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ARTICLE

Uncovering Disparities in Vision Health in Rural vs Urban Areas: Is There a Difference?

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Abstract

Background: Blindness describes a condition in which patients have low vision, are legally blind, or totally blind. Disparities in vision health is a public health concern because it decreases quality of life and subsequently leads to a series of other health-related issues. These disparities exist across demographics, socioeconomic status, disease history, genetics, and geographic location, particularly in the urban vs. rural setting. Public health professionals need to shed light on these disparities to properly address them to ensure that individuals affected by blindness can receive proper care.

Objective: To investigate if there are discrepancies or inequalities in vision care in a rural setting vs. urban setting.

Methods: A multivariate binary logistic regression analysis using cross-sectional data from the Vision and Eye Health Surveillance System (VEHSS) was done using SAS Studio. Blindness, the outcome of interest, was defined as best-corrected visual acuity at less than 20/200 in the better-seeing eye. Each demographic subgroup was assessed in the counties included for upstate New York and downstate New York. Prevalence rates are expressed as a percent.

Results: The multivariate binary logistic regression analysis showed that non-Hispanic black individuals from upstate New York and downstate New York were most likely to be blind compared to white, non-Hispanic, any Hispanic, and other individuals. Factors that were significantly associated with blindness include the female gender, individuals aged 65 years and older, non-Hispanic black individuals, and those without Medicare. Residents from upstate New York had a slightly increased likelihood to develop blindness, 1.04 (1.01, 1.07), compared to residents in downstate New York.

Conclusions and Relevance: Blindness prevalence was highest in upstate New York, among non-Hispanic black individuals, the female gender, and individuals 65 years and older. Despite the blindness prevalence highest upstate, the difference was not clinically significant compared to downstate New York, despite a considerably larger number of resources present downstate compared to upstate. Given the severity of blindness as a public health concern, the discrepancies in eye care in urban vs. rural settings need to be investigated further.

I. Introduction

Health disparity (HD) is a health difference that adversely affects disadvantaged populations[1]. Marginalized populations may be disadvantaged towards a higher disease prevalence, disease risk factors, unhealthy conditions, an increased disease mortality rate, or combination of such factors[1]. Disparities in vision health is a serious public health concern as vision loss leads to a decreased quality of life[2] and possibly shortening an individual's life span due to an increased mortality rate[3].

Blindness is a comprehensive term that is used to describe the condition of patients with low vision, legal blindness, or total blindness[11]. Total blindness is defined as having no light perception (NLP)[11]. Legal blindness is classified as having visual acuity (VA) 20/200 or less in the better eye, or when the field of vision is less than 20 degrees[8]. Legal blindness is used to determine who is eligible to receive disability benefits, tax exemption programs, and rehabilitation training by the government[11].

The purpose of this article is to investigate the correlation between the prevalence of legal blindness and socioeconomic factors in upstate and downstate New York. Potential risk factors investigated in this study include age, race, ethnicity, median household income, educational level, health insurance and or availability of healthcare providers. Kings County, Brooklyn, NY, was chosen to represent downstate New York. Greater Rochester was chosen to represent upstate New York with a collection of nine counties. These counties include Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates.

Kings County has diverse ethnic groups (49.8% white alone, not Hispanic or Latino, 33.8% black or African American alone, 12.7% Asian, and 18.9% Hispanic or Latino)[9] and similar socioeconomics as in Greater Rochester. In addition, 44.9% of the households in Kings County, NY were reported to use language other than English as their primary language[10]. Due to the diversity of the county and the increased availability of health care, Kings County was selected as a representative county of downstate New York in this study. Greater Rochester had a similar income level and demographics to Kings County with the greatest diversity in Monroe County (76.8% white alone, not Hispanic or Latino, 16.2% black or African American alone, 3.7% Asian, and 9.2% Hispanic or Latino)[21]. **Figure** 1 shows the population estimates of both regions.

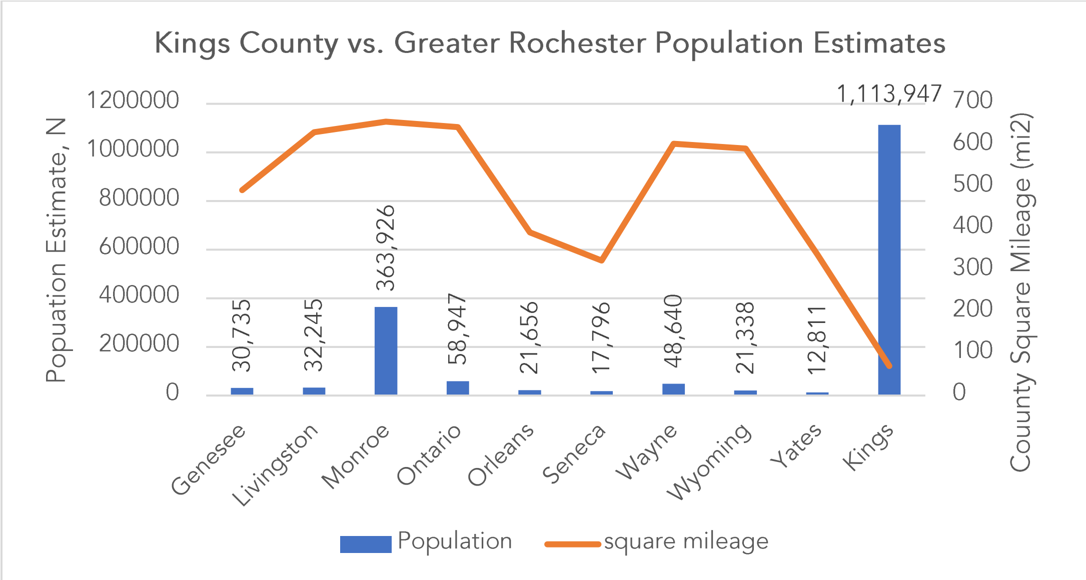

Figure 1. Greater Rochester vs. Kings County Pop

II. Objectives

The study was designed to see if there are any differences in blindness prevalence between upstate and downstate New York. Upon reviewing these differences, blindness treatment and evaluations should be reassessed to improve quality of care. Public health researchers and clinicians should evaluate if there are any implicit or explicit biases present that affects adequate care delivery. Upon evaluation of these biases, they can work to enhance quality of care and its access to disadvantaged populations. This will in turn decrease the discrepancies that may contribute to under care or no care that may lead to blindness.

