SOCIAL ECONOMIC STATUS ASSOCIATION WITH INTRAOCULAR PRESSURE IN RURAL ALABAMA

by

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PUBLIC HEALTH

ABSTRACT

Background. Residents of the relatively-isolated, needy population of the rural Alabama Black Belt are afflicted with high levels of diabetes, hypertension, hypercholesterolemia and obesity which have been shown to be significantly related to the presence of open-angle glaucoma (OAG). This study was designed to assess the relevance of a range of potential risk factors for intraocular pressure (IOP), significantly related to OAG, in a population that has not been well-described through multivariate analysis.

Objective. The aim of this study is to develop models to assess the relationship of demographic variables, socioeconomic status (SES) and physical systemic variables to IOP in an adult population.

Methods. The Rural Alabama Diabetes and Glaucoma Initiative (RADGI) is a multi-disciplinary service and research project dedicated to assisting in identification, triage and management of vision and health problems likely to affect citizens in rural Alabama, particularly the Black Belt. RADGI performed comprehensive vision and health evaluations on adult volunteers from rural Alabama. The vision and health assessment included height, weight, blood pressure, blood sugar, glycosolated hemoglobin (HbA1C) level, blood cholesterol levels, presenting visual acuity, examination of the front of the eye structures (e.g., cornea, lens and iris) and back of the eye structures (e.g., optic nerve and retina, i.e., fundus evaluation). Three multiple linear
regression models were used to adjust for potential risk factors for IOP. Model 1 consisted of SES variables, model 2 consisted of demographic and physical systemic variables and model 3 consisted of SES, demographic, and physical systemic variables.

Results. The results included 2,446 adult volunteers (mean 50 yrs, SD=15) from 8 Black Belt counties and 1 contiguous county of Alabama. The group was heavily female and African-American. After conducting multivariate analyses, model 2 variables were most significantly related to IOP.

Conclusion. Since model 2 accounted for a low variation in IOP (R^2=0.069), future studies should control for missing data and include additional variables—possibly alternative SES variables. Public health intervention in these areas should focus on healthy diets and exercise. Also, future studies should research genetics as possible predictors of elevated IOP.

Keywords: IOP, intraocular pressure, glaucoma, epidemiology, socioeconomic status, rural health
DEDICATION

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Mrs. Ella Irby

Mrs. Daisy D. Vincent
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CHAPTER 1

INTRODUCTION

Glaucoma is a serious eye disease that may be complex to diagnose and manage. Intraocular pressure (IOP) is the major, modifiable, etiological factor in this disease. Presently, the literature contains a host of challenging and occasionally conflicting data about the etiology of glaucoma and its relationship to IOP. Understanding the underlying aspects of IOP and glaucoma is particularly relevant to residents of rural Alabama. Residents of rural Alabama experience a critical lack of health care and few resources are available to address critical problems such as glaucoma. This project is designed to elucidate factors related to IOP such that considering its relationship to glaucoma, the most efficient prevention, health care management, and diagnosis can be completed.

Glaucoma

Definition. Glaucoma, “the silent thief of sight,” is a common eye disease that can cause irreversible blindness (D. Lee & Higginbotham, 2005). Glaucoma is a progressive optic nerve disease often associated with elevated IOP and retinal ganglion cell death that results in optic disc cupping and visual field loss (Distelhorst & Hughes, 2003). Primary open-angle glaucoma (POAG) has been defined as a progressively chronic disease with risk factors which include IOP and leads to degradation of the optic nerve and loss of cells in the adult eye (Distelhorst & Hughes). The lack of a concise definition for POAG contributes to uncertainty about the prevention, diagnosis and treatment of POAG (Distelhorst & Hughes).
Epidemiology. Worldwide, an estimated 45 million people are blind from visual impairments (Hyman et al., 2001). Open angle glaucoma (OAG) has few symptoms until severe visual impairment has occurred and thus it must be detected through active examination (Quigley & Jampel, 2003). In population-based prevalence surveys in developed countries, about half of those persons identified with OAG were unaware that they had the disease (Quigley & Jampel). In the United States, OAG accounts for more than 90 percent of cases of glaucoma, with an estimated 2.22 million people affected by OAG in the United States (Distelhorst & Hughes, 2003). By the year 2020, as the population ages, data suggests that there will be 3.3 million people affected with OAG in the United States (Distelhorst & Hughes).

