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What Contributes to Lack of Glaucoma Awareness in an Urban Population? Factors Associated with Lack of Knowledge of Glaucoma at Three New Haven Clinic Sites

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WHAT CONTRIBUTES TO LACK OF GLAUCOMA AWARENESS IN AN URBAN POPULATION?

Factors Associated with Lack of Knowledge of Glaucoma at Three New Haven Clinic Sites.

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Abstract

Factors Associated with Lack of Knowledge of Glaucoma Risk Factors at Three New Haven Clinic Sites.

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To evaluate variables associated with lack of knowledge regarding glaucoma risk factors. A survey was administered to 397 participants in July 2004 at two Primary Care clinics and an Eye Care center. The survey had social variables and knowledge of risk factors associated with glaucoma. The variables were then correlated with lack of knowledge of glaucoma using the Chi squared test, and logistic regression analysis.

Using bi-variate analysis, factors that independently predicted increased likelihood of lacking knowledge about glaucoma risk factors were; being at a primary care location ($p=0.0003$, OR 2.3, 95% CI 1.471-3.750), not having a family history of glaucoma ($p=0.0003$, OR 3.4, 95% CI 1.762-6.682), being an ethnic minority ($p<0.0001$, OR 2.6, 95% CI 1.652 - 4.198), not having been screened for glaucoma ($p=0.0005$, OR 2.1, 95% CI 1.386-3.228), not wearing prescription eyeglasses/contact lenses ($p=0.013$, OR 1.7, 95% CI 1.119-2.681), not having elevated eye pressures ($p=0.032$, OR 1.9, 95% CI 1.05-3.317), not having had an eye appointment in the past year ($p=0.015$, OR 1.8, 95% CI 1.119-2.85), and not having glaucoma ($p= 0.013$, OR 3.1, 95% CI 1.2199-8.0289).

When controlling for confounding variables in multivariate analysis, lack of knowledge for glaucoma risk factors was associated with; not having a family history of glaucoma (p=0.0003, OR 3.7, 95% CI 1.194-4.254), being an ethnic minority (p=0.012 , OR 2.3, CI 1.194-4.254), and being at a primary care center (p= 0.02, OR 2.2, CI 1.130-4.186). Participants more likely to have no knowledge of glaucoma risk factors were those without a family history of glaucoma (3.4 times more likely), those belonging to an ethnic minority group (2.3 times), and those at a primary care center (1.9 times).

In this analysis, we identity various factors which may predispose patients to having no knowledge of risk factors associated with glaucoma. Our results suggest that attention to educating minority patients who visit primary care clinics may improve knowledge of glaucoma amongst those less likely to know much about glaucoma. Knowledge may increase if patients who do not have regular eye care are targeted for education about glaucoma and other potentially serious eye diseases.

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Introduction

Glaucoma; The Sneak Thief of Sight

Glaucoma is the second leading cause of bilateral blindness worldwide [1]. Several types of glaucoma have been described: acute and chronic, secondary and primary. Primary Open Angle Glaucoma (POAG) is the most common, making up approximately 30% of all glaucoma cases [2], the highest percentage reported being 73% in Japan [3]. POAG is a disease in which there is a progressive, slow, and irreversible loss of optic nerve fibers over time, leading to progressive visual field loss beginning in the periphery and expanding toward the center. Left untreated, it may progress to complete bilateral blindness. Treatment of glaucoma consists of topical or systemic intraocular pressure lowering agents, laser treatment or surgery. POAG has been termed the "sneak thief of sight" as it is an often-unrecognized disease due to its slow, insidious course and lack of symptoms. Because the decline in vision may be slowed but not restored by treatment, it is important that this condition be diagnosed early in its course.

Patho-physiology

Previously, POAG was considered a disease of "elevated" intraocular pressure (IOP). However, the existence of people with high IOP who have no disease, and some POAG sufferers with normal IOP, have led researchers to look for other definitions of POAG. High IOP is now no longer a definition of POAG, but an important risk factor (see risk factors below). POAG is defined as a disease of retinal ganglion cells (RGCs),

which is characterized by structural change in the optic disc that is best described as "excavation" [4]. Although Panda et al [5], in a study of secondary glaucoma found decreased photoreceptor count in human eyes with secondary angle-closure glaucoma loss, Kendell et al [6] found that photoreceptors and other retinal layers are generally intact in human POAG, and only RGCs die.

Epidemiology

Glaucoma is a major public health problem. Since the 1994 World Health Bulletin consensus that the glaucomas comprise the second leading cause of blindness worldwide [7], the trend continues into the 21st century, having surpassed trachoma during the past decade. From a meta-analysis of existing prevalence data 10 years ago that was based on age- and gender-specific world population data, Quigley et al estimated that Glaucoma affects more than 50 million persons and bilaterally blinds more than 7 million. [1]. In developed countries, it is estimated that only fifty percent of people with glaucoma are aware they have the disease [8]. One can only speculate that this number is much higher in the developing world.

In the United States, it is estimated that 2-3 million people are affected by POAG, an overall prevalence of 1.55%, of which 130,450 are bilaterally blind [9,10], with the burden of blindness from POAG and other eye diseases falling more on the elderly and minority populations [11-13]. Leske et al [14], in their 1981 study calculated incidence from the age-specific prevalence of POAG since glaucoma is an illness which can be prevented from worsening, but does not tend to improve. Also, glaucoma patients do not

have a higher mortality rate than the general population, so we can assume that incidence can be inferred from prevalence. Ie the incidence is the increase in prevalence each year. Using a cohort from a four year prevalence study, (The Barbados Eye Study 1988-1992) Leske et al [15], found the following pertinent figures about incidence; the 4-year risk of POAG in black participants was 2.2%, based on 67 newly developed cases of POAG. Incidence rates increased from 1.2% at ages 40 to 49 years to 4.2% at ages of 70 years or more, tending to be higher in men than women (2.7% vs 1.9%). About half of the incident cases were undiagnosed previously, and the rest were receiving POAG treatment. Of the 67 new cases of POAG, 32 had intraocular pressure of 21 mm Hg or less at baseline (1.2% incidence) and 35 had higher pressures (9% incidence). Risk was highest among persons classified as having suspect POAG at baseline (26.1%), followed by those with ocular hypertension (4.9%) and lowest in the remaining population (0.8%). From this data, we can extrapolate that since POAG incidence increases with age, the American population is more at risk as people live longer.

Using incidence data and United States mortality data, Quigley et al [10] showed that the typical person with POAG will live approximately 15 years from initial field loss to death, but that the average black American has POAG 27% longer than the average white American (16.3 years compared to 12.8 years). Investigators in the Blue Mountains Eye Study [16], examining POAG prevalence in Australia, found an even higher prevalence in the same over-80 age group (8.17%). In a population study of 6250 older people in urban Rotterdam, [17] those aged 55 to 64 years had a 3% prevalence of visual field loss; for those 85 years and older, prevalence rose to 19%. Because the future prevalence of POAG is likely to increase in developed countries, open-angle glaucoma

will become an even greater public health concern, and screening will be crucial to decrease morbidity.

Risk Factors

Many risk factors for POAG have been found, including increasing age, high intraocular pressure (IOP), positive family history, and African heritage. Others are diabetes and severe myopia.

High IOP and Optic Disc Diameter

Varma et al [18] analyzed optic disc photographs, and after adjusting for age and disc area found that Americans of European descent had a 6% decrease in neural rim area for every 10-mm Hg increase in IOP (P = .0001), while African Americans had a quadratic relationship between neural rim area and IOP (Very little decline with IOP up to approximately 17 mm Hg, after which neural rim area declined significantly with higher IOP (P = .001).) They also found that neural rim area-to-disc area ratio decreased and the vertical cup-to-disc ratio increased with increasing IOP in both black and white Americans. Sommer et al [9], in the Baltimore Eye Survey found that the IOP levels of those with POAG overlapped with the normal population distribution, though, on average, POAG cases had a higher mean IOP. While POAG was more common at higher IOP, it occurred nearly as often at normal IOP. Since there were so many more persons in a population with lower IOP, the prevalence of OAG at lower IOP was substantial. IOP is now more accurately being treated as a parameter, rather than a cutoff criterion, in order better to understand and study POAG.

Optic disc diameter varies widely in normal subjects, leading to POAG misdiagnosis in large discs with large cup-disc ratios. Quigley et al, [19] in their population study show that there is a slightly greater POAG risk in eyes with larger disc diameter. Although optic disc area was somewhat larger among patients with glaucoma than control subjects, in a regression model adjusting for age, gender, and race, the significance of this difference had a probability of 0.06. Among patients with glaucoma, disc area was not related to IOP level measured at study examination. They therefore concluded that disc area is a weak risk factor for open-angle glaucoma. A finding that was later corroborated by Healey et al [20].

Family History

Family history is an important risk factor for POAG and has been reported in 13–25% of patients with POAG [21-23]. Tielsh et al [24], found age-adjusted associations of primary open angle glaucoma with a history of glaucoma were higher in siblings (odds ratio [OR] = 3.69) than in parents (OR = 2.17) or children (OR = 1.12). Odds ratios were slightly higher in blacks than in whites, and there was evidence of selection bias, with ORs between two and three times higher for those who had prior knowledge of their glaucoma diagnosis than for those who first received their diagnosis by the study examination. They concluded that family history is an important risk factor for POAG. Wolfs et al [25] found that people are more likely to report a positive family history if they have been previously diagnosed by examining all available family members of a population-based POAG cohort. They found the prevalence of glaucoma to be 10.4% in siblings of patients, 1.1% in offspring of patients, 0.7% in siblings of controls, and 0% in

offspring of controls. Their reported life-time risk of elevated intraocular pressure in relatives of patients vs relatives of controls was 42.5% vs 6.7%, and of glaucoma was 22.0% vs 2.3%. This yielded a risk ratio for glaucoma of 9.2. The population-attributable risk of glaucoma was 16.4%. They thereby concluded that in a general population, relatives of patients with glaucoma have a strongly increased risk of glaucoma. However, the findings, of the Glaucoma Inheritance Study of Tasmania (GIST) suggest that a higher percentage of adult POAG may be inherited than hitherto reported [26].

So what role does genetics play in the familial increased risk of glaucoma? Implications of specific POAG genes began with the discovery of myocilin in 1997 by Stone et al [27] who found a gene encoding a trabecular meshwork protein (*TIGR*) mapped to the narrowest disease interval by STS content and radiation hybrid mapping. They found that 3.9% of the glaucoma patients had one of three mutations in this gene, compared to 0.2% of the controls who had only one of these mutations in the gene. However, much more research needs to be done in this area, because glaucoma is a complex disease, and disorders in mutations in different genes can be associated with a similar phenotype, while mutations in a single gene can cause different clinical pictures. Also, it is now known that many people with normal alleles have indistinguishable POAG from those with mutations [4].

Systemic Illness

Systemic Risks such as hypertension (HTN) and Diabetes mellitus (DM) have been studied as possible risk factors for POAG. Leske et al [22], in the Baltimore Eye

Study found a complex relationship between HTN and POAG. Although hypertension and diabetes were common in Barbados Eye Study participants, they were unrelated to the prevalence of POAG. Rather, younger participants with HTN were less likely to have POAG than young participants without HTN, while older persons with HTN were at greater risk for POAG. They also found that a lower blood pressure, combined with higher IOP was a much more serious risk factor because this meant lower perfusion to the optic nerve. Commenting on this finding, Quigley [4] speculated that the vascular perfusion of the RGC layer was higher in young eyes with HBP and that their vessels had not yet undergone chronic damage, leading to a protective effect. The elderly with HBP, on the other hand, had vessel damage from prolonged disease, and their RGCs had poorer nutrition as a result.