The objective of this study is to determine if disparities exist that are leading to discrepancy or inequality in eye care in Greater Rochester (upstate NY), a rural area, and Kings County (downstate NY), an urban area. Identifying discrepancies unique to each county would help in leading to more equitable vision healthcare in both upstate and downstate New York.

Studying these counties would offer insight into the care in the country at large as these represent varied communities.

III. Major Eye Disease Mechanisms

The major eye diseases that can lead to blindness or vision loss include age related cataracts, glaucoma, age-related macular degeneration, and diabetic retinopathy[4]. Blindness due to such diseases is a serious public health concern both domestically and globally[6-7]. A summary of major blindness causing diseases can be found in **Table 1**.

Table 1. Leading Causes of Blindness Globally and with Associated Risk Factors

	Age-related cataract	Glaucoma	Age-related macular degeneration	Diabetic Retinopathy
Leading cause of global blindness	First	Second	Fourth	Fifth
Major Risk Factors	UV exposure, diabetes, drug ingestion, smoking, and alcohol use	Family history of glaucoma, age, and high IOP	Age, smoking, and low dietary intake of antioxidants	Uncontrolled diabetes, hemoglobin A1c level, HTN, etc.

Glaucoma is a group of disorders that leads to degeneration of the optic nerve and loss of retinal ganglion cells[16, 17]. It is the second leading cause of blindness globally that leads to irreversible blindness[7,17]. Family history of glaucoma, age, high intraocular pressure (IOP) are all major risk factors for glaucoma[17].

Age-related macular degeneration (AMD) is a retinal disease that causes central vision defects and severe vision loss as it affects the macula, or central part of the retina[13]. It is regarded as the fourth leading cause of blindness globally[7]. Risk factors for AMD include age, smoking, and low dietary intake of antioxidants (zinc and carotenoids)[13,14].

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both[5]. Patients with diabetes are at risk for diabetic retinopathy (DR), which can lead to adult-onset blindness in working-age populations[6,12]. DR is known to be the fifth leading cause of blindness globally[7]. The duration of DM, hemoglobin A1c level, uncontrolled diabetes, hypertension (HTN), dyslipidemia, nephropathy, insulin treatment, and age are known to be the risk factors for DR[15].

Cataracts is a disease that causes opacification of the lens of the eye[18]. This obscures the passage of light through the lens to the retina[18-19]. Cataracts is known to be the leading cause of blindness globally[7]. Ultraviolet (UV) exposure, diabetes, drug ingestion, smoking, and alcohol use are all known to be risk factors for age-related cataract[20].

IV. Methods

A. Participant selection

This study was conducted using data from the Vision and Eye Health Surveillance System, or VEHSS. VEHSS is a program developed by the Center for Disease Control Vision Health Initiative (CDC VHI) and NORC at the University of Chicago. Through previous and current data sources, the VEHSS integrates multiple data sources into a database containing comprehensive information to understand the burden of vision loss and eye disorders and the scope of eye care services in the United States. This data is evaluated at the state, national, and occasionally, the county level[28]. The data from VEHSS contributes to the overall mission of the CDC VHI to promote vision health and quality of life for all populations through eye disease prevention and control by making it publicly available for research and treatment-related purposes[28]. Data in the VEHSS is included using a five-step approach. First, data is identified and selected from national surveys, administrative claims records, electronic health records, population-based studies, and other sources of information. Then, health and care outcomes are defined so they can be used by key stakeholders and so that data indicators can measure these outcomes across different types of data. Next, through the defined data indicators, selected data creates a single-source estimate to compare prevalence estimates across varied data sources.

Then, statistical models integrate information across the multiple data sources to create comprehensive estimates of the prevalence of vision loss, eye disease, and service utilization. Finally, the data is transparently and continuously disseminated publicly to the final VEHSS system[29]. Secondary data are collected from multiple publicly available resources. Data from the US Census[10, 21], U.S. Department of Agriculture Economic Research Service[24], and United for ALICE (Asset Limited, Income Constrained, Employed)[26] for a demographic profile of the settings that were evaluated. Availability of healthcare providers (Primary care provider, ophthalmologist, and optometrist) data are derived from Health Resources & Services Administration[22], and New York State Education Department[27]. Lastly, prevalence of blindness of each county data was received from Vision and Eye Health Surveillance System (VEHSS)[30].

The objective of this study was to explore where disparities may exist that are leading to disparities in eye care for blindness in an urban setting versus a rural setting. For this study, upstate New York represents the rural setting and downstate New York represents the urban setting. The VEHSS system was used for participant selection because potential participants can be filtered according to the prevalence of blindness, the outcome of interest. Additionally, this system contained variables of interest as potential risk factors for developing blindness. Using the VEHSS system, participants selected for this study were assessed according to the prevalence of blindness and being 40yrs and older.

B. Variable Selection

The outcome variable for this study was the prevalence of blindness which was defined as a best-corrected visual acuity at $\leq$ 20/200 in the better-seeing eye according to the CDC, which is the same definition used in the VEHSS system[30]. After selecting the participants for the study, variables were selected for a series of analyses and model development. Potential risk covariates were considered based on previously published research and their availability through VEHSS at the county level. The risk covariates included in the analyses and model development were geographic region, age, gender, race/ethnicity, and Medicare claims. Age, gender, race/ethnicity, and Medicare claims were categorized according to the VEHSS. The geographic regions of interest in this study were upstate New York represented by the Greater Rochester area and downstate New York represented by Kings County. Throughout the remainder of the methods and results section, Greater Rochester will refer to upstate New York and Kings County will refer to downstate New York. VEHSS collected data according to Kings County alone, however several counties had to be combined to create Greater Rochester. These counties include Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates. There are several other potential risk covariates that were initially considered for the analyses and model development; however, they were not able to be included because there were not assessed at the county level for New York. These potential risk covariates include commercial medical insurance and Medicaid claims. Additionally, variables included in the analyses and model development could only be assessed from 2017 because the composite estimates of blindness for New York were only available for that year, as a result, subsequent variable selection could only be from the same year.

Additional potential risk covariates that were considered for inclusion were the number of physicians by county, median household income by county, and education by county; however, these could not be included in the model development step as they were not variables included in the VEHSS system which defined the prevalence of blindness. Despite this, these variables were assessed through literature reviews and publicly available data and are included in the supplemental tables and figures as these were still deemed to be relevant. The physicians by county were categorized by ophthalmologists, optometrists, and primary care physicians.