Primary open-angle glaucoma (POAG) is one of the most prevalent forms of OAG and is a leading cause of blindness (Bonovas, Peponis, & Filioussi, 2003; Distelhorst & Hughes, 2003). There are an estimated 2.47 million people in the United States affected by POAG (Racette, Wilson, Zangwill, Weinreb, & Sample, 2003). IOP (Distelhorst & Hughes; Quigley & Jampel, 2003), age (Distelhorst & Hughes), family history (Distelhorst & Hughes), race or ethnicity (Distelhorst & Hughes), central corneal thickness (Browning, Bhan, Rotchford, Shah, & Dua, 2004; LaRosa, Gross, & Orengo-Nania, 2001) and socioeconomic factors (Fraser, Bunce, Wormald, & Brunner, 2001) are recognized as risk factors associated with glaucoma (Distelhorst & Hughes).

Risk Factors for Glaucoma

Intraocular Pressure (IOP). In the United States, 4-7% of persons older than 40 years have elevated IOP without detectable glaucomatous damage on standard clinical
tests (Kass et al., 2002). Studies have formed inconsistent conclusions concerning the relationship of gender to OAG and IOP (Y. Lee et al., 2008; Rudnicka, Mt-Isa, Owen, Cook & Ashby, 2006). However, in numerous studies, men have been shown to have higher IOP than women (Y. Lee et al.; Wu, Nemesure, Hennis & Leske, 2006). Recent studies have shown that African-Americans with healthy eyes, ocular hypertension and POAG have higher IOP levels (Distelhorst & Hughes, 2003; Racette et al., 2003). IOP has also been shown to increase with increasing systolic blood pressure (Deokule & Weinreb, 2007; Yip et al., 2007). Based on cross-sectional data, IOP tends to decrease with age in Asians, while the opposite appears to occur in Europeans (Foster et al., 2003).

*Age.* African-Americans older than 40 years and European-Americans older than 65 years have an increased risk of developing open angle glaucoma (Distelhorst & Hughes, 2003). Some African-American age groups may be up to six times more likely to develop glaucoma as compared to European-Americans (Racette et al., 2003). Some literature has indicated that women have a greater age-adjusted risk for blindness from glaucoma than men (The Eye Disease Prevalence Research Group, 2004).

Several relationships between IOP and age have previously been described. Using univariate analysis, studies examining European-American adults have shown little to no relationship between IOP and age (Bonomi et al., 1998; Klein, Klein, & Linton, 1992; Rochtchina & Mitchell, 2002; Weih, Mukesh, & McCarty, 2001). In Japanese adults, a negative association between IOP and age has been demonstrated (Mori, Ando, Nomura, Sato, & Shimokata, 2000; Shoise, 1984; Weih et al.). One study has shown an age-related increase in IOP in older adults in the black Barbados population (Wu & Leske, 1997). Univariate analyses may not reflect the complexity of relationships among
data in a data set. When other variables (e.g., diabetes, glaucoma family history, myopia, systolic blood pressure) are taken into account in multivariate analyses, age has not been shown to be significantly associated with IOP (Rochtchina & Mitchell; Fraser et al., 2001). Studies of Japanese men and women have reported a statistically significant decrease of IOP with increasing age among both women and men (Shiose; Mori et al.) using multivariate analysis adjusting for systolic blood pressure and body mass index (BMI). The differences in these results suggest that the relationships between IOP and age may vary with ethnicity and other characteristics. Therefore, an examination of the relationship between factors known to relate to IOP appears to be particularly apt in the Black Belt with a population whose ethnicity probably most closely matches the Barbados study (Wu & Leske). A Japanese study has assessed the influence of aging, blood pressure and BMI on IOP and has shown an inconsistent change in IOP with age (Nomura, Shimokata, & Ando, 1999).

*Family history.* A family history