The association of diabetes mellitus (DM) with POAG is more controversial. Mitchell et al [28] in 1997 found that glaucoma prevalence was increased in people with diabetes, (5.5%), compared with age-gender adjusted controls without diabetes (2.8%). Ocular hypertension was also more common in people with diabetes (6.7%), compared with those without diabetes (3.5%). Diabetes was present in 13.0% of people with glaucoma, compared with 6.9% of those without glaucoma. However, in 67% of such cases, glaucoma was diagnosed before the diabetes. So although they conclude that there is a significant and consistent association between diabetes and glaucoma, this association was independent of the effect of diabetes on IOP. Other studies [22,29] also found that diabetes is not a risk factor, but is associated with POAG. However, Gordon et al [30] in the Ocular Hypertension Treatment Study (OHTS) showed that diabetes was protective against progressive disease in early POAG. .

Race/Ethnicity and POAG

Both the Barbados study [15] and the Baltimore Survey [24] have shown that there is a greater risk (4-5 times higher) of POAG in people of African descent than Caucasians. Since then, another study has shown a higher OAG prevalence in Africans in Tanzania [31] although not uniformly high in all black populations, as shown by Murdock et al 01[32] who described a population-based survey for glaucoma in rural Northern Nigeria. They found the overall prevalence of open angle glaucoma in this population was 1.02% in individuals 45 years of age and older. This is lower than the prevalence rates reported for other "black" populations. They conclude with the possibility that the prevalence of glaucoma varies considerably between "black" populations due to genetic heterogeneity or the effect of some unidentified environmental exposure. Could the differences in prevalence be explained by socio-economic and cultural factors? For example Orr et al, [33] found that Blacks were significantly less likely to see any type of eye care provider over 1 year: 50% versus 69% among whites. Those who reported having a vision problem, those with more education, and those in the older age groups were significantly more likely to see either an ophthalmologist or an optometrist. Diabetes and driving a car were predictive factors for seeing an ophthalmologist. Although blacks are known to be at greater risk for several age-related eye diseases, they are much less likely to see an eye care provider.

People of African descent are not the only ones to have an increased prevalence of POAG More recently, Quigley et al [29] show that prevalence is higher in people who self identified as Hispanics in the US. Ramakrishnan et al [34], also found a higher prevalence in Indians in India. Foster et al [35], found a similar prevalence among

Chinese in Singapore. The age-standardized prevalence of glaucoma was 3.2% in the population 40 years and older. Glaucoma was the leading cause of blindness. However, their findings suggest that current projections of glaucoma prevalence among ethnic Chinese are substantially underestimated. They suggest that this may be in part due to that fact that tonometric IOP in Asians may read differently from Europeans [36]. To date, no genes associated with POAG have been identified in people of African descent. However, differences in disc anatomy may play a role in greater POAG risk among people of African descent. Varma et al [18], found that on average, blacks had significantly larger disc areas (blacks, 2.94 mm^2; whites, 2.63 mm^2), larger cup areas (blacks, 1.04 mm^2; whites, 0.71 mm^2), larger cup-to-disc ratios (blacks, 0.56; whites, 0.49), similar neural rim areas (blacks, 1.90 mm2; whites, 1.92 mm^2), and smaller neural rim area-to-disc area ratios (blacks, 0.66; whites, 0.74) compared with whites. There were no age-related differences in any of the disc measurements. Male subjects had 2% to 3% larger optic discs compared with female subjects.

Screening

While other conditions may be potentially blinding, glaucoma is unique. Unlike conditions such as cataract, visual loss from glaucoma is not reversible. Diagnosis requires accurate assessment of optic disc structure and retinal functional assessment. Screening for glaucoma cannot be done with a single test. It requires tonometry to measure IOP, visual field testing to quantify loss of vision, and pupil dilation for visualization of the optic nerve. A diagnosis of glaucoma is made if damage to the optic nerve is observed. Breakthroughs in automated analysis of the visual field and optic disc

are an exciting area that promises increasing potential for early diagnosis. However, even with the most sophisticated technology to facilitate diagnosis, patients and the community will not benefit if the knowledge is not communicated to them and the importance of taking advantage of the new technology. To encourage regular screening, follow up and compliance with treatments, the community needs to be informed about glaucoma and the benefits of early detection, and the detrimental effects of late presentation and late stage disease on their quality of life and morbidity.

The screening process is a costly one, and it is therefore necessary to focus screening efforts on high risk populations. Such screening is essential, since early intervention, including eye drops, laser treatment and traditional surgery, have been shown to prevent blindness and impede further damage to the optic nerve [30, 37, 38].

Knowledge and Awareness

Since one in two people who have glaucoma are unaware of their illness, and many more at risk do not know it, Javitt et al [39] propose that beyond universal access to health insurance, eye health education that influences people to see an ophthalmologist may be the single most important step we can take to prevent needless blindness. Not only can education and preventive eye care save needless suffering, it can also reduce the economic burden of the disease. Grant et al [40] in a retrospective analysis of patients blinded by glaucoma have shown a need to educate patients about the significance of the lack of symptoms in the early stages of the disease. In studies by Livingston et al and Gasch et al [41,42], up to 40% of participants demonstrated inadequate knowledge of

glaucoma. Even in large POAG pedigrees such as those studied in GIST, [26] up to 27% of patients of COAG were unaware of their positive family history.

Eye health education that influences individuals to participate in regular ophthalmologic care may be an important means of detecting glaucoma early, thereby preventing needless visual impairment and preserving quality of life [39]. Several studies have examined knowledge and beliefs about glaucoma in general clinic or population-based samples [42-46]. Previous surveys conducted amongst clinic populations in a North Carolina rural center, England, Australia, and Germany show a wide range of 7% to 70% of participants reporting that they are unfamiliar with glaucoma. Michielutte [43] et al found that increasing age was associated with lack of awareness of glaucoma. Attebo et al [47], found a lack of family history of glaucoma to be strongly associated with lack of glaucoma awareness. All three studies found education to be a strong determinant of glaucoma awareness. Gasch et al [42] were the first to study race or ethnicity as a predictor of glaucoma awareness.

Petty et al [46], describe the process of behavior change which culminates in action and maintenance. But in order for this process to begin, the individual must first be made aware of the existing problem. It is this knowledge that equips the individual for change. For glaucoma diagnosis, this starting point may be the key for motivating someone to seek screening. There is evidence to suggest that public health education can be effective in reducing morbidity. Knowledge about glaucoma is known to improve compliance of patients with the disease, and also might increase the likelihood that glaucoma patients would prompt relatives to undergo glaucoma screening [41, 48].

Campaigns are ongoing to educate individuals at risk, and family members of patients with glaucoma. Celebrate Sight, Vision 2020, and the Vision Council of American all have strategies in place to increase glaucoma awareness by educating primary caregivers and the public about the disease. To most efficiently use resources to enhance public awareness about glaucoma, subgroups of the population that are at highest risk both for developing the disease and having insufficient knowledge about it need to be identified and targeted. The successful treatment of POAG depends on awareness of the disease and good compliance with treatment by the patient. An aware and knowledgeable patient is in a good position to inform their family members about the need to utilize screening services provided by optometrists and ophthalmologists. This could diminish the morbidity, personal and economic burden of the disease if individuals are encouraged to undergo appropriate screening that could lead to early detection and therefore early treatment.

Hypothesis:

In Connecticut, African Americans make up 15% of the population, yet they make up 33% of the glaucoma cases [49]. There are an estimated 14-21,000 African Americans with glaucoma, half of whom are unaware of their diagnosis. Given the benefits to patients of early detection, it was hypothesized that this high risk community would benefit immensely from an effective screening method that could detect glaucoma in its early stages. The Yale Eye Center Glaucoma Screening Project [50] was set up in September 2001 to test the effectiveness of current screening methods in the New Haven African-American Community. The goal was twofold: to determine the optimal protocol for detecting glaucoma in the African American community, and to study how to improve access to appropriate eye care amongst those who screen positive for the disease.

In our study, we found that noncompliance with follow up after glaucoma screening was associated with smoking (OR 3.1, p=0.0005), living alone (OR 2.2 p=0.008), and lacking access to a car for a previous eye exam (OR 2.1, p=0.0002). This raised further questions. Did people fail to return because they were unaware of their need for full screening? Whatever assumptions we might make about people's knowledge, there is still a large discrepancy between what people do and what people should do. This was illustrated by Sheldrick *et al.* [51] who found that almost 20% of glaucoma patients had advanced visual field loss at diagnosis. What does the community understand about glaucoma? Is this altered by risk factors for the disease? Can we determine who is well informed and who may need to be targeted in public health campaigns? These are some of the questions we set out to answer in this study.

Methods:

This is a retrospective review of 397 responses to a survey administered to patients in the waiting area of three New Haven health care facilities. Sites include two primary care centers; the Hill Health Center (PCC 1) and the hospital of St. Raphael (PCC 2) as well as the Yale Eye Center comprehensive eye service (CES) in June 2004. Institutional Review Board (IRB) approval was obtained from all three institutions for the study. Patients and those visiting the three sites were approached by the author and a research assistant as they were in the waiting area and invited to participate in the study. Pregnant women were excluded in compliance with institutional IRB recommendations. Patients who had previously been diagnosed with glaucoma were not excluded. All participants provided verbal informed consent for the screening. A total of 11 patients refused to take the survey for personal reasons.

Survey (see Figures 1&2 below)

The survey was designed to ask questions about knowledge of glaucoma, knowledge of glaucoma risk factors, and factors that might be associated with lack of knowledge of glaucoma. The survey was available in both English and Spanish.

Demographic Data.

Participants were asked to give data about their age, sex and race but not their names or other personal information. We declined to ask about education level and income, both of which would have given us more information about socioeconomic status. We declined to ask more personal information because we felt that since

participants were volunteering to answer the survey questions and were not being reimbursed in any way, asking personal information might increase their reluctance to complete the questionnaire. Since other studies have shown the link between socio-economic status (SES) and knowledge of glaucoma, we did not feel the need to reconstruct this information with this study.

Glaucoma and Knowledge

Participants were first asked whether or not they knew what glaucoma was. They were then given a list of four known risk factors and asked to circle which ones they knew to be risk factors for glaucoma. Other ways of determining knowledge were whether people knew they could become blind from glaucoma, and whether one can have glaucoma without having symptoms. Participants who said they knew what glaucoma is, but declined to circle any risk factors, or circled that they knew no risk factors were not considered to have knowledge of glaucoma in the analysis. Although a person may know what glaucoma is, and be unaware of the risk factors, we felt that knowing risk factors was more important for our analysis and in the long run, more important for targeting people who may need more education. Participants were also asked about personal history of glaucoma, family history of glaucoma, history of high IOP, previous screening, and their perceived risk of developing glaucoma.

General Health and Eye health information

Participants were asked to provide information about other systemic illnesses they had or were being treated for. This is because as stated in the introduction, many illnesses

such as hypertension and diabetes have a complex relationship with glaucoma. Hence, we wanted to elucidate whether or not patients with more illnesses would tend to know more or less about glaucoma than those who have no illnesses and who do not regularly visit a physician. Also, patients were asked about their use of ophthalmologists/eye care practitioners and prescription lense use as possible factors that may predict or be associated with lack of knowledge and glaucoma awareness.

Miscellaneous SES questions

These were included in the survey to find out if these two socio-economic factors would affect knowledge of glaucoma. As stated in the introduction, we found in our first project, that failure to follow up after glaucoma screenings was associated with smoking, living alone and lack of access to a car. It was therefore interesting to us to find out whether or not an association existed with knowledge and car ownership, living alone, and smoking. Employment history was included in the survey, but was not used in the analysis because of the difficulty of subjecting the five different types of responses to bivariate analysis.

The survey was self administered, but the author or a research associate were available to help if needed. The survey was available in English and Spanish to accommodate both English speakers and Spanish only speakers. The survey did not go through a develop phase, but since there is a consensus amongst previous studies that older age is associated with a higher prevalence of chronic illnesses, this question was used to validate the survey. Our analysis showed the ORs of participant above age 40 having one or more chronic illnesses to be 3.4 (CI 2.158 - 5.478 $p < 0.0001$) compared to

those below the age of 40. The age of 40 was picked as the cut off because it is the age at which there seems to be an increase in the risk of developing POAG.