Education by county was categorized by those that completed college, completed some college, completed high school only, and did not complete high school at all. Overall, variables were categorized according to VEHSS, the CDC, or previously published research.

C. Statistical Analyses and Model Development

SAS Studio from SAS OnDemand for Academics was used for the analyses, while Microsoft Excel 2010 was used for data collection. Creating a causal model involved three main steps: descriptive analysis, univariate analysis, and multivariate binary logistic regression analysis. The purpose of the descriptive analysis was to examine the population distribution, summarize the data points, and identify any outliers. The descriptive analysis was completed using proc univariate for continuous variables and proc freq for categorical variables. The variables included in the descriptive analysis are geographic region, age, gender, race/ethnicity, Medicare claims, physicians by county, median household income by county, and education by county.

After analyzing the descriptive statistics, variables such as geographic region, age, gender, race/ethnicity, and Medicare claims were selected for the univariate analysis, the second step in the model development process. These variables were chosen for the univariate analysis because they were included in the VEHSS program in which blindness was defined among each of these variables. This step tests for association between one independent variable with the dependent variable, blindness. The univariate analysis helps to determine what variables to include in the multivariate binary logistic regression analysis, the next and final step of the model development process. A chi-square test with proc freq was used for categorial variables while a proc t-test was used for continuous variables. The only continuous variable from the selection was age. Age was also analyzed as a categorical variable per the VEHSS categories and ultimately chosen for future analyses in this study because age as a continuous variable did not have any measurable change and had more analytical purposes as a categorical variable. The univariate analysis was performed at an alpha of 0.20. Due to their demographic and public health importance, all variables from the univariate analysis step were then used in the multivariate binary logistic regression analysis regardless of their alpha, except for age as a continuous variable.

For the third and final step of the model development process, data from a multivariate binary logistic regression analysis estimates the parameters from chosen potential risk covariates to evaluate the potential causal relationship between our exposure and outcome of interest. Finalizing the predictive model using the parameter estimates was through a backward stepwise logistic regression approach at an alpha of 0.05. In the backward stepwise approach, variables were removed one by one if the value was greater than alpha, starting with the variable containing the highest value until all values were less than alpha. The final predictive model indicated the probability of being blind as a function of potential risk covariates. The multivariate binary logistic regression analysis was done for three separate models: a general model that includes both geographic regions (Greater Rochester and Kings County), and two models without geographic region, blindness in Greater Rochester and blindness in Kings County. The variables included for the general model were geographic region (Greater Rochester and Kings County), age categorized, gender, race/ethnicity, and Medicare claims while the other two models excluded the geographic region and kept the rest of the potential risk covariates. For the general model and the Kings County model, the 'White, Non-Hispanic' category under race/ethnicity was the only variable with an alpha greater than 0.05. Conversely, for the Greater Rochester model, the 'White, Non-Hispanic' and 'Other' categories under race/ethnicity were the variables with an alpha greater than 0.05. For all three models, all values in the initial model were kept for the final model due to the significance of each potential risk covariate. Through the model, a relationship between an independent variable and the outcome variable can be isolated from the effects of other variables, meaning the model adjusts for confounding.

V. Results

A. Sample Demographics

The final analytic sample examined blindness prevalence in Greater Rochester and Kings County separately. In 2017, Greater Rochester had a population of 608,094 individuals 40yrs and older with a population density at 130 individuals per square mile. In contrast, Kings County had a population of 1,113,947 of individuals 40yrs and older with a population density at 15,730 individuals per square mile in 2017. Of the participants in Greater Rochester, 11,208 (0.57%) were blind and of the participants in Kings County, 21,172 (0.52%) were blind based on study-specific criteria. There was a similar blindness rate in Greater Rochester males at 0.48%, and Kings County females at 0.44%. Furthermore, **Table 7, Figure 4 shows** participants in the 40-64yr age category from Greater Rochester had a blindness rate at 0.12% and Kings County participants of the same group had a blindness rate slightly higher rate at 0.13%. This blindness rate similarity was also reflected in the 65-84yr age category with Greater Rochester participants at a blindness rate of 0.85% and Kings County participants at a blindness rate only slightly higher at 0.91%.

B. Covariates

The crude unadjusted odds ratios were calculated which showed the effects of the independent variables on a participant's likelihood of becoming blind. These covariates included geographic region, age categorized, gender, race/ethnicity, and Medicare. Many of these were significantly associated with blindness, or risk factors, while others were determined to be protective factors. Variables with an estimated odd ratio greater than 1.0 were identified as potential risk factors for blindness while those having odds ratios less than 1.0 were determined to be potentially protective against blindness shows unadjusted odds ratios with 95% confidence intervals for each variable associated with the outcome of blindness.

According to the multivariable logistic regression analysis, Greater Rochester residents have a 4% increased odds of being blind compared to Kings Country residents.

This mirrors the analysis results for the Kings County odds at 1.14. For race/ethnicity, black, non-Hispanic individuals serve as a potential risk factor from our analysis across each model, with the black, non-Hispanic individuals in Greater Rochester at a higher risk of developing blindness compared to Kings County. Conversely, white, non-Hispanic and other individuals serve as protective factors in the total model and Kings County model. It is important to note that the odds ratios for white, non-Hispanic individuals in each model was not significantly different from one another because the confidence intervals overlapped. Much like race/ethnicity, the total model and Kings County model showed similar results of odds ratios for those without Medicare. In the total model, compared to those who do have Medicare, those who did not have Medicare have 1.17 times the odds of being blind.

For age, individuals that are 65-84 and 85yrs and older are potential risk factors for developing blindness where the odds of being 85yrs and older among those who are blind are 31.77 times the odds of individuals being 85yrs and older among those who are not blind. Based on the logistic regression analysis, age exhibited the strongest association with blindness regardless of geographic region.

C. Multivariate Model

The multivariate binary logistic regression analysis provided unadjusted odds ratios and 95% confidence intervals after holding all other variables in the model constant (**Table 2 and 3**).

