Overall utilization rates from inner city areas of Milwaukee were measurably higher for our laryngology services when compared to rhinology services for CRS at our institution. Our study revealed a smaller proportion of black patients seen for dysphonia when compared to our health system (14.9 vs. 15.6%, $p < .001$), though the black population was proportionally higher than that seen for other conditions in our department (14.9 vs. 12.0%, $p < .001$, highlighted by black oval in Figure 1).

We also compared the dysphonic population at our institution to that of CRS, another common clinical disorder in our clinic with no known racial predilection. We found a greater proportion of black patients in the dysphonia group than in the CRS cohort (14.9 vs. 9.3%, $p < .001$). When compared to the population of Southeast Wisconsin, the laryngology service saw a greater percentage of both white (79.7 vs. 77.9%, $p < .001$) and black patients (14.9 vs. 13.8%, $p < .001$), while non-white and non-black races were represented at a much lower rate (5.4 vs. 8.3%, $p < .001$).

There were similar rates of insured patients observed in the laryngology clinic when compared to the entire Otolaryngology department, though these rates were higher than the insurance rate in the

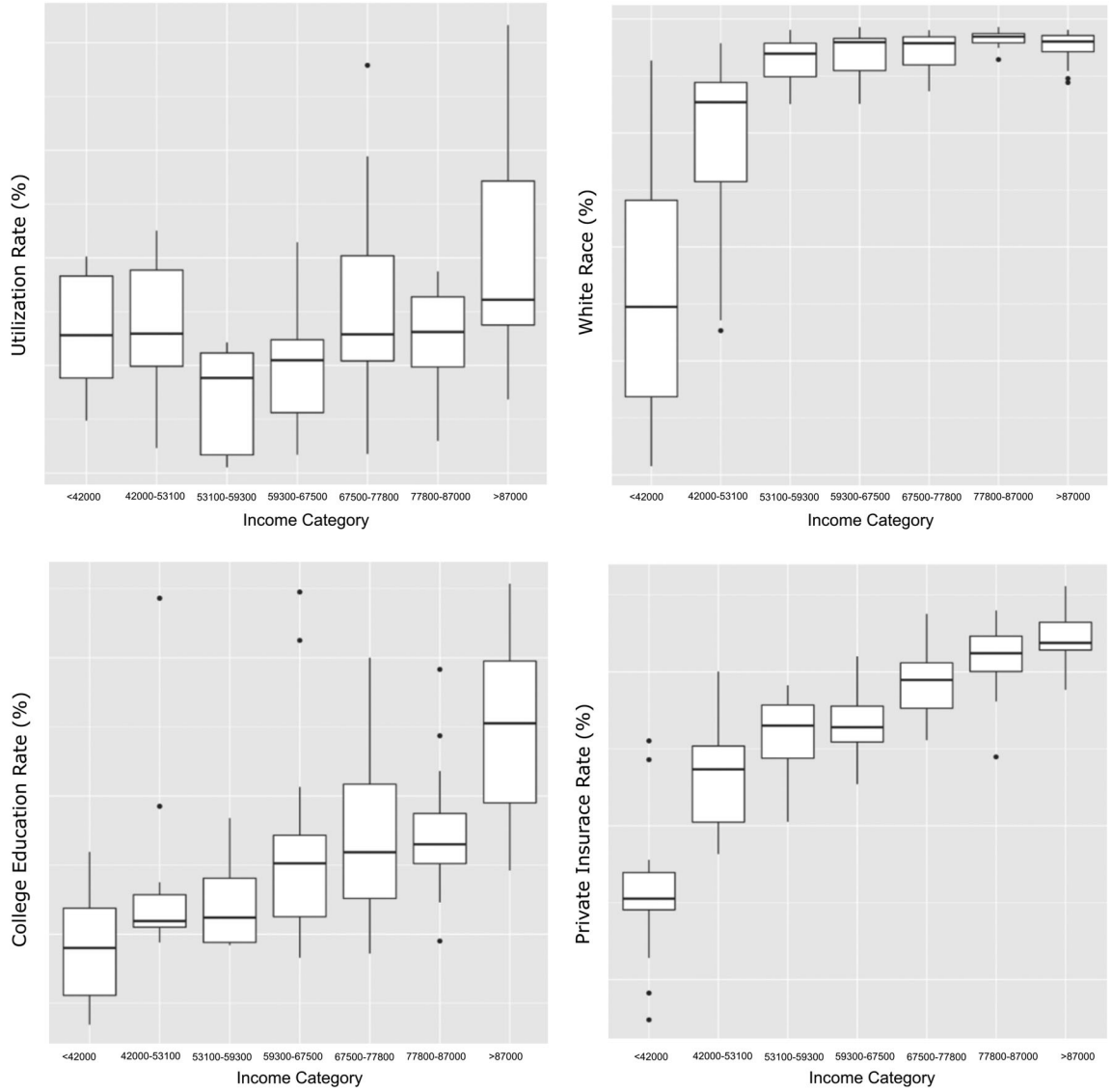

FIGURE 2 Comparison of laryngology clinic utilization, white race, insurance status, and education among income categories of the ZIP codes of southeast WI. White race, college education, and private insurance all demonstrated linear correlation with income, while laryngology clinic utilization showed minimal correlation. The middle line in each box represents the median value the box is between 25% lower bound and 75% upper bound. The vertical line is the 95% confidence interval. Dots represent ZIP codes with values that are outside the 95% confidence interval range