Statistical Analysis:

For the purposes of statistical analysis, "knowledge" was made into a dichotomous variable by using the "risk factor score", ie the answers to question 13 of the survey. The number of risk factors (1-4) known to participants, compared to none (0) known or "I don't know" category. If the participant answered between 1-4 factors right, they were assigned to the " having knowledge" category for the purposes of analysis. If they answered "I don't know" or "none" they were assigned to the "lacking knowledge" category.

Bi-variate and multivariate analyses were conducted using the commercially available SAS software program version 9.1. The χ^2 test was used to compare variables in the survey that were significantly different between the two groups. All variables, except the continuous variable age, were subjected to χ^2 analysis. The Student's T test was used for comparing differences in the mean of the continuous variable "age". Estimates of the multivariate adjusted odds ratios (ORs) for lack of knowledge and 95% confidence intervals (CIs) were made. All variables, whether they were significant or not in bi-variate analysis, were analyzed in linear logistic regression models to identify the ones associated with lack of knowledge. Variables were added to the model one at a time, and were only removed if the model lost significant ($p>0.05$) using forward selection. All p values reported are two tailed and significance was defined as $p<0.05$. The Akaike Information Criterion (AIC) and Schwartz Criterion (SC) were applied to the significant

models, and the one with the lowest values, indicating a better fit were chosen. Finally, the Hosmer and Lemeshow Goodness-of-Fit Test was also applied to all statistical models, and the one with the highest p value, which would allowed for acceptance of the null hypothesis that the data fit the specified model was chosen.

Figure 1.

Survey

Age:

Sex: Male Female

Race/Ethnicity (please circle all that apply)

a) Asian
b) Black
c) Caucasian
d) Hispanic
e) Other

1) Do you have an ophthalmologist? (eye doctor) YES NO

2) Do you wear prescription glasses/contact lenses? YES NO

3) How many times a year do you see an eye doctor/practitioner? 0 1 >1

4) Have you ever been told you have high eye pressures? YES NO

5) Do you know what glaucoma is? YES NO NOT SURE

6) Have you ever been screened for glaucoma? YES NO

7) If YES, where?

Your doctor
At a health fair
At a community clinic
Other (please specify) _____

8) Has anyone ever told you that you have glaucoma? YES NO NOT SURE

9) Do you have family members with glaucoma? YES NO NOT SURE

10) What do you think your risk of getting glaucoma is? NONE MEDIUM HIGH

11) Can people go blind from glaucoma? YES NO NOT SURE

12) Can you have glaucoma without any symptoms? YES NO NOT SURE

13) How many of the following do you know to be risk factors for glaucoma?

a) Age over 40
b) Family history of glaucoma
c) African descent
d) High eye pressures
e) I'm not sure

14) Do you have/have you ever had any of the following illnesses?

High Blood Pressure YES NO
Cancer YES NO
Stroke YES NO
Diabetes YES NO

15) Do you own a car? YES NO

16) How do you travel to your eye doctor? Car Bus Walking

17) What is your current job situation?

a) Employed
b) Unemployed
c) Disability
d) Retired
e) Self employed

18) Do You Smoke YES NO

19) Do You Live Alone? YES NO

THE END - THANK YOU

Figure 2.

Cuestionario

Edad:
Sexo: Masculino Femenina
Raza: (favor de circular todo que aplique a usted)
a) Asiático/a
b) Blanco/a
c) Negro/a
d) Latino/a
d) Otro (se especifico/a) _____

1. Tiene un oftalmólogo (doctor de los ojos)? SI NO
2. Usa lentes recetados/lentes de contactos? SI NO
3. Cuantas veces al ano ve a su oftalmólogo? 0 1 >1
4. Le han dicho alguna vez que tiene alta presión en los ojos? SI NO NO ESTOY SEGURO/A
5. Sabe lo que es glaucoma? SI NO NO ESTOY SEGURO/A
6. Le han hecho un chequeo para glaucoma alguna vez? SI NO NO ESTOY SEGURO/A
7. Si SI, a donde?
   a) Su doctor/a
   b) En una Feria de Salud
   c) En una clínica en la comunidad
   d) Otro (se especifico/a) _____
8. Le han dicho alguna vez que tiene glaucoma? SI NO NO ESTOY SEGURO/A
9. Tiene familia con glaucoma? SI NO NO ESTOY SEGURO/A
10. Que riesgo cree que tiene de tener glaucoma? Ninguna Mediana Alto
11. Sabe si gente puede terminar ciego a causa de glaucoma? SI NO NO ESTOY SEGURO/A
12. Tiene síntomas de glaucoma? SI NO NO ESTOY SEGURO/A
13. Cuales de los siguientes conoce como elementos de riesgo de glaucoma?
    a) Mas de 40 anos de edad
    b) Historia familiar de glaucoma
    c) Raza Negra
    d) Presión alta en los ojos
    e) No estoy seguro/a
14. Tiene/Ha tenido alguna vez cualquiera de las siguientes enfermedades?
    a) Presión Alta SI NO
    b) Cáncer SI NO
    c) Hemorragia cerebral SI NO
    d) Diabetes SI NO
    e) Otro (se especifico/a) _____
15. Tiene automóvil (carro)? SI NO
16. Como va a su visita con el doctor? Carro Autobús Tren A pie
17. Cual de estos describe su situación de empleo?
    a) Empleado/a
    b) Sin trabajo
    c) Deshabilitado/a y sin trabajo
    d) Retirado/a
    e) Auto-empleado/a
18. Fuma cigarrillos? SI NO
19. Vive solo/a? SI NO

EL FIN-GRACIAS!

Results:

1) Demographic Data:

Total number of people approached N= 402.

Total number of participants surveyed = 397.

Total number declining to be surveyed for personal reasons N=11

Total number answering all questions N=352; 230 = 65.6% women, 122 = 34.4% men

Number declining to answer 1 or more questions = 45

Number of participants at PCC 1 = 159

Number of participants at PCC 2 = 122

Number of participants at CES = 116

Age Range 18-85 years, mean age was 48.4 ± 15.7 years.

a) Age Data N=397

Average Age at each location

Location	Age in Years	Stnd. Dev
PCC 1	46.5	±13.3
PCC 2	45.8	±15.4
CES	52.8	±18.3

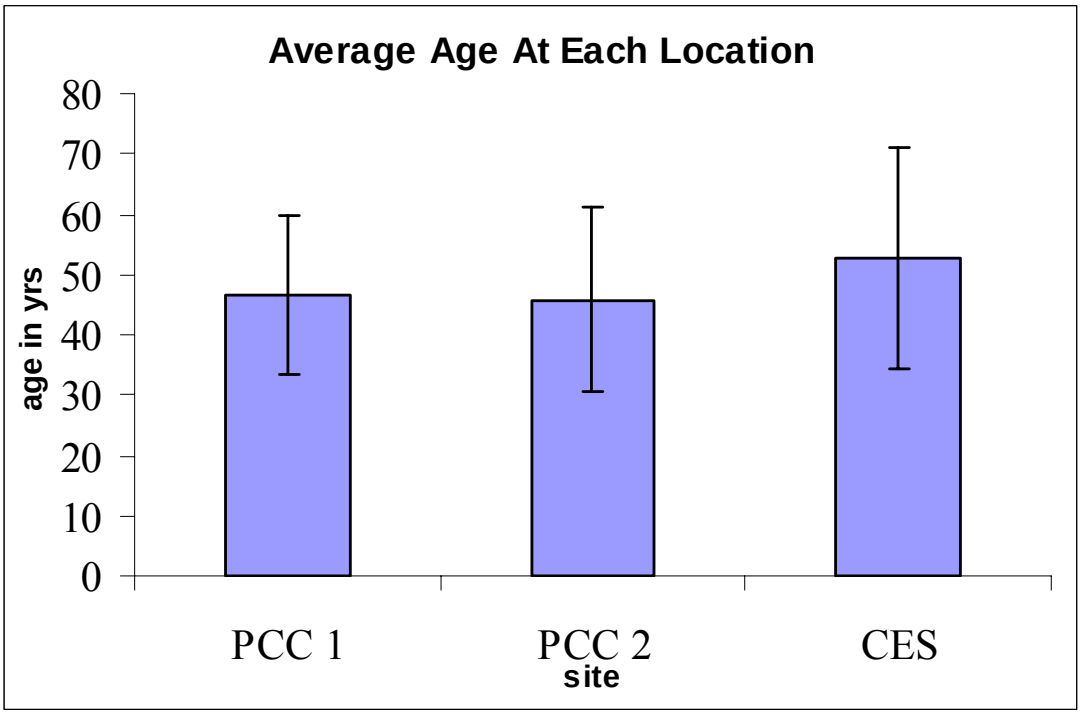

Figure 1a: Graph and chart showing mean age at each location, with standard deviation in years. Graph shows the mean age to be higher at the Eye Center than at the Primary Care Centers. However when taking the standard deviations into account, the means are no longer statistically different. Using the Student's T test, the difference between the means fails to reach statistical significance. p=0.586
PCC: Primary Care Center
CES: Comprehensive Eye Service

b) Gender Distribution of Participants (N= 389)

Ratio of Males and Females

Location	**M**	**F**
PCC 1 N=154	56 (36.36%)	98 (63.6%)
PCC 2 N=120	37 (30.8%)	83 (70.2%)
CES N= 115	42 (34.5%)	73 (63.5%)

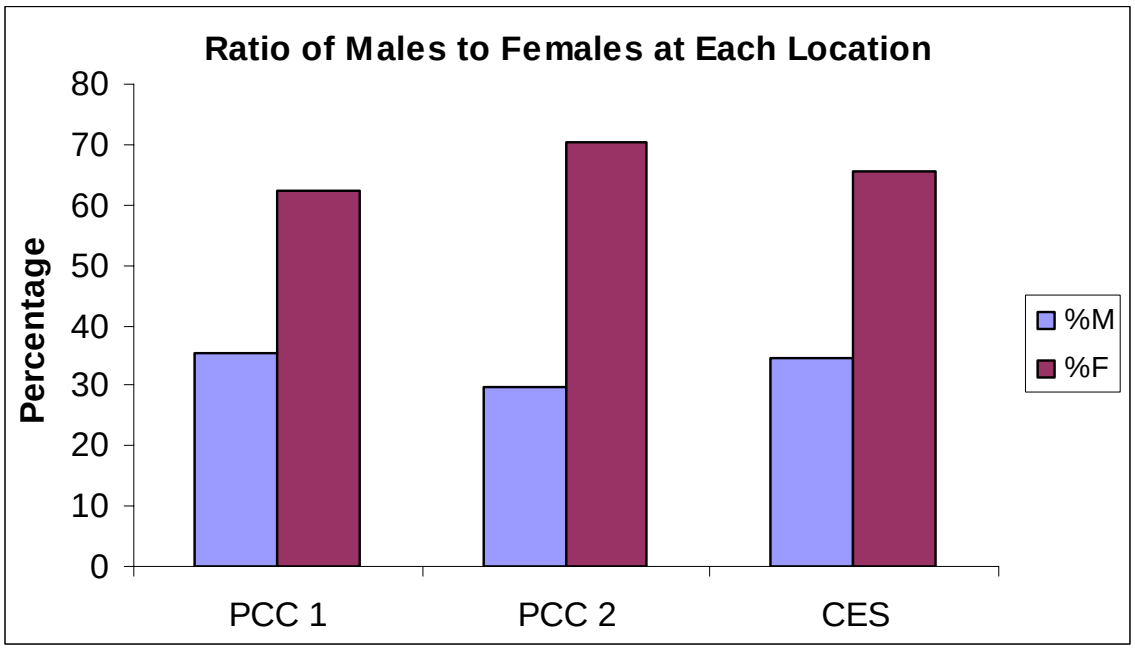

Figure 1b: Chart and Graph showing numbers and percentages of males and females at each location. At each location, there are about twice the number of women as men. This difference does not reach statistical significance. P=0.59. 8 participants in total did not answer this question. (5 at PCC 1, 2 at PCC 2 and 1 at CES).
PCC = primary care center
CES = comprehensive eye service

c) Living Situation/Smoking/Car Ownership

Percent of participants who live alone, smoke or own a car

Location	Live alone N=86	Location	Own a car N= 207	Location	Smoke N=109
PCC 1 N=153	42(27.4%)	PCC 1 N= 152	67 (44.8%)	PCC 1 N=153	52 (34%)
PCC 2 N=117	26 (22.2%)	PCC 2 N= 112	57 (50.8%)	PCC 2 N=116	34 (29.3%)
CES N=109	18 (16.5%)	CES N=109	83 (76.2%)	CES N=109	23 (21.0%)