Table 2: Descriptive Analyses

Blindness[1] Prevalence: Greater Rochester vs. Kings County				
Variables	Greater Rochester Blindness, N (%)	Greater Rochester No Blindness, N (%)	Kings County Blindness, N (%)	Kings County No Blindness, N (%)
Gender				
Male	1284 (0.48)	267704 (99.52)	2289 (0.44)	520039 (99.56)
Female	1929 (0.66)	291711 (99.34)	3924 (0.60)	649977 (99.40)
Age (years)				
40-64	442 (0.12)	371680 (99.88)	1043 (0.13)	801177 (99.87)
65-84	1377 (0.85)	161072 (99.15)	2947 (0.91)	320845 (99.09)
$\geq$ 85	1403 (5.00)	26652 (95.00)	2184 (4.35)	48032 (95.65)
Race				
Black, Non-Hispanic	270 (0.59)	45326 (99.41)	2334 (0.62)	373416 (99.38)
White, Non-Hispanic	2821 (0.59)	468968 (99.41)	2488 (0.60)	412909 (99.40)
Hispanic, any race	63 (0.31)	20193 (99.69)	949 (0.42)	224474 (99.58)
Other	63 (0.34)	18246 (99.66)	552 (0.35)	159108 (99.65)
Medicare				
Yes	884 (1.33)	62766 (98.67)	2006 (1.43)	13829 (98.57)

[1] Blindness is defined as: $\leq$ 20/200 (better-seeing eye)
% = blindness population $\geq$ 40yrs/total population $\geq$ 40yrs

Table 3: Logistic Regression Analyses

Variables	Total Model Odds Ratios (95% CI)	Greater Rochester Model Odds Ratios (95% CI)	Kings County Model Odds Ratios (95% CI)
Region		NA	NA
Kings County (ref)			
Greater Rochester	1.04 (1.01, 1.07)		
Gender			
Male (ref)			
Female	1.13 (1.08, 1.17)	1.10 (1.02, 1.18)	1.14 (1.08, 1.20)
Age (years)			
40-64 (ref)			
65-84	6.34 (6.14, 6.55)	6.38 (6.01, 6.76)	6.34 (6.10, 6.59)
$\geq$ 85	31.77 (30.72, 32.86)	37.15 (35.02, 39.42)	29.31 (28.12, 30.54)
Race/Ethnicity			
Black, Non-Hispanic	1.38 (1.28, 1.49)	1.72 (1.30, 2.27)	1.38 (1.26, 1.46)
White, Non-Hispanic	0.97 (0.90, 1.04)	1.10 (0.86, 1.42)	0.95 (0.88, 1.02)
Hispanic, any (ref) Other	0.86 (0.78, 0.96)	1.01 (0.71, 1.44)	0.85 (0.77, 0.95)
Medicare			
Yes (ref)			
No	1.17 (1.12, 1.22)	1.10 (1.01, 1.19)	1.19 (1.13, 1.26)

The descriptive analysis and multivariate binary logistic regression analysis helped to derive the final multivariate logistic regression model. The logistic regression analyses created a series of causal models to with geographic region as the primary exposure and the presence of blindness as the outcome.

The final multivariate binary logistic regression total predictive model is given as:

lnOdds (Blindness) = β_0 + β_1(Geographic region) + β_2(Gender) + β_3(Age) + β_4(Race/Ethnicity) + β_5(Medicare)

The final multivariate binary logistic regression Kings predictive model is given as:

lnOdds (Kings County Blindness) = β_0 + β_1(Gender) + β_2(Age) + β_3(Race/Ethnicity) + β_4(Medicare)

The final multivariate binary logistic regression Greater Rochester predictive model is given as:

lnOdds (Greater Rochester Blindness) = β_0 + β_1(Gender) + β_2(Age) + β_3(Race/Ethnicity) + β_4(Medicare)

D. General Characteristics of Included Variables Compared to the Outcome

Potential risk covariates included in the analysis and additional relevant variables that were examined through literature review and publicly available data were all assessed in comparison to blindness. These additional relevant variables include the number of physicians by county, median household income by county, and education by county all in 2017. As these are not included in the VEHSS system which defines the prevalence of blindness, these were not included in the model development process.

Table 4. New York State Population Estimates for Individuals ≥40yrs in 2017

County	Population, N	County Square Mileage	Population Density (per mi^2)
Genesee	30,735	492.94	62.35
Livingston	32,245	631.76	51.04
Monroe	363,926	657.21	553.74
Ontario	58,947	644.07	91.52
Orleans	21,656	391.26	55.35
Seneca	17,796	323.71	54.98
Wayne	48,640	603.83	80.55
Wyoming	21,338	592.75	36.00
Yates	12,811	338.14	37.89
Kings	1,113,947	70.82	15729.27

Table 5. Blindness Prevalence of Race/Ethnicity by County

County	Black, Non-Hispanic (%)	Hispanic, any race (%)	White, Non-Hispanic (%)	Other (%)
Genesee	4 (0.78)	1 (0.35)	167 (0.62)	4 (0.47)
Livingston	5 (0.75)	1 (0.21)	153 (0.55)	2 (0.38)
Monroe	231 (0.57)	50 (0.31)	1634 (0.61)	47 (0.33)
Ontario	6 (0.65)	2 (0.23)	264 (0.53)	3 (0.35)
Orleans	8 (08.1)	1 (0.31)	110 (0.60)	1 (0.32)
Seneca	3 (0.65)	1 (0.30)	95 (0.61)	1 (0.36)
Wayne	9 (0.76)	5 (0.52)	235 (0.56)	3 (0.38)
Wyoming	5 (0.71)	1 (0.33)	98 (0.54)	1 (0.43)
Yates	0 (0.00)	0 (0.00)	66 (0.57)	0 (0.00)
Kings	2334 (0.62)	949 (0.42)	2488 (0.60)	552 (0.35)