surrounding region and health system. Patients with dysphonia had a lower private insurance rate (47.7%) than either the health system (49.8%) or the surrounding region (56.1%). Likewise, a greater percentage of patients with dysphonia had public insurance (50.2%) when compared with the region (30.9%), hospital system (36.5%), and department (44.9%). Of the 3545 patients on public insurance, 2704 (76.28%) were on Medicare. Accordingly, the laryngology clinic saw a significantly lower percentage of self-pay or noninsured patients (1.6%) than either the health system (12.5%) or surrounding region (9.4%).

Laryngology clinic utilization was not correlated with median income using categorized income levels based on the ZIP code of residence (Table 2). White race, private insurance, and college education were positively correlated with median income within ZIP codes demonstrating the complex socioeconomic interactions among social determinants (Figure 2).

Income, college education, and insurance all had a significant impact on utilization based on linear regression analysis, though white race did not reach statistical significance (Figure 3). To control for the interaction among these variables, multivariate analysis was performed, showing college education, race, and insurance status as independently significant factors in clinic utilization in the dysphonic patient population. Median income, however, did not have significant independent correlation with utilization (Table 3). There was a 1.59% increase in laryngology utilization for each 1% increase in insurance rate. Both college education and white race had a lesser magnitude on utilization, with the latter was noted as having a negative correlation.