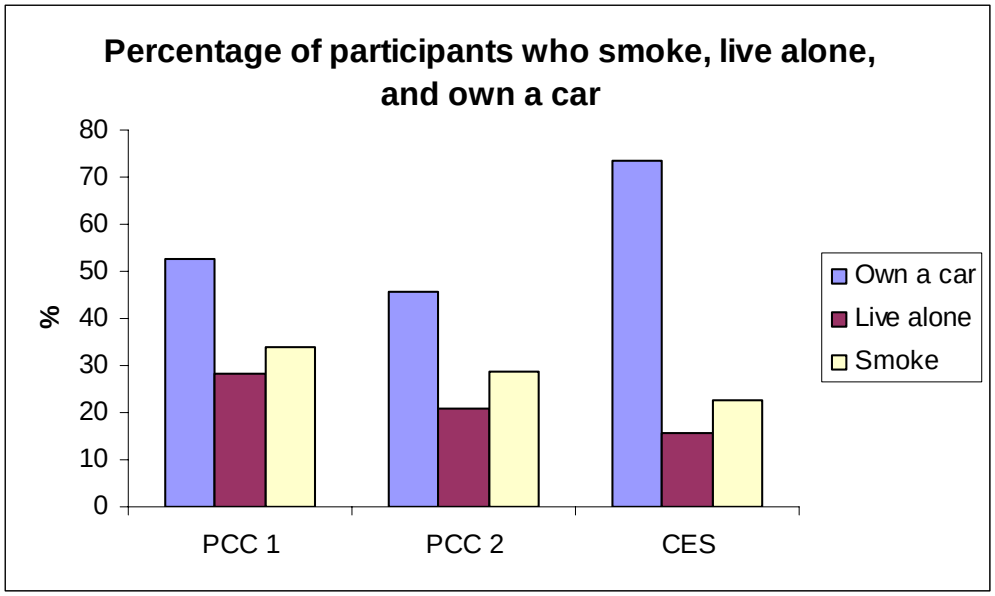

Figure 1c) Table and graph showing number/percentage of participants who smoke, live lone, and own a car at each location. The differences between the values at each location did not reach statistical significance when subjected to the student's T test for any of the factors. Smoking p=0.51, (19 participants did not answer this question. 6 at PCC1, 6at PCC 2, 7 at CES).Living alone p=0.63 (18 participants did not answer this question. 6 at PCC1, 5 at PCC2, 7 at CES). Owning a car p= 0.06 (24 participants did not answer this question. 7 at PCC1, 10 at PCC2, 7 at CES).

1d) Glaucoma history

Participants with Glaucoma, high intraocular pressure, previous screening

Location	**Glaucoma**	**Location**	**High IOP**	**Location**	**Previously Screened**
	N = 30		**N= 66**		**N=**
PCC 1 N= 158	7 (4.4%)	PCC 1 N= 153	20 (13.1%)	PCC 1 N= 156	49 (31.4%)
PCC 2 N=122	9 (8.3%)	PCC 2 N= 119	23 (19.3%)	PCC 2 N= 116	64 (55.2%)
CES N=113	14 (12.9%)	CES N= 116	23 (20.2%)	CES N= 116	75 (64.7%)

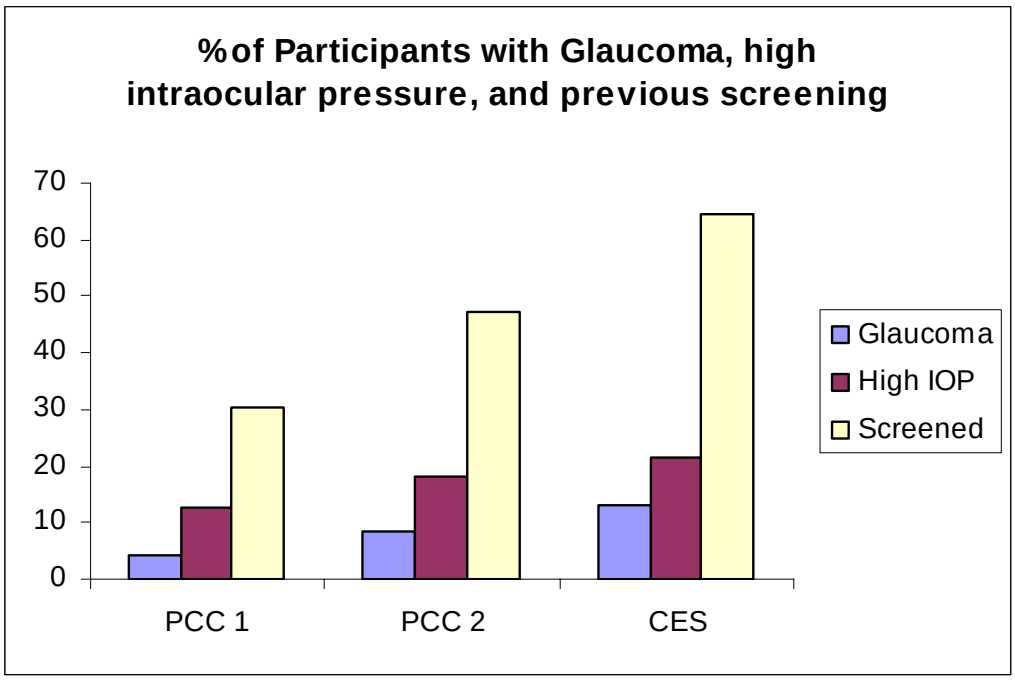

Figure 1d). Table and graph showing number/percentage of participants who were previously screened, had a history of high intra ocular pressure (IOP) and a history of glaucoma. The differences between the values at each location did not reach statistical significance when subjected to the student's T test for any of the factors. None of the differences reach statistical significance. Previous screening, p=0.92, (9 participants did not answer this question. 3 at PCC1, 6 at PCC2). High intraocular pressure (IOP) p=0.89, (9 participants did not answer this question. 6 at PCC1, 3 at PCC2.) Glaucoma history p=1.00, 4 participants did not answer this question. 1 at PCC1 and 3 at CES)

1e) Racial profile of participants

Racial profile of participants

Location	Asian N=2	Black N=155	Hispanic N=104	White N=123	Other/no answer N=13
PCC 1 N=159	0 (0%)	69(43.4%)	66(41.5%)	22(13.8%)	2 (1.2%)
PCC 2 N=122	2(1.6%)	61(50%)	21(17.2%)	29(23.7%)	9 (7.4%)
CES N=114	0 (0%)	25(21.9%)	17(14.9%)	72(63.2%)	2 (1.6%)

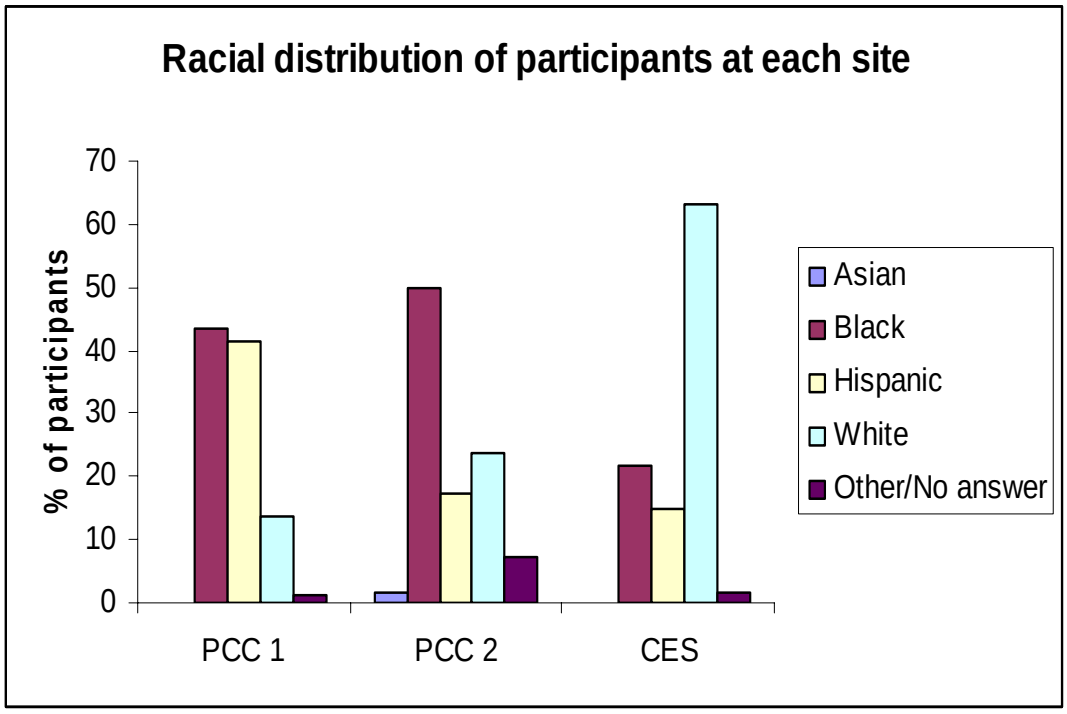

Figure 1e). Table and graph showing racial distribution of participants at each site. "Other" was added to "no answer" for analysis purposes only, since the different races specified included combinations of races that could not be teased apart in analysis.
PCC = Primary care center
CES = comprehensive eye service

f) Family History of Glaucoma?