% = blindness population ≥ 40yrs/total population ≥ 40yrs

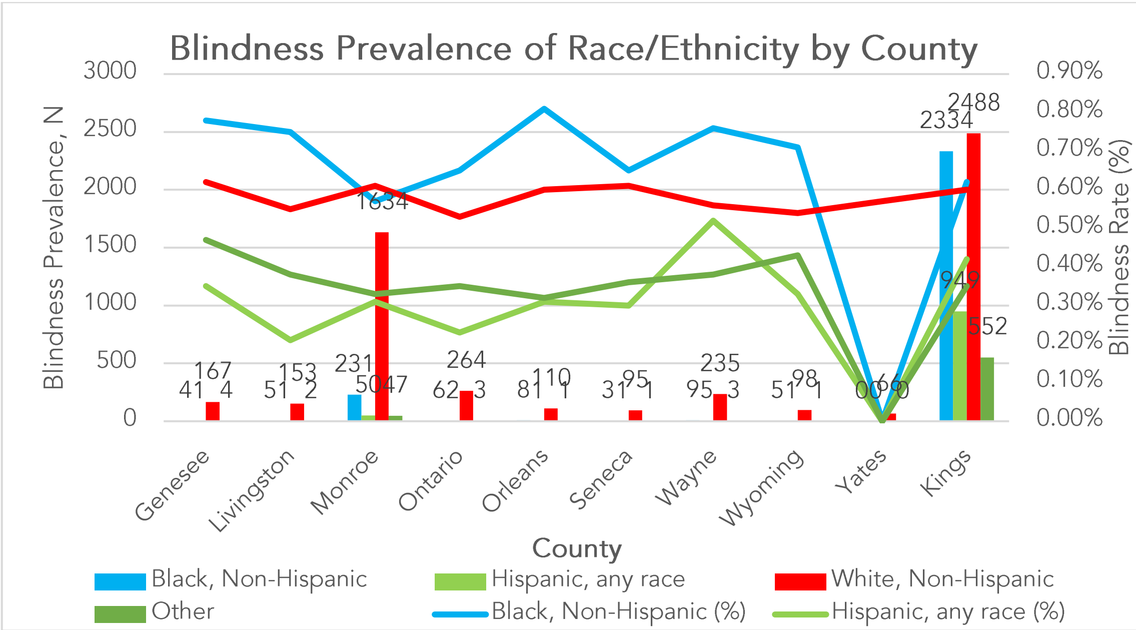

Figure 2. Blindness Prevalence of Race/Ethnicity by County.

Figure 2 and Table 5 depicts the prevalence of blindness and blindness rate in each county by race and ethnicity according to the data in **Table 4**. White, non-Hispanic participants have the largest prevalence of blindness in each county, however the only counties at which the rate of blindness is also the highest in that same category are Monroe and Yates. White, non-Hispanic participants are also the only race with blind individuals in Yates County. Black, non- Hispanic participants had the highest blindness rate in Livingston County at 0.75%, Ontario County at 0.65%, Orleans County at 0.81%, Seneca County at 0.65%, Wayne County at 0.76%, Wyoming County at 0.71%, and Kings County at 0.62%. The average blindness rate for black, non-Hispanic participants was 0.63%, for Hispanic, any race participants at 0.3%, for white, non- Hispanic participants at 0.58%, and for other participants at 0.34%. According to the 2010 US Census, the race/ethnicity breakdown is as follows in Kings County: white alone, not Hispanic or Latino at 36.8%, black or African American alone at 33.8%, others at 29.4%, and Hispanic or Latino at 18.9%[31]. The same census breaks down race/ethnicity as follows for Greater Rochester: white alone, not Hispanic or Latino at 87.71%, black or African American alone at 5.18%, others at 7.11%, and Hispanic or Latino at 4.53%[31]. **Table 6 and Figure 3** shows the prevalence of blindness by gender showing an increase in females versus males.

Table 6. Blindness Prevalence of Gender by County

County	Male (%)	Female (%)
Genesee	74 (0.53)	103 (0.71)
Livingston	66 (0.45)	94 (0.64)
Monroe	756 (0.48)	1200 (0.66)
Ontario	110 (0.44)	165 (0.61)
Orleans	50 (0.50)	70 (0.68)
Seneca	43 (0.51)	56 (0.68)
Wayne	107 (0.49)	143 (0.63)
Wyoming	49 (0.47)	58 (0.64)
Yates	29 (0.50)	38 (0.62)
Kings	2289 (0.44)	3924 (0.60)

% = blindness population ≥ 40yrs/total population ≥ 40yrs

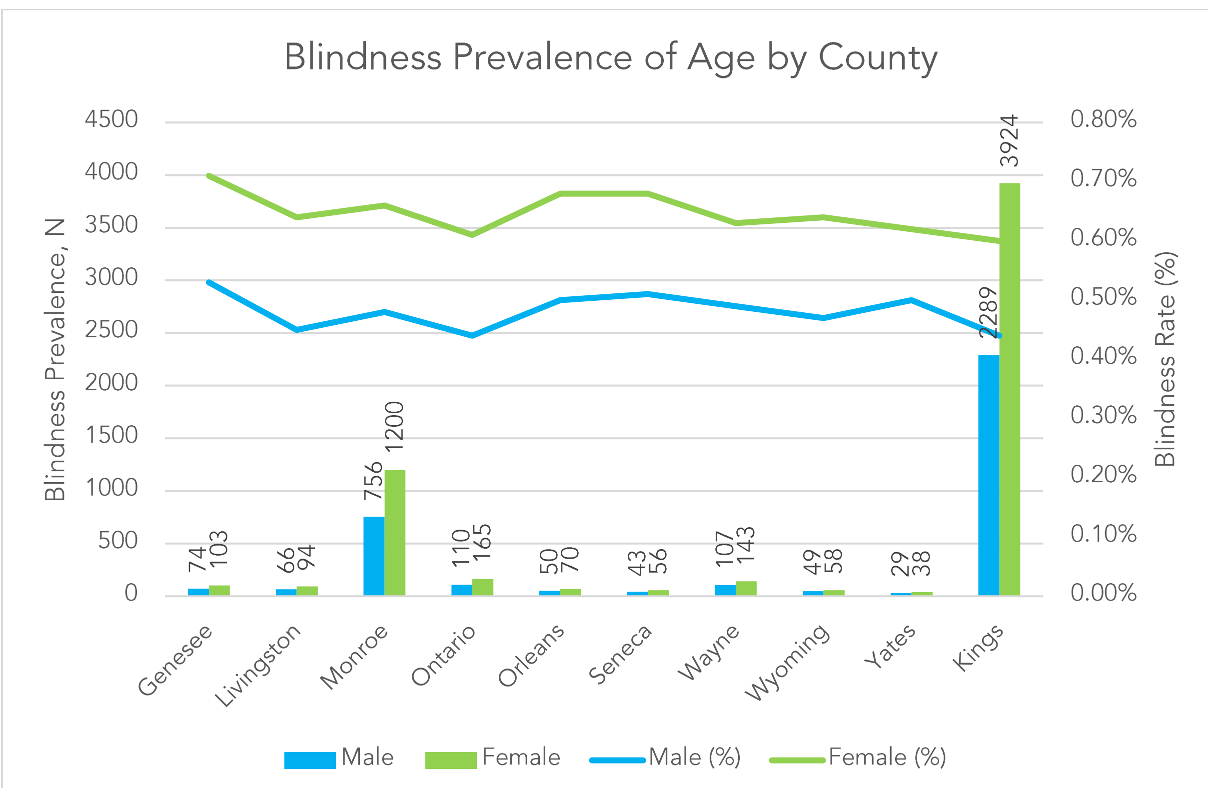

Figure 3. Blindness Prevalence of Gender by County

Table 7. Blindness Prevalence of Age by County.