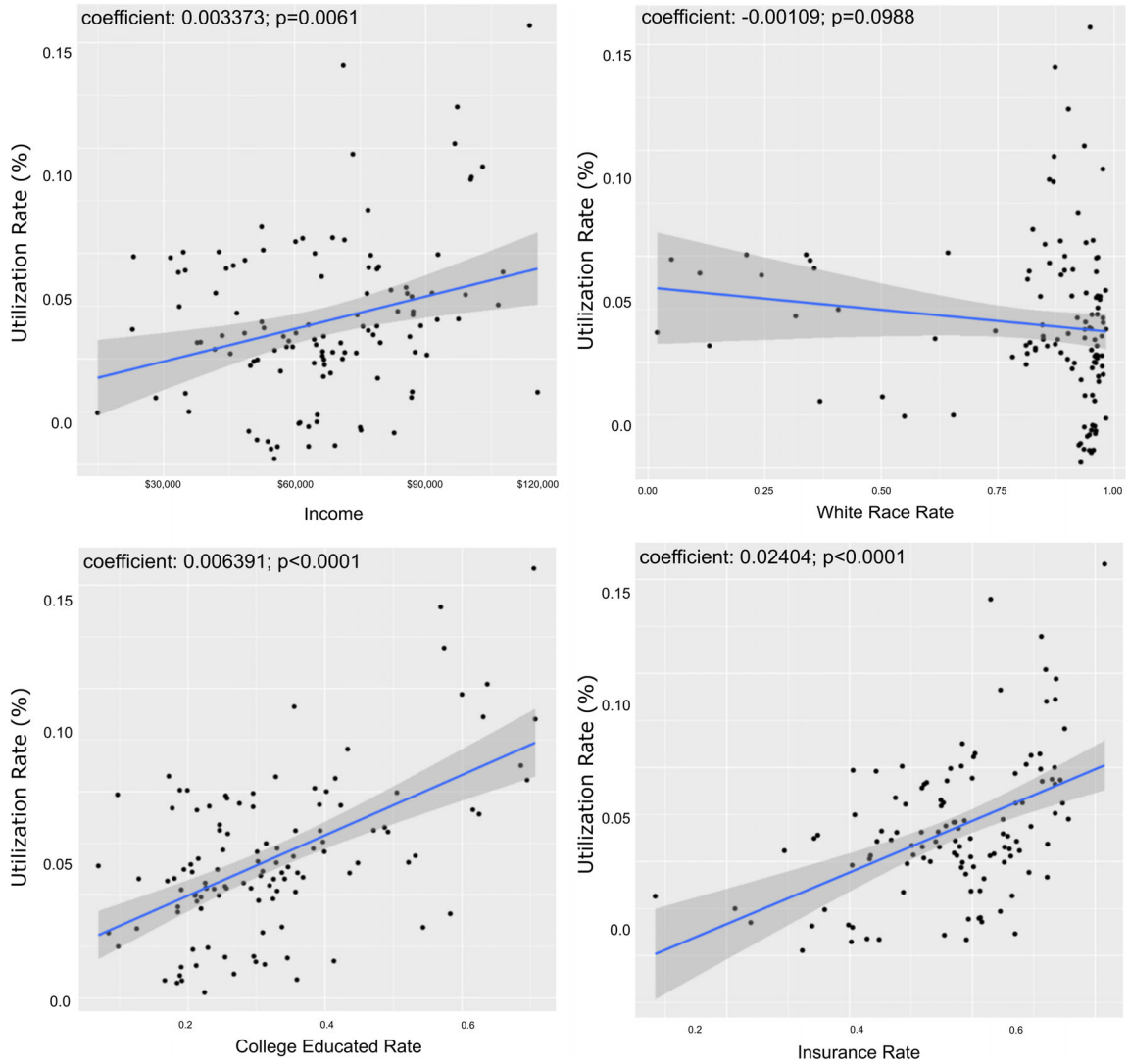

FIGURE 3 Results of linear regression modeling evaluating predictors of laryngology utilization in Southeast Wisconsin. Median income, education rate, and insurance rate all positively correlated with utilization rate. White race did not reach statistical significance in linear regression and was negatively associated with utilization rate in multiple regression analyses

TABLE 3 Multivariate regression analyses of predictors of utilization for dysphonia in SE Wisconsin

Variable	Coefficient	Standard error	Lower bound	Upper bound	*p*-Value
College educated %	0.005235	0.0009145	0.00344258	0.000702742	<.001
White %	−0.003299	0.0005914	−0.004458144	−0.002139856	<.001
Median income	9.687E-09	7.949E-09	−5.89304E-09	2.5267E-08	.226
Insured %	0.01586	0.003421	0.00915484	0.02256516	<.001

Note: For every 1% increase in college education rate in a given ZIP code, there is a 0.5235% increase in laryngology utilization. For every 1% increase in white proportion among the population, there is a 0.3299% *decrease* in laryngology utilization. For every 1% increase in insurance rate among the population, there is a 1.586% increase in laryngology utilization.

4 | DISCUSSION

This study evaluated disparities in health care utilization in a major metropolitan academic tertiary laryngology clinic in the upper Midwest. Healthcare disparities may be present due to a variety of socioeconomic determinants and can lead to unequal health outcomes for specific populations. We did not evaluate for differences in disease incidence between socioeconomic groups in this study although unique susceptibility to a disease can influence utilization rates. Hur et al., by comparison, examined disease burden disparities in addition

to health care disparities for voice conditions. Their study also used self-reported data obtained via survey, whereas our study utilized health records to collect data.[13]

As our study was conducted at an academic center, it is worth noting that generalized local physician referral patterns may alter which patients present for care at our facility. Many local general otolaryngologists successfully treat dysphonic patients, only referring to our services when the complexity of the disease process necessitates more advanced care. Patients may also rely on referral from primary care physicians for laryngology care. Many insurance providers even require such referrals for evaluation by a specialist, though some do allow for self-referral via directly calling advertised patient-facing scheduling resources.