Participants with and without a family history of glaucoma at each location

Location	No family history N= 215	Family history N=79	Not sure N=94
PCC 1 N=155	86 (55.5%)	32 (20.7%)	37 (23.8%)
PCC 2 N=119	63 (52.9%)	22 (18.5%)	34 (28.6%)
CES N=114	66 (57.9%)	25 (21.9%)	23 (20.2%)

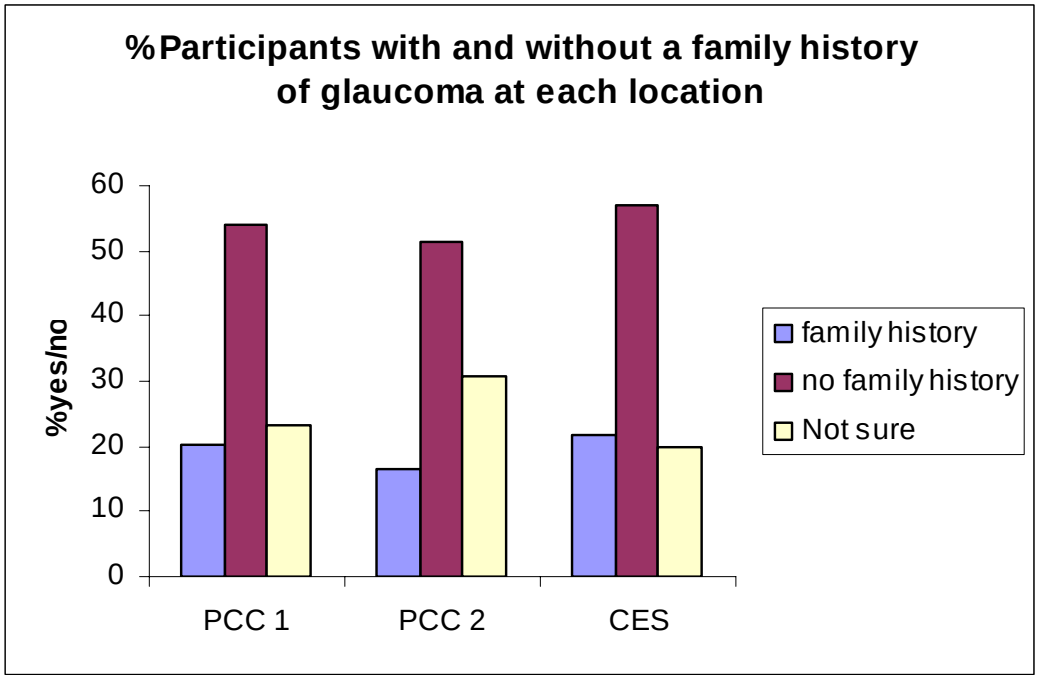

Figure 1f) Table and graph showing participants with a family history of glaucoma at each location. People at the CES had more family members with glaucoma, and fewer of them did not know or were not sure of their family history compared to participants at the two PCCs. (9 participants did not answer this question 4 at PCC1, 3 at PCC 2, 2 at CES).
PCC = Primary care center
CES = Comprehensive eye service

g) Participants with an Ophthalmologist and Prescription glasses/contacts

% of People with a regular Eye Practitioner and with Prescription glasses/Contact Lenses

Location	**Ophthalmologist N=243**	**Location**	**Prescription N=259**
PCC 1 N=158	87 (55.1%)	PCC 1 N=158	98(62.0%)
PCC 2 N=120	68 (56.7%)	PCC 2 N=121	78 (64.4%)
CES N=115	88 (76.5%)	CES N=116	83 (71.5%)

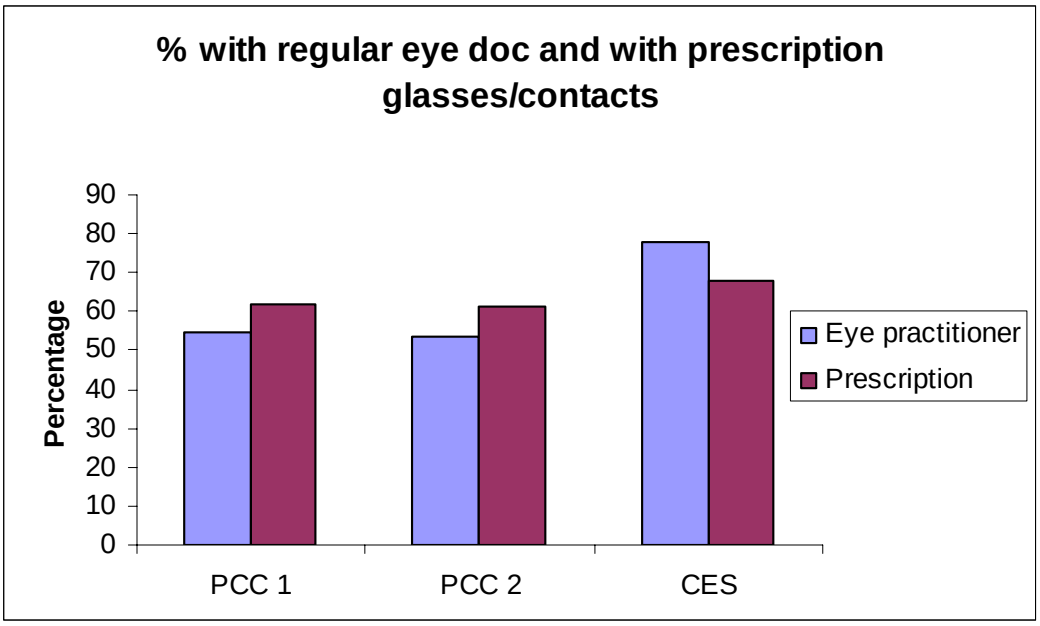

Figure 1g) Graph and Table showing participants with an ophthalmologist and those with prescription glasses/contact lenses. More of the participants at the CES had access to an ophthalmologist than those at the PCCs. None of these differences reach statistical significance with the student's T test. (Prescription, p=0.64, Ophthalmologist, p= 0.11) (4 participants did not answer this question, 1 at PCC 1, 2 at PCC 2, 1 at CES).
PCC- primary care center
CES – comprehensive eye service

h) Participants with and without eye appointments during the year

Participants with none, 1, or greater than 1 eye appointment within the year

Location	**0**	**1**	**>1**
	N=109	**N=199**	**N=80**
PCC 1 N=154	49 (31.8%)	81(52.6%)	24(15.5%)
PCC 2 N=120	38 (31.7%)	62 (51.7%)	20 (16.7%)
CES N=114	22 (19.3%)	56 (49.1)	36 (31.6%)

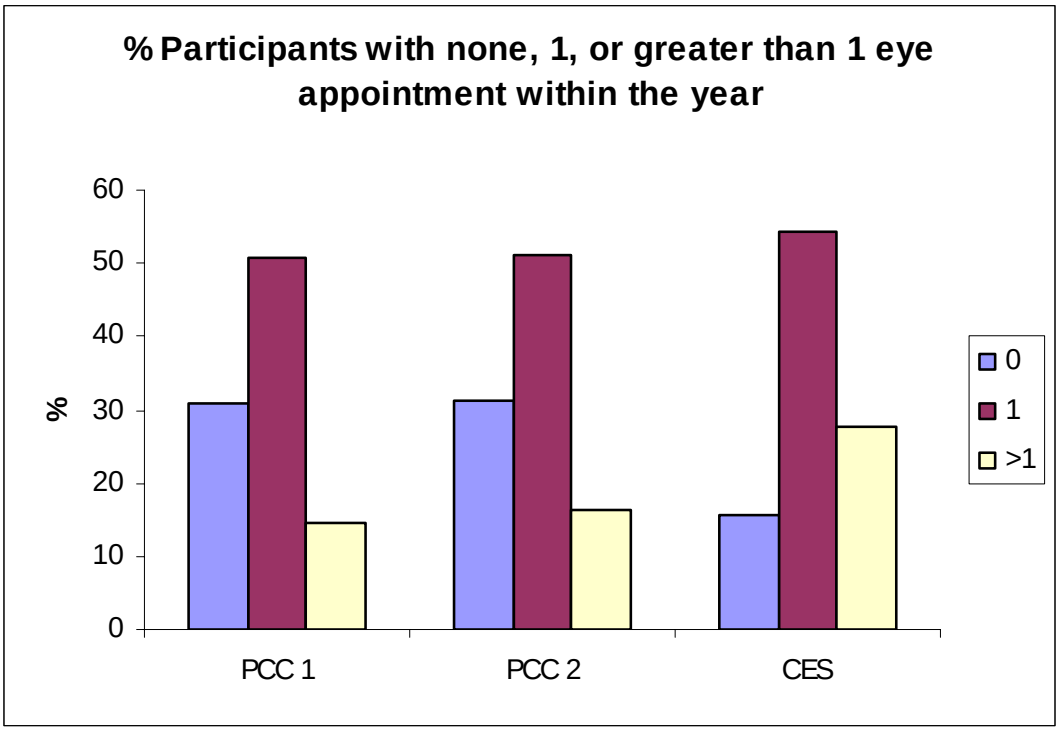

Figure 1h) Table and graph showing participants with and without an eye appointment within the year at each location. Participants at the CES saw an ophthalmologist more times during the year than those at the PCCs. (9 Participants did not answer this question, 5 at PCC1, 2 at PCC 2, 2 at CES)
PCC = primary care center
CES = comprehensive eye service

i) Partcipants'perceived risk of developing glaucoma at each site

Participants' perceived risk of developing glaucoma at each location

Location	None N=168	Medium N=125	High N=38	Not sure N=21
PCC 1 N=137	75 (54.7%)	50(36.5%)	12 (8.7%)	0 (0%)
PCC 2 N=110	54 (49.1%)	39 (35.5%)	9 (8.2%)	8 (7.2%)
CES N=105	39(37.1%)	36 (34.3%)	17(16.2%)	13(12.4%)

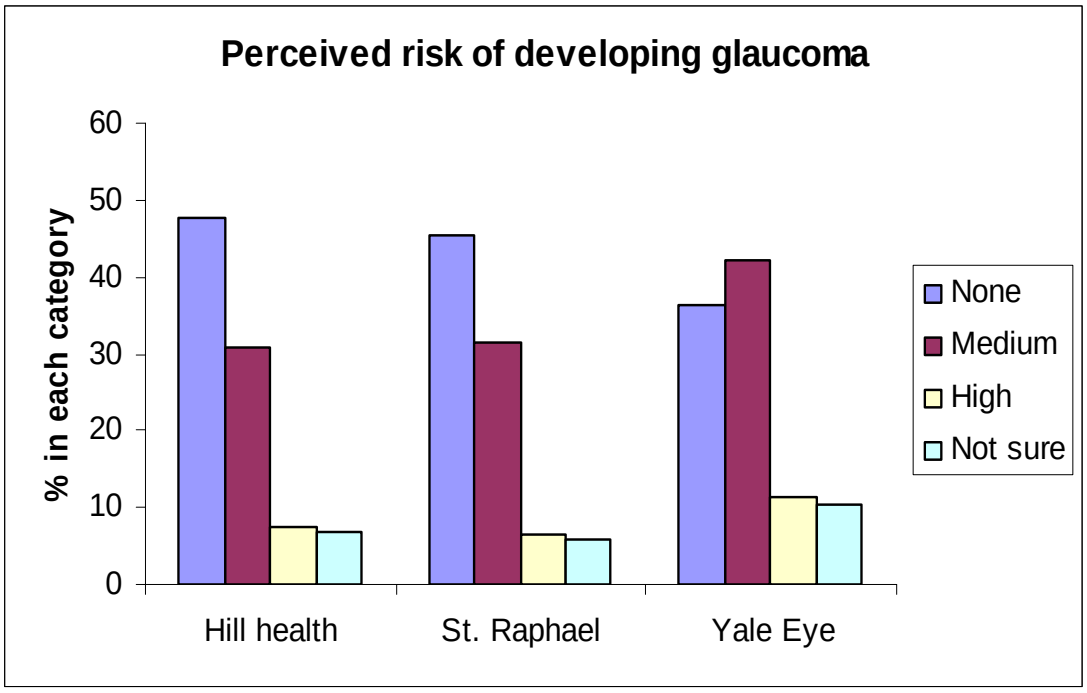

Figure 1i) Table and graph showing participant's perceived risk of developing glaucoma at each site. More participants at the two primary care centers felt they were at low risk of developing glaucoma than those at the CES. (*45 participants did not answer this question, 22 at PCC1, 12 at PCC 2, 11 at CES)
PCC = primary care center
CES= comprehensive eye service

j) Types of Chronic Illnesses reported by participants at each location

Participants with various chronic illnesses at each location

Location	**HTN N=157**	**Diabetes N=72**	**Cancer N=22**	**Stroke N=24**
PCC 1 N=154	62(40.8%)	34(22.2%)	5(3.3%)	9(5.9%)
PCC 2 N=117	53(45.3%)	24(20.9%)	5(4.3%)	9(7.7%)
CES N=108	42(38.5%)	14(13.1%)	12 (11.1%)	6(5.6%)