County	40-64yrs (%)	65-84yrs (%)	≥85yrs (%)
Genesee	20 (0.11)	75 (0.87)	82 (5.44)
Livingston	24 (0.12)	70 (0.83)	67 (5.23)
Monroe	270 (0.12)	821 (0.85)	877 (4.89)
Ontario	34 (0.10)	118 (0.76)	123 (4.79)
Orleans	17 (0.13)	53 (0.91)	49 (5.67)
Seneca	13 (0.12)	45 (0.88)	41 (5.24)
Wayne	36 (0.12)	116 (0.90)	98 (5.55)
Wyoming	20 (0.15)	47 (0.87)	38 (4.89)
Yates	7 (0.10)	31 (0.79)	28 (4.86)
Kings	1043 (0.13)	2947 (0.91)	2184 (4.35)

% = blindness population ≥ 40yrs/total population ≥ 40yrs

Table 8. Blindness Prevalence of Medicare Claims by County

County	Medicare Claims (%)
Genesee	52 (1.27)
Livingston	47 (1.30)
Monroe	469 (1.43)
Ontario	90 (1.33)
Orleans	22 (0.80)
Seneca	22 (0.80)
Wayne	90 (1.47)
Wyoming	30 (1.17)
Yates	20 (1.03)
Kings	2006 (1.43)

% = blindness population ≥ 40yrs/total population ≥ 40yrs

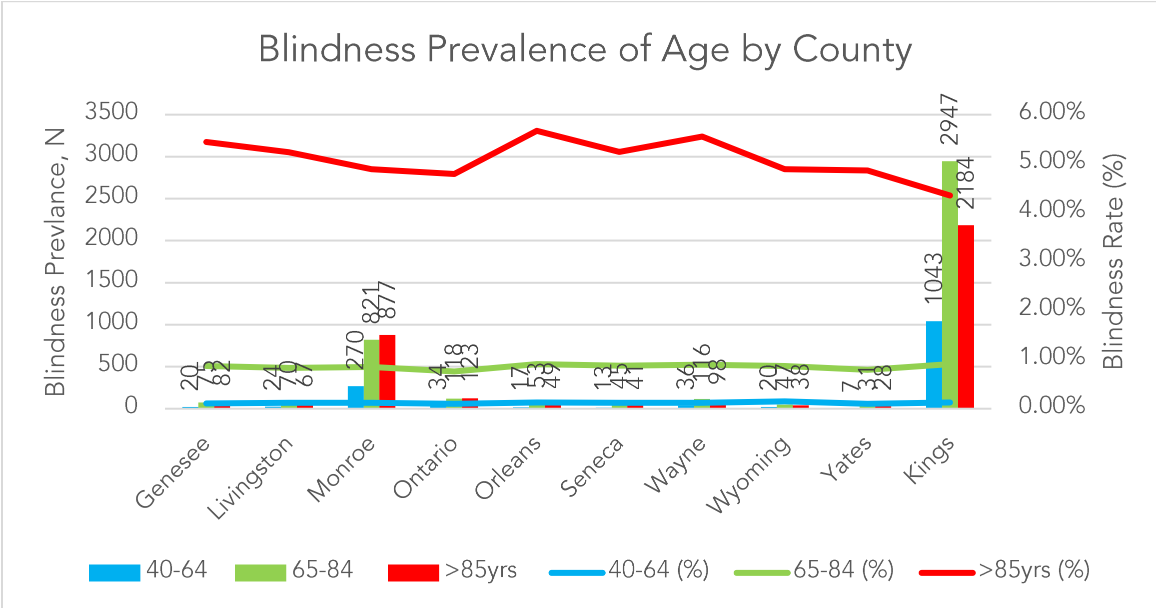

Figure 4. Blindness Prevalence of Age by County

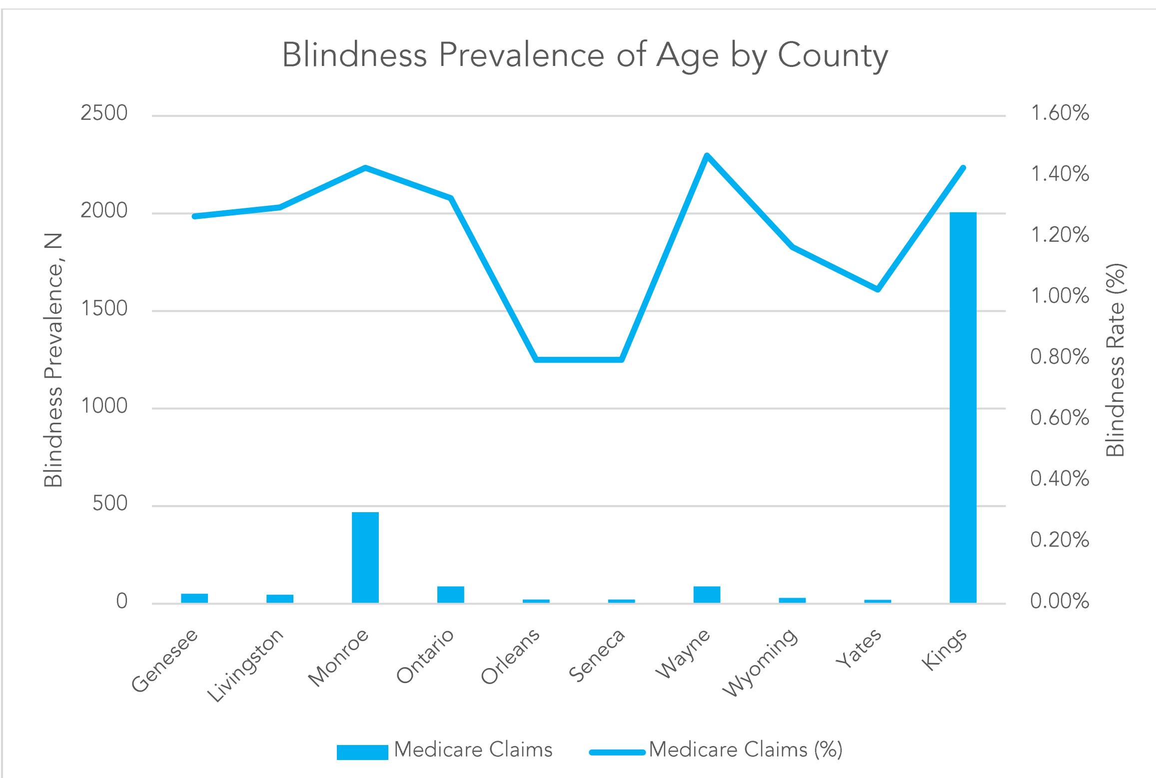

Figure 5. Blindness Prevalence of Medicare Claims by County

According to **Table 9 and Figure 6**, Kings County has 118 ophthalmologists and 299 optometrists, compared to Greater Rochester which only has 82 total ophthalmologists and 178 optometrists. Orleans County does not have either eye care specialist. Monroe County has the largest number of ophthalmologists, optometrists, and primary care physicians compared to all other Greater Rochester counties, yet still pales in comparison to the Kings County physician availability.