Our tertiary care laryngology clinic saw significantly higher proportions of both the elderly and women than seen in our comparison groups. These findings are reflective of data in literature revealing a higher prevalence of dysphonia in these populations.[2,3,14–16] In the elderly, both presbylaryngis and dysphonia secondary to other disease processes have been suggested as the source of this higher incidence.[3,15] However, in the only two studies performed in which sociodemographic factors were controlled for using multivariate regression, no significant association between age and dysphonia has been observed.[13,17] In women, differences in laryngeal anatomy and phonatory physiology have been purported as the cause of this difference, though further studies on this topic are needed for better understanding.[2]

Our results did not reveal any significant racial barriers in access to care for evaluation of dysphonia. These findings differ from departmental utilization statistics as well as other subspecialty services such as rhinology. This difference between our laryngology and rhinology departmental results is highlighted in Figure 1, where the utilization rates from central Milwaukee County ZIP codes differ quite noticeably and show far greater laryngology clinic utilization rates compared to utilization rates of rhinology services in our clinic. A possible explanation for these findings lies in the difference of cigarette usage in the African American population when compared to the white population in Wisconsin. Recent data reveal a 25.5% prevalence of cigarette smoking in the Wisconsin black population compared to only 16.4% in whites.[18] General otolaryngologists and primary care physicians may have a lower threshold for referral to our service for voice concerns as malignancy may be higher in their differential due to tobacco usage. This study does demonstrate proportionally higher rates of laryngology clinic utilization among African Americans for dysphonia than other disorders in our tertiary clinic and supports increased attention toward awareness of dysphonia evaluation and preventive measures in this population. The underrepresentation of Asians and "other" races in our cohort is a disparity in need of further analysis. Available data from a nationwide Korean survey demonstrates a comparable prevalence of perceived dysphonia (6.9%) as that found in the American population (7.6%), indicating that racial predilection is an unlikely explanation for our findings.[16,19]

Patient income did not show statistically significant correlation with utilization of tertiary laryngology services in this study. However, upon closer examination of the data, there are some interesting observations to be made: First, those in the highest income brackets (>$87 k) had significantly higher utilization rates than any other income bracket. Second, the most disadvantaged groups when considering access to care were those with mid-level incomes ($53.1 k–$67.5 k). These findings closely mirror those seen in Hur et al.'s study which revealed that, when examining cost of care, those with income >400% of the poverty level had drastically easier access to care, while those at 200–300% of the poverty levels were affected most heavily by cost of care.[13] This likely speaks to the negative effects of the current health care insurance system on the variety of private coverage plan, including those that may require large copays that potentially inhibit patients from pursuing care.

Insurance rate had the largest impact on access to tertiary laryngology services for dysphonia. Interestingly, our study group consisted of a far higher rate of publicly insured and a far lower rate of self-pay than the surrounding population. In addition, our dysphonia group was publicly insured at a far higher rate than those seen in our clinic for rhinology services (50.2 vs. 38.1%, $p < .001$). These findings may indicate once more the deterrent of personal cost to dysphonia treatment access, or could be another testament to the effect of tobacco usage on our patient population, as poorer populations qualifying for public insurance have also been reported to have greater tobacco usage.[18] Most patients in this study with public insurance utilized Medicare and not Medicaid, which may potentially reflect more of an effect of age on dysphonia care compared to income.

There are some potential limitations to our study. Health record data extraction using our OTO Clinomics platform is dependent on the accuracy of data fields populated in the EHR. To account for this, we have performed manual data extractions on small sub-populations of patients in this database to confirm this accuracy. This type of research also assumes that correct diagnoses have been made by the treating physicians as well as correct concomitant coding of these diagnoses during the patient care encounter. The limitation to fellowship trained laryngologists should mitigate this issue. This study did not directly evaluate the prevalence of dysphonia in the studied populations and therefore no conclusions can be made directly from this study regarding socioeconomic differences in disease burden. Healthcare utilization analyses are also dependent on local insurance networks and public health coverage availability which can vary markedly across regions. Therefore, caution should be used in generalizing the findings from this study to other geographic areas.

5 | CONCLUSION

Utilization of tertiary laryngology services correlated with education, race and insurance status but not median income. We observed an increased utilization for dysphonia care in black adults and those with public insurance relative to the entire Otolaryngology clinic and other subspecialties in our department. These results, when considered alongside similar studies, highlight the roles that various social determinants and patient behaviors may play in utilization of tertiary laryngology care.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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