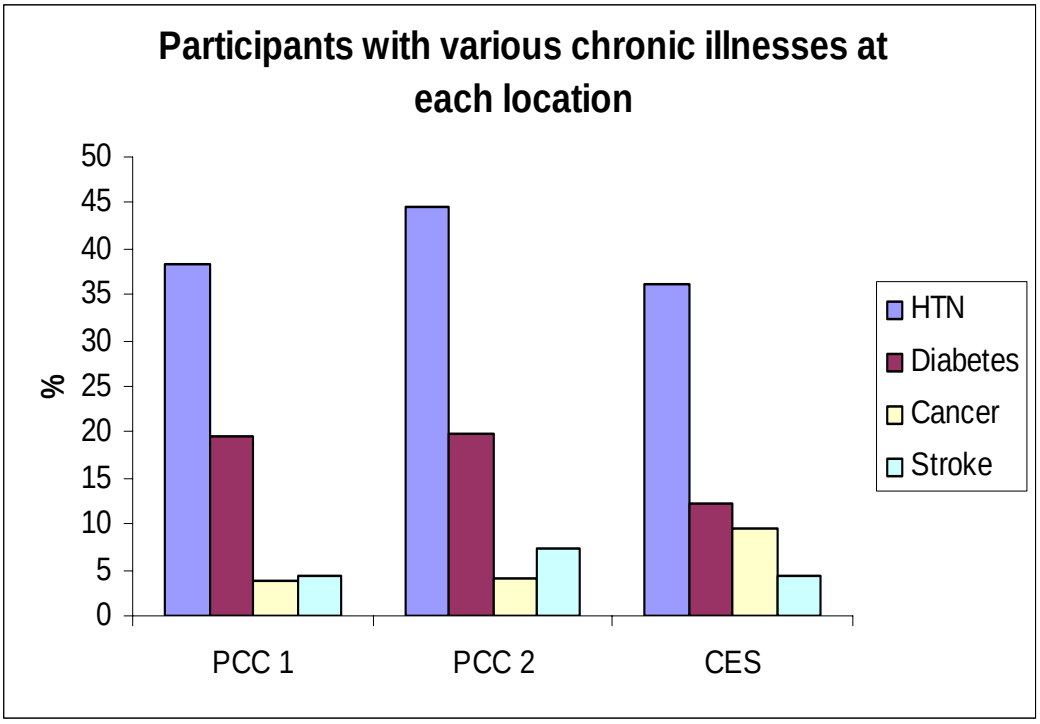

Figure 1j) Table and graph showing participants with various chronic illnesses at location. Both PCCs have more participants with illnesses than the CES. When comparing all chronic illnesses at different sites using a student's T test, the difference does not reach statistical significance. (p= 0.58). 18 Participants did not answer this question. 5 at PCC 1, 5 at PCC 2, and 8 at CES.
PCC = primary care center
CES= comprehensive eye service

k) Percent of participants at each location circling 1-4 risk factors for glaucoma

Number of risk factors for glaucoma circled by participants at each site

Location	One N=94	Two N=47	Three N=38	Four N=14	Don't Know N=175
PCC 1 N=144	37(25.6%)	16(11.1)	9(6.3%)	42(2.8%)	78(54.2%)
PCC 2 N=115	32(27.8%)	12(10.4%)	8(7.0%)	2(1.8%)	61(53.0%)
CES N=109	25(22.9%)	19(17.5%)	21(19.3%)	8(7.3%)	36(33.0%)

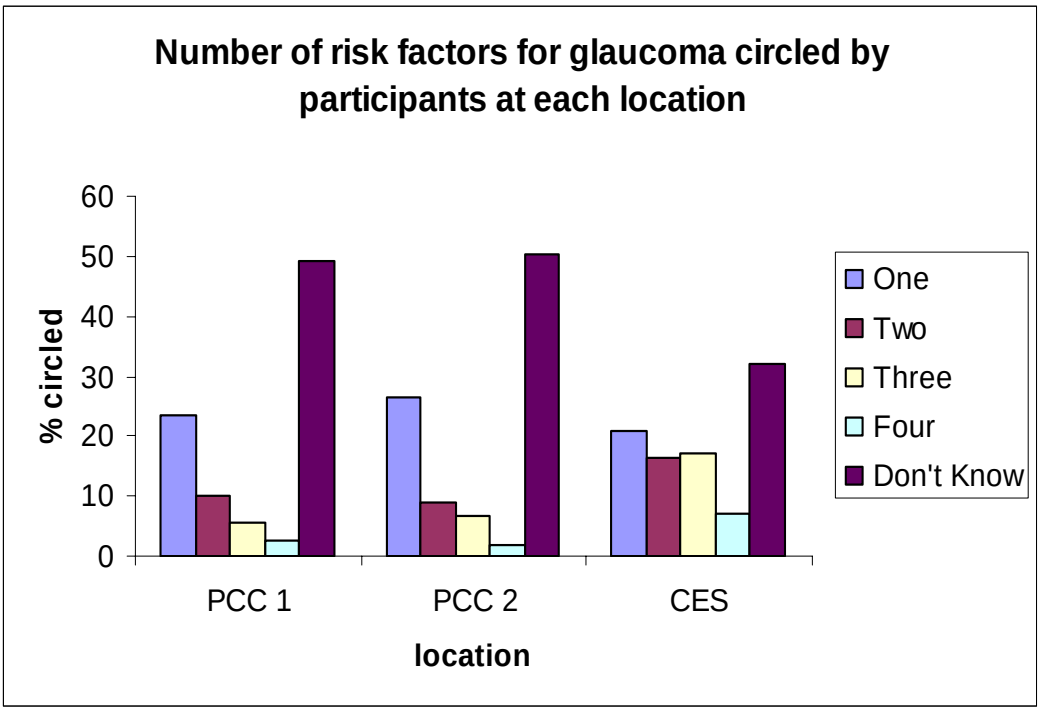

Figure 1k) Table and graph showing the number of factors participants at each location knew to be risk factors for glaucoma. More participants at the PCCs circled “I don’t know” as an answer than at the CES. Overall, people at the CES knew more risk factors than those at the PCCs. (29 Participants did not answer this question, 15 at PCC1, 7 at PCC 2, 7 at CES.)

2) Statistical Analysis

(a) Bivariate analysis of factors associated with lack of knowledge of glaucoma risk factors and the associated P values.

Variable	Lacking Knowledge of glaucoma risk factors	Having knowledge of glaucoma risk factors	ORs with 95% (CI)	P Values
Female Gender	110 (46.4%)	127 (53.6%)	0.84 (0.542 - 1.295)	0.42
Age below 40	58 (48.3%)	62 (51.7%)	1.13 (0.725 - 1.767)	0.58
Location at a PCC	139 (79.4%)	36 (20.6%)	2.35 (1.471 - 3.750)	0.0003
No Family History of Glaucoma	104 (51.7%)	97 (49.3%)	3.00 (1.679 - 5.365)	0.0001
Ethnic Minority	132 (55.2%)	107 (44.8%)	2.60 (1.65 - 4.19)	<0.0001
No Previous Screening	105 (59.5%)	83 (40.5%)	2.10 (1.38 - 3.23)	0.0005
No Prescription lenses (glasses/contacts)	70 (56.5%)	54 (43.5%)	1.70 (1.12 - 2.68)	0.013
No History of Elevated Eye Pressures	147 (49.5%)	150 (50.5%)	1.90 (1.05 -3.32)	0.032
No eye appointments in past year	58 (58.0%)	42 (42.0%)	1.80 (1.12 - 2.85)	0.015
No glaucoma history	169 (49.7%)	171 (50.3%)	3.13 (1.22 - 8.03)	0.013
No eye doctor/ophthalmologist	74 (53.2%)	65 (46.8%)	1.45 (0.947 - 2.215)	0.08
No perceived risk of glaucoma	87 (56.1%)	68 (43.9%)	2.31 (1.482 - 3.602)	0.0002
No Chronic illnesses	85 (49.7%)	86 (50.3%)	0.95 (0.627 - 1.431)	0.79
Lacking a car	79 (50.9%)	76 (49.1%)	1.37 (0.900 - 2.084)	0.14
Not living alone	133 (46.5%)	153 (53.5%)	0.85 (0.514 - 1.395)	0.51
Not smoking	118 (45.5%)	141 (54.5%)	0.80 (0.508 - 1.273)	0.35

Table 2 a) Bivariate analysis of various factors and their association with lack of knowledge of glaucoma. ORs = Odds Ratios for the probability of lacking knowledge. CIs = 95% confidence intervals.

Significant Variables: Data from All Sites

Bivariate analysis of variables at all three sites shows that the following are significantly associated with lack of knowledge of glaucoma risk factors. (see Table 2a for full statistics.)

- *No previous screening for glaucoma*: Participants who have not been screened previously for glaucoma are 2.1 times more likely to lack knowledge of glaucoma risk factors than those who have previously been screened (p=0.0005).
- *No prescription lenses*: Participants who do not wear prescription glasses or contact lenses are 1.7 times more likely to lack knowledge of glaucoma risk factors than those who wear prescription lenses (p=0.013).
- *No history of increased IOP*: Participants who do not have a history of increased IOP are 1.9 times more likely to lack knowledge of glaucoma risk factors than those who have been told previously that they have high IOP in either eye (0.032).
- *Not having glaucoma*: Participants who do not have glaucoma or a history of being told they have glaucoma are 3.1 times more likely to lack knowledge of glaucoma risk factors than participants who have glaucoma (p=0.013).
- *No eye appointments*: Participants who have not had any eye appointments within the year are 1.8 times more likely to lack knowledge of glaucoma risk factors than those who had had one or more eye appointments within the year (p=0.015).
- *No perceived risk of developing glaucoma*: Participants who felt they had no risk of developing glaucoma are 2.3 times more likely to lack knowledge of glaucoma risk factors than those who felt they had a medium or high risk of developing glaucoma (p=0.0002).

- *No family history of glaucoma*: Participants who had no family history of glaucoma are 3.0 times more likely to lack knowledge of glaucoma risk factors than those who have a family history of glaucoma (p=0.0001).
- *Being an ethnic minority*: Participants who self identified as Black or Hispanic are 2.6 times more likely to lack knowledge of glaucoma risk factors than those who self identified as White/Caucasian (p<0.0001).
- *Being at a PCC*: Participants who were at a primary care center are 2.4 times more likely to lack knowledge of glaucoma than those who were at the CES (p=0.0003).

Non-significant Variables

Bivariate analysis of variables at all sites shows that some variables, although different between the knowledgeable and those lacking knowledge, did not reach statistical significance. (See Table 2a for full details.). The variables are as follows: age below 40 (p=0.58), female gender (0.42), having no chronic illnesses (p=0.79), no ophthalmologist (p=0.08), lacking a car (p=0.14), not living alone (p=0.51) and not smoking (p=0.35).

Figure 2 (b) Multivariate Analysis of factors associated with lack of knowledge of glaucoma risk factors

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	P Value
No family History of glaucoma	3.7	1.905 – 7.375	0.0003
Ethnic minority	2.3	1.194 - 4.254	0.012
Being at a Primary Care Center	2.2	1.130 - 4.186	0.02

Figure 2 b) Table showing factors remaining significant after adjusting for confounding variables in multivariate analysis. Model Fit Statistics are as follows; Akaike Information Criterion (AIC) = 369.8 (intercept only) Schwartz Criterion (SC) = 373.38 (intercept only). Hosmer and Lemeshow Goodness-of-Fit test, $\chi^2 = 4.406$, with 4 Degrees of Freedom (DF). Final P value 0.353.

Multivariate analysis: Significant Variables:

When adjusting for confounding variables in multivariate analysis, lack of knowledge of glaucoma risk factors is associated with 3 significant variables. (See Table 2b for full details).

- Participants without a family history of glaucoma are 3.7 times more likely to lack knowledge of glaucoma than those with a positive family history (p=0.0003).
- Participants who self identified as an ethnic minority are 2.3 times more likely to lack knowledge of glaucoma risk factors than those who self identified as White/Caucasian (p=0.012).
- Participants who were at a PCC are 2.2 times more likely to lack knowledge of glaucoma risk factors than those who were at the CES (p=0.02).

Variables that were statistically significant in predicting lack of knowledge of glaucoma in bivariate analysis that are no longer significant include; no previous

screening, no prescription lenses, no history of elevated IOP, no eye appointments this year, no history of glaucoma, and no perceived risk of developing glaucoma.