Table 9. Physicians by County

County	Ophthalmologists, N	Optometrists, N	Primary Care Physicians, N
Genesee	3	2	17
Livingston	0	5	26
Monroe	77	132	787
Ontario	1	24	84
Orleans	0	0	3
Seneca	0	1	9
Wayne	0	10	23
Wyoming	1	3	12
Yates	0	1	12
Kings	118	299	1746

% = blindness population ≥ 40yrs/total population ≥ 40yrs

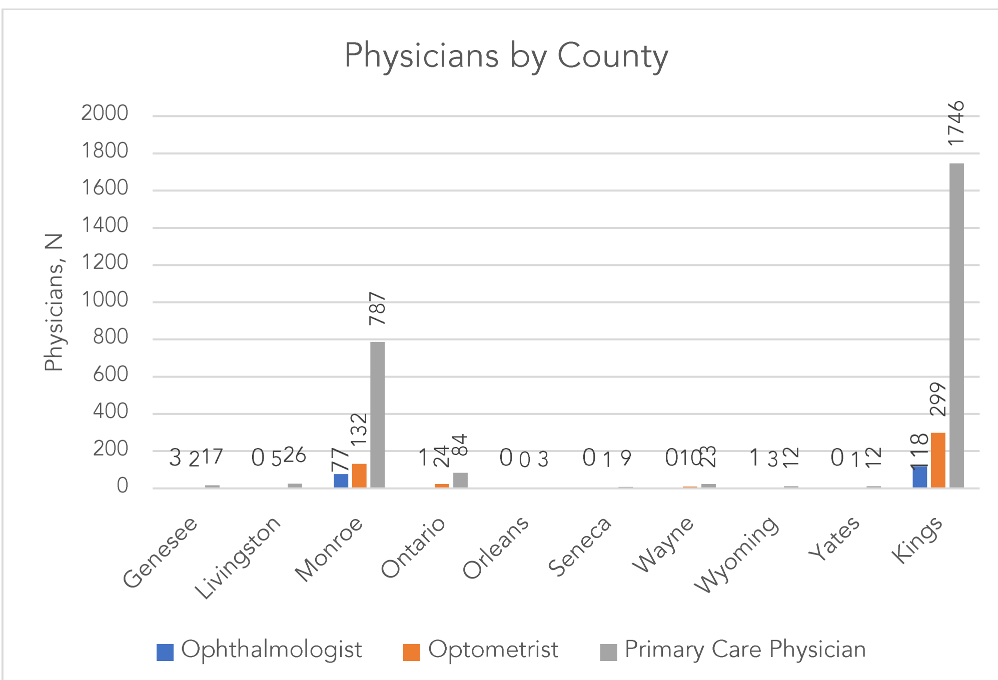

Figure 6. Physicians by County

Table 10 and figure 7 depicts the median household income similar across all counties, with Ontario County at the wealthiest with $65,271 in 2017 and Orleans County with the lowest at $48,799 in the same year. Much like the median household income, **Table 11** illustrates education levels by county yielded similar trends across multiple counties. According to **Figure 8**, Genesee, Livingston, Orleans, Seneca, Wayne, Wyoming, and Yates County all had the same trend with education completion where individuals in those counties completed high school only at the highest rate and completed college was the lowest rate. Monroe is the only county in Greater Rochester where the rate of completing college is nearly as high as the rate of completing high school only. In Kings County, individuals did not complete high school at the highest rate while those who completed some college was at the lowest rate.

Table 10. Median Household Income by County

County	Income ($)
Genesee	$55,522
Livingston	$56,407
Monroe	$57,660
Ontario	$65,271
Orleans	$48,799
Seneca	$54,563
Wayne	$52,709
Wyoming	$53,986
Yates	$49,198
Kings	$56,548

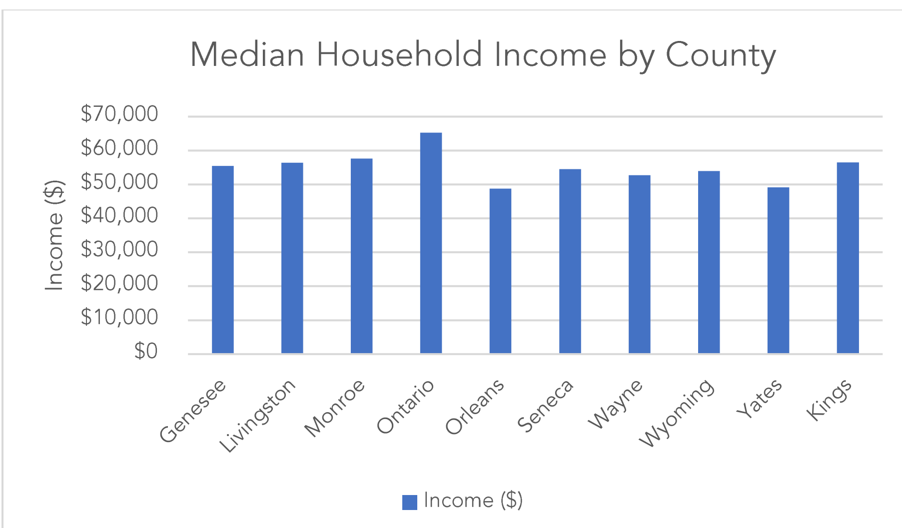

Figure 7. Median Household Income by County

Table 11. Education by County (Individuals 25 and above)