Summary Statistics 3 (a)

Bivariate analysis of factors associated with lack of knowledge of glaucoma risk factors at primary care centers only

Variable	Lacking Knowledge of glaucoma risk factors	Having Knowledge of glaucoma risk factors	ORs with 95% (CI)	P Values
Female Gender	81 (47.9%)	88 (52.1%)	0.77 (0.457 - 1.316)	0.06
Age below 40	47 (51.6%)	44 (48.4%)	0.93 (0.549 - 1.572)	0.78
No History of Glaucoma	134 (54.7%)	111 (45.3%)	1.93 (0.614 - 6.071)	0.25
Ethnic Minority	118 (59.4%)	80 (40.6%)	3.13 (1.622 – 6.055)	0.0005
No Previous Screening	86 (58.1%)	62 (42.9%)	1.62 (0.976 - 2.698)	0.06
No Prescription Eye Wear (glasses/contacts)	59 (64.1%)	33 (35.9%)	1.97 (1.166 - 3.324)	0.01
No History of Elevated Eye Pressures	116 (54.5%)	97 (45.5%)	1.64 (0.8181 - 3.305)	0.16
No eye appointments in past year	51 (64.6%)	28 (35.4%)	1.89 (1.089 - 3.265)	0.02
Not Living Alone	104 (52.8%)	93 (47.2%)	0.83 (0.465 - 1.482)	0.53
Lacking a car	73 (56.1%)	57 (43.9%)	1.32 (0.806 - 2.173)	0.26
Not Smoking	98 (55.4%)	79 (44.6%)	1.24 (0.730 - 2.105)	0.42
No family history of glaucoma	84 (60.4%)	55 (39.6%)	3.77 (1.890 - 7.507)	0.0001
No Eye Doctor	65 (57.5%)	48 (43.5%)	1.29 (0.790 - 2.133)	0.30
No perceived risk of glaucoma	76 (63.8%)	43 (36.2%)	2.86 (1.673 - 4.893)	0.0001
No Chronic illnesses	65 (46.7%)	74 (53.3%)	0.82 (0.502 - 1.341)	0.43

Table 3 a) Bivariate analysis of various factors and their association with lack of knowledge of glaucoma amongst participants at the two primary care centers only. ORs = Odds Ratios for the probability of lacking knowledge. CIs = 95% confidence intervals.

Significant Variables: Data from PCCs only

Bivariate analysis of variables from the two primary care centers was done to figure out if there was an inherent bias in the data from the CES that was perhaps causing the data to be skewed in any way. The analysis shows that the following are significantly associated with lack of knowledge of glaucoma risk factors amongst participants at the primary care centers. (see Table 3a for full statistics.)

No prescription lenses: participants who do not wear prescription glasses or contact lenses are 1.9 times more likely to lack knowledge of glaucoma risk factors than those who wear prescription lenses. (p=0.01)

No eye appointments: participants who have not had any eye appointments within the year are 1.9 times more likely to lack knowledge of glaucoma risk factors than those who had had one or more eye appointments within the year. (p=0.02)

No perceived risk of developing glaucoma: participants who felt they had no risk of developing glaucoma are 2.9 times more likely to lack knowledge of glaucoma risk factors than those who felt they had a medium or high risk of developing glaucoma. (p=0.001)

No family history of glaucoma: participants who had no family history of glaucoma are 3.8 times more likely to lack knowledge of glaucoma risk factors than those who have a family history of glaucoma. (p=0.0001)

Being an ethnic minority: participants who self identified as Black or Hispanic are 3.1 times more likely to lack knowledge of glaucoma risk factors than those who self identified as White/Caucasian. (p=0.0005)

Non-significant Variables

Bivariate analysis of variables from the two primary care sites only, shows that some variables, although different between the knowledgeable group and those lacking knowledge, did not reach statistical significance. (See Table 2a for full details.). The variables are as follows; age below 40 (p=0.78), female gender (p=0.06), not having been previously screened for glaucoma (p=0.06), no history of elevated IOP (p=0.16), having no history of glaucoma (p=0.25), not having an ophthalmologist (p=0.30), having no chronic illnesses (p=0.43), lacking a car (p=0.26), not living alone (p=0.53) and not smoking (p=0.42).

Summary Statistics 3 (b)

Multivariate Analysis of factors associated with lack of knowledge of glaucoma risk factors at primary care centers only.

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	P Value
No family History of glaucoma	3.6	1.635 – 8.054	0.0003
Ethnic minority	2.9	1.285 – 6.549	0.0042
No perceived risk of glaucoma	2.0	1.009 – 3.086	0.045

Table 3b) Table showing factors remaining significant after adjusting for confounding variables in multivariate analysis of variables from the two primary care sites only. Model Fit Statistics are as follows; Akaike Information Criterion (AIC) = 223.782 (intercept only) Schwartz Criterion (SC) = 226.850 (intercept only). Hosmer and Lemeshow Goodness-of-Fit test, $\chi^2 = 2.354$, with 5 Degrees of Freedom (DF). Final P value 0.798.

Multivariate analysis: Significant Variables:

When adjusting for confounding variables in multivariate analysis, lack of knowledge of glaucoma risk factors at the two primary care sites is associated with 3 significant variables. (See Table 3b for full details).

- Participants without a family history of glaucoma are 3.6 times more likely to lack knowledge of glaucoma than those with a positive family history. (p=0.0003)
- Participants who self identified as an ethnic minority (Black or Hispanic) are 2.9 times more likely to lack knowledge of glaucoma risk factors than those who self identified as White/Caucasian. (p=0.0042)
- Participants who felt they were not at any risk of developing glaucoma were 2.0 times more likely to lack knowledge of glaucoma risk factors. (p=0.045)

Variables that were statistically significant in predicting lack of knowledge of glaucoma in bivariate analysis that are no longer significant include; no prescription lenses, and no eye appointments within the year.

Summary Statistics 4

(a) Bivariate analysis of factors associated with lack of knowledge of what glaucoma amongst minorities only

Variable	Lacking Knowledge of glaucoma risk factors	Having Knowledge of glaucoma risk factors	ORs with 95% (CI)	P Values
Female Gender	93 (54.1%)	79 (45.9%)	0.81 (0.469 - 1.401)	0.45
Age below 40	48 (51.1%)	46 (48.9%)	0.84 (0.494 - 1.417)	0.51
Primary Care Location	123 (58.9%)	86 (41.1%)	2.67 (1.345 - 5.296)	0.004
No History of Glaucoma	132 (57.1%)	99 (42.9%)	3.11 (1.154 - 8.383)	0.019
Black Race	71 (43.6%)	76 (56.4%)	0.47 (0.276 - 0.814)	0.006
No Previous Screening	90 (59.2%)	62 (40.7%)	1.65 (0.981 - 2.787)	0.058
No Prescription Eye Wear (glasses/contacts)	57 (60.6%)	37 (39.4%)	1.48 (0.882 - 2.491)	0.14
No History of Elevated Eye Pressures	112 (56.3%)	87 (43.7%)	1.76 (0.915 - 3.389)	0.088
No eye appointments in past year	48 (64.0%)	27 (36.0%)	1.70 (0.969 - 2.966)	0.064
Not Living Alone	104 (53.9%)	89 (46.1%)	0.82 (0.455 - 1.494)	0.53
Lacking a car	71 (55.0%)	58 (45.0%)	1.10 (0.667 - 1.825)	0.70
Not Smoking	97 (53.0%)	86 (46.0%)	0.76 (0.431 - 1.343)	0.34
No family history of glaucoma	83 (61.5%)	52 (39.5%)	4.10 (2.022 - 8.331)	<0.0001
No Ophthalmologist	64 (58.7%)	45 (41.3%)	1.34 (0.810 - 2.226)	0.25
No perceived risk of glaucoma	71 (61.2%)	45 (36.1%)	2.45 (1.417 - 4.219)	0.0012
No Chronic illnesses	70 (51.9%)	65 (48.1%)	1.08 (0.652 - 1.777)	0.77

Table 4 a) Bivariate analysis of various factors and their association with lack of knowledge of glaucoma amongst minorities only. ORs = Odds Ratios for the probability of lacking knowledge. CIs = 95% confidence intervals.

Significant Variables: Data from Minorities at All 3 Sites

Bivariate analysis of surveys from ethnic minorities at at all three sites was done, in order to find out if there was any difference between knowledge amongst minorities at different sites, and amongst the two major minority groups, Black and Hispanic. The analysis shows that the following are significantly associated with lack of knowledge of glaucoma risk factors amongst minorities. (see Table 4a for full statistics.)

No perceived risk of developing glaucoma: participants who felt they had no risk of developing glaucoma are 2.5 times more likely to lack knowledge of glaucoma risk factors than those who felt they had a medium or high risk of developing glaucoma. (p=0.0012)

No history of glaucoma: participants who did not have glaucoma or a history of glaucoma were 3.1 times more likely to lack knowledge of glaucoma risk factors than those who did have glaucoma. (p=0.019)

No family history of glaucoma: participants who had no family history of glaucoma are 4.1 times more likely to lack knowledge of glaucoma risk factors than those who have a family history of glaucoma. ($p<0.0001$)

Hispanic ethnicity: participants who self identified as Black are 0.47 times less likely to lack knowledge of glaucoma (2.1 times more likely to have knowledge of glaucoma risk factors) than those who self identified as Hispanic. (p=0.006)

Being at a PCC: participants who were at a primary care center are 2.7 times more likely to lack knowledge of glaucoma than those who were at the CES. (p=0.004)

Non-significant Variables

Bivariate analysis of variables amongst minorities at all sites shows that some variables, although different between the knowledgeable and those lacking knowledge, did not reach statistical significance. (See Table 4a for full details.). These variables are as follows; age below 40 (p=0.51), female gender (p=0.45), not having been previously screened (p=0.058), not having prescription lenses (p=0.14), not having a history of elevated IOP (0.088), not having had one or more eye appointments within the year (p=0.064), not having an ophthalmologist (p=0.25), having no chronic illnesses (p=0.77), lacking a car (p=0.70), not living alone (p=0.53), and not smoking (p=0.34).

Summary Statistics 4 (b)

Multivariate Analysis of factors associated with lack of knowledge of glaucoma risk factors amongst minorities

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	P Value
No family History of glaucoma	5.08	2.195 11.772	0.0001
Black Race	0.39	0.181 - 0.818	0.012
Being at a Primary Care Center	3.89	1.482 - 10.232	0.0054

Table 4b) Table showing factors remaining significant after adjusting for confounding variables in multivariate analysis of variables from the two primary care sites only. Model Fit Statistics are as follows; Akaike Information Criterion (AIC) = 205.70 (intercept only) Schwartz Criterion (SC) = 208.70 (intercept only). Hosmer and Lemeshow Goodness-of-Fit test, $\chi^2 = 1.424$, with 4 Degrees of Freedom (DF). Final P value 0.84

Multivariate analysis: Significant variables amongst ethnic minorities

When adjusting for confounding variables in multivariate analysis, lack of knowledge of glaucoma risk factors amongst minorities at all three sites is associated with 3 significant variables. (See Table 4b for full details).

- Participants without a family history of glaucoma are 5.1 times more likely to lack knowledge of glaucoma than those with a positive family history (p=0.0001).
- Participants who self identified as Black are 0.39 times less likely to lack knowledge of glaucoma (2.6 times more likely to have knowledge of glaucoma risk factors) than those who self identified as Hispanic (p=0.012)
- Participants who were at a primary care center were 3.9 times more likely to lack knowledge of glaucoma risk factors than those who were at the CES. (p=0.0054)

Variables that were statistically significant in predicting lack of knowledge of glaucoma in bivariate analysis that are no longer significant include; no history of glaucoma, and no perceived risk of developing glaucoma.

Discussion:

Since most chronic forms of glaucoma, and more specifically Primary Open Angle Glaucoma (POAG) provide no symptoms until the condition is advanced, effectively educating the public about the disease is necessary to increase public awareness. But who should be targeted for education since resources are limited? Our results suggest that an effective strategy might involve targeting not only groups of people who are at risk for developing glaucoma – namely people over age 40, people with elevated IOP, people of African descent, and people with a positive family history of glaucoma, but also those who are more likely to lack knowledge of glaucoma. In this study, we found that lack of knowledge of glaucoma is associated with being an ethnic minority, lacking a family history of glaucoma, and being at a primary care center.

Family history and lack of knowledge of glaucoma

Our results show that participants who lack a family history of glaucoma are 3.7 times more likely to lack knowledge of glaucoma risk factors compared to those with a family history of glaucoma (p=0.0003). This variable has remained statistically significant in multivariate analysis regardless of the population sample. Amongst participants at the two primary care centers only, those lacking family history are 3.6 times more likely to lack knowledge of glaucoma risk factors (p=0.0003). Amongst minorities, those who lack a family history of glaucoma are 5.1 times more likely to lack knowledge of glaucoma than those with a family history (p=0.0001).

Similar to our study, previous studies have also found lack of family history of glaucoma to be associated with poor knowledge about glaucoma. [41,45]. These findings

are also corroborated by Fraser et al [52], in their study of factors affecting late presentation in chronic (or primary) open angle glaucoma (COAG), who found that at diagnosis, glaucoma patients with advanced disease were less likely to have a family history of the disease. The conclusion drawn from their study was that an increased awareness and knowledge of a condition may stimulate assessment and thus permit earlier diagnosis.

It makes intuitive sense that those who have a family member with glaucoma will have at least heard of the illness. What is less clear however, is how exactly those with a family history of glaucoma come about the knowledge of glaucoma. Do glaucoma patients contact family members? Do family members bring the patients in for their eye appointments and gather the information from their eye care physician? Gasch et al [42], speculate that some risk factors may encourage increased awareness, and that a positive family history for instance, might provoke a search for more information and assessment. Deokule et al [53], in their survey of glaucoma patients attending a clinic, found that although 73% of patients were aware of the availability of free eye tests for their relatives, only 59% had used this facility. They also found that only 45.5% of patients' relatives from their study group had undergone screening. A previous study by Vernon et al [54] showed a higher percentage (65%) of the relatives of patients who were aware of the hereditary nature of glaucoma had undergone the screening.

Could it then be assumed that many patients do not routinely inform their relatives regarding screening or other information about glaucoma? This being the case, it is interesting to note here and in other studies, the glaucoma knowledge amongst those with a family history of glaucoma is increased in comparison the general public or study

population. How they come to this increased knowledge is unclear, but since individuals with a family history of glaucoma are at increased risk of developing glaucoma, it is still expedient to target those with a family history of glaucoma, as well as those without a family history of glaucoma for public health education. Vernon et al also found that 90% of siblings who were invited, attended the screening for glaucoma, and stipulate from this that the practice of directly contacting relatives can be effective and should be encouraged [54].

Ethnic minorities and Lack of knowledge of glaucoma:

After adjusting for age and other potentially confounding variables in multivariate analysis, our results suggest that ethnic minorities (people self identifying as "Black" and those self identifying as "Hispanic" ethnicity are 2.3 times more likely to lack knowledge of glaucoma than those self identifying as "White" or Caucasian. (See Table 2a for details) This is consistent with a study done by Gasch et al in 2000 [42], where they indicate that African American and Hispanic ethnicity are both associated with reduced glaucoma awareness. Amongst minorities, lack of knowledge is associated further with Hispanic compared to African American ethnicity. Our results show that participants self identifying as "Black" are 2.6 times more likely to have knowledge of glaucoma, compared to those self identifying as ethnically "Hispanic". To our knowledge, this is the first study comparing knowledge of glaucoma between minority groups. Some have suggested that a language barrier may play a large part in the increased lack of knowledge amongst Hispanics, or those for whom English is not a first language. [42]. To get around the fact that some participants may not understand the survey, each

participant was given a choice of filling out the survey in English or in Spanish. Although this may have helped with understanding the survey on that day, we cannot make up for the lack of knowledge that participants came in with prior to the survey, or for the fact that even if they had previously been told about glaucoma, they may not have understood if the education was done in English, or if the level of English was too difficult to understand. As stated in the introduction, African American race is a well established risk factor for primary open-angle glaucoma [11]. More recently, other studies have shown that Hispanic ethnicity is also associated with increased prevalence of glaucoma [12,13,29].

Our results also show that amongst minorities, lack of family history of glaucoma and being at a primary care center are both significantly associated with lack of knowledge of glaucoma risk factors, as in the general population. (See discussion sections on family history and being at a PCC). Minorities without a family history of glaucoma are 5.08 times more likely to lack knowledge of glaucoma risk factors than those who have a positive family history of glaucoma ($p=0.0001$). This odds ratio is 1.4 times as high as in our general population. (OR is 3.7 for participants without a family history lacking knowledge). This would suggest that even amongst minorities, particular attention should be paid to those who do not have a family history of glaucoma. One positive aspect of these results is that individuals with a positive family history ie those more at risk, are more likely to know about glaucoma. The assumption then is that they will be more likely to get screened and their disease treated earlier. However, that is an assumption, as it is now well known that there are other barriers that get in the way of

people accessing screening and care, such as lack of access to transportation, living alone, and lack of health insurance [33,42,52,55].

This being the case, it is still expedient for members of ethnic minority communities to be targeted with increased glaucoma public health education, to help reduce the burden of glaucoma in amongst the people who need it the most. In order to do this, we must first answer some questions about some assumptions inherent in our analysis. We must ask whether or not our results can be applied to the general population, since the general population may not necessarily visit a primary care center or an eye center. Orr et al [33], in their population-based study of eye care use among older Americans conclude that African-Americans were less likely to see an eye care professional. This helps validate our results, and justifies our use of this data to suggest that targeting ethnic minorities with glaucoma public health education is indeed an economically sound use of our limited resources.

Being at a Primary Care Center (PCC) and lack of knowledge of glaucoma

Our results show that being at a primary care center is associated with lack of knowledge of glaucoma risk factors (OR 2.2 p=0.02). Overall lack of awareness of glaucoma risk factors in this clinic-based population was high at the two primary care centers (79.4%). Compared to the Comprehensive Eye Center, there are no glaucoma education materials or programs currently available in the clinic where participants were recruited. At the primary care centers, there did not seem to be an increased glaucoma awareness amongst participants who had glaucoma, nor amongst those who had previously been screened. Participants at the PCCs who did not have a family history of

glaucoma were 3.6 times more likely to lack knowledge of glaucoma risk factors than those who had a family history of glaucoma. (p=0.0003). Ethnic minorities are the PCCs were 2.9 times more likely to lack knowledge of glaucoma than others at the PCCs. (p=0.0042). (See previous discussions on family history and ethnic minorities and lack of knowledge of glaucoma).

Interestingly, participants at the PCCs who felt they were at no risk of developing glaucoma were 2.0 times more likely to lack knowledge of glaucoma risk factors than those who felt they were at any risk of developing glaucoma. To our knowledge, this is the first study linking lack of knowledge of glaucoma risk factors with participants' perception of their risk of developing the disease. This observation did not reach statistical significance when combined with data from the Eye Center. It is possible that those visiting an eye care center become more aware that they are likely to develop eye disease. It could also be possible that the lack of knowledge of glaucoma, and its devastating effects is what causes participants to perceive their risk as low, rather than the other way round. (ie participants thinking they do not need to learn about glaucoma because their risk is low.) This is an interesting area of further study- namely how an individual's perception of a disease affects their likelihood to know about it and be screened for it.

Other positive associations not significant under multivariate analysis:

Gasch et al [42], found that a positive association between myopia and glaucoma awareness may result because myopes have more contact with eye-care providers because of the need for eyeglasses and thus have more glaucoma checks and more potential for exposure to information about glaucoma than hyperopes, who may see

adequately with over-the-counter eyeglasses, or emmetropes. Also, Pfeiffer et al [56] found that respondents who had dilated eye examinations had heightened glaucoma awareness. In our study, we found an association between lack of prescription lenses and lack of knowledge of glaucoma in bivariate analysis (OR 1.7, p= 0.013). However, when adjusting for confounding variables in multivariate analysis, this variable did not reach statistical significance and was not included in the final model.

Participants who had not been tested for glaucoma were more likely to lack glaucoma awareness in a study by Michielutte et al [43]. This seems to make intuitive sense. However, we found that this positive association between screening and glaucoma awareness, although significant in bivariate analysis (OR 2.1 p=0.0005) was not significant in multivariate analysis.

Although two other studies found male gender to be associated with poor knowledge about glaucoma [41,43], one study found no association between gender and glaucoma knowledge, [45]. Similar to our results, although female gender was associated with less likelihood of lacking knowledge, this never reached statistical significance in bivariate analysis (OR 0.84, p=0.42).

We found that participants who had other chronic illnesses such as diabetes or hypertension did not have an increased knowledge of glaucoma risk factors. Similar to other studies, participants who have conditions associated with glaucoma such as diabetes mellitus, had no increased knowledge of glaucoma compared with those without these conditions [27,57]. It is very likely that although such patients are followed up in clinics, they are not receiving any increased education regarding glaucoma as a result of having these conditions.

Similar to our study, Landers et al [58] show that previous visits to an optometrist or ophthalmologist did not seem to help with increasing knowledge of glaucoma. We found that participants not having an ophthalmologist were only 1.45 times more likely to lack knowledge of glaucoma risk factors, but this did not reach statistical significance. ($p=0.08$). Also, participants who had not had one or more eye appointments within the past year were 1.8 times more likely to lack knowledge of glaucoma risk factors ($p=0.015$). This odds ratio although reaching statistical significance in bivariate analysis, was not significant when adjusting for confounding variables in multivariate analysis. Our findings suggest that more physician-directed patient education is necessary to increase glaucoma awareness in the clinical setting.

Study Limitations

Our questionnaire was not designed to examine depth or accuracy of knowledge about glaucoma. For example, participants who indicated that they were familiar with glaucoma and its risk factors may still be inadequately informed about glaucoma, and assume that they do not need to be screened if they do not have any of the mentioned risk factors. The 1984 National Society to Prevent Blindness Survey, [59] and other surveys have shown that despite a reasonable understanding of the disease, study participants still carried the misconception that they would be symptomatic from the onset if they developed POAG [47]. Also, the relationship between socioeconomic status (SES) and glaucoma awareness was not explored. There were no questions on the survey pertaining to education, type of employment or income. This may have weakened the study, because it is possible education or income may have confounded any of the variables found to be

significant on multivariate analysis. However, given the correlation of our results with previous studies, this possibility is small. Also, a previous study we did a year earlier showed no correlation between SES and noncompliance with follow up after screening in a New Haven African American population, but rather noncompliance was associated with smoking, living alone and lack of access to a car [50]. It is possible that there are other factors associated with lack of knowledge of glaucoma that have not been explored. Future studies might concentrate on the effects of SES and other factors, such as type of job and attitudes towards the health system on knowledge of glaucoma.

Conclusion

In the present study, factors which may be associated with lack of knowledge of glaucoma risk factors and therefore lack of awareness of glaucoma in general were lack of family history of glaucoma, being at a primary care location, and being an ethnic minority. Special attention to targeting individuals with these risk factors for lack of glaucoma knowledge may help to identify those who require additional encouragement to ensure screening and treatment of the disease to avoid late presentation and increased risk of blindness. Further study in this area should target the effectiveness of health education programs in improving access to eye care for urban African Americans. It is noted that a survey in of itself can be a very useful educational tool, and one which the author and research associate are pleased to have had the pleasure to put to good use during this study. Future studies could examine the effectiveness of our educational tools in the populations we have identified as “at risk” for lack of knowledge of glaucoma.

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