County	Completed College (%)	Completed Some College (%)	Completed High School Only (%)	Did Not Complete High School (%)
Genesee	14.48	23.40	37.96	24.20
Livingston	17.78	22.28	33.94	26.02
Monroe	26.38	22.10	28.52	23.02
Ontario	21.28	23.88	33.12	21.70
Orleans	11.34	19.96	37.26	31.46
Seneca	14.58	20.64	35.98	28.80
Wayne	14.52	21.66	35.32	28.46
Wyoming	10.82	20.50	38.40	30.24
Yates	16.20	20.28	35.24	28.26
Kings	18.82	15.12	28.22	37.80

% = attendance rate

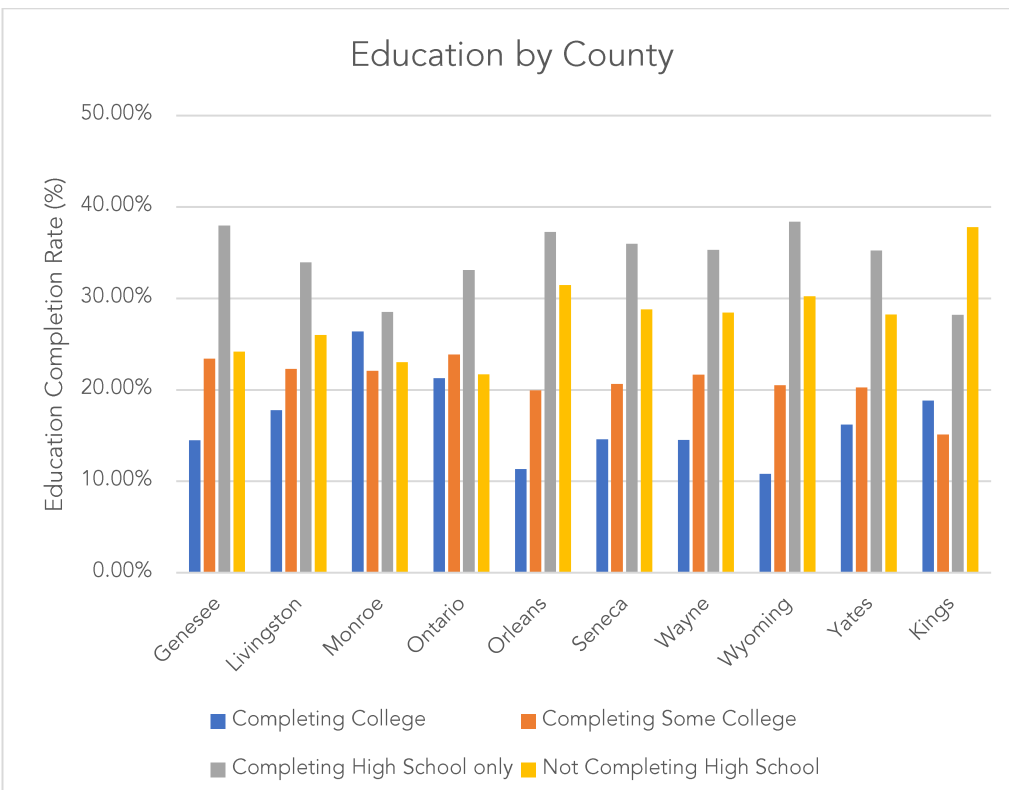

Figure 8. Education by County (Individuals 25 and above)

VI. Conclusion

Social factors are powerful determinants of health and are a large variable in health care disparity. Greater Rochester is an accurate representation of a rural setting, while Kings County is an accurate representation of an urban setting. According to McGinnis et al., medical care represents only 10-15% of preventable mortality in the US. Social factors such as income, education, employment, racial segregation, poor policies, and low social support maybe responsible for another large percentage[33]. Other relevant factors at which there is no control include age, genetics, hereditary, race, and ethnicity[32].

With the availability of many eye care providers in Kings County, there is still an increased rate of blindness among black, non-Hispanic individuals compared to white, non-Hispanic individuals. The providers may be segregated to certain areas and not be readily accessible to all making it difficult to receive adequate medical care. In Greater Rochester, eye care providers are more isolated throughout the nine included counties, leaving some counties with no providers at all. Access to care for patients may be difficult as they must travel long distances. The source used to pull physician data from **Table 9** also did not indicate if any providers were part time, which would only exacerbate the disparity to access to care across all counties studied. This may lead to minimal care or no care. Lack of insurance often amplifies the situation. Given the small number of VA facilities upstate compared to downstate, veteran care was also of interest to this study, however this information was not publicly available.

The VEHSS system was used for this study because it compiles vision health data from multiple data sources into a database with comprehensive information at the country, state, and county level. It also yielded data by details and major age groups that were categorized accordingly for the study analyses. While this system proved effective to the aim of this study, there were a few limitations because of using this system.

For New York, the VEHSS system filters according to composite estimates, claims, HER registry through the IRIS Registry, and surveys from the American Community Survey (ACS), Behavioral Risk Factors Surveillance System (BRFSS), and National Survey of Children's Health (NSCH)[28]. In terms of composite estimates, VEHSS provides prevalence estimates of blindness, but provides no clarification on the etiology of blindness. The subgroup of these estimates is categorized as 'any vision loss'[28].

Additionally, this paper evaluates blindness data at the county level in New York. Comprehensive data for blindness prevalence is only available at the county level for 2017, thus, blindness prevalence could not be evaluated across several years[28]. As such, all additional variables that were assessed as potential risk factors could also only be compared to blindness prevalence of the same year. Also, any changes in blindness prevalence across several years could not be evaluated.

Claims data in the VEHSS system included commercial medical insurance, managed vision care, Medicaid claims, and Medicare claims[28]. Medicare claims data was included in the multivariate binary logistic regression analysis because data was available from 2017 at the county level and for individuals categorized according to 40-64yrs, 65-84yrs, and 85yrs and above **Table 8 and Figure 5**. All other forms of insurance could not be filtered as such; therefore, they could not be used in any analyses.

Despite the limitations of the study, the results indicated that there is a disparity in adequate care and access to care between upstate and downstate New York. It is recommended that the VEHSS system give every effort to address the limitations specified above so that users have a more complete picture of blindness health care. New policies are necessary to improve health outcomes for socially disadvantaged populations. Identifying factors that influence end results and other health related behaviors may assist healthcare providers with creating proper treatment plans to yield improved patient compliance, cooperation, and results[33]. Providers can incorporate health equity into treatment plans and subsequently advocate for creating polices to improve the quality of patient care and its equitability and accessibility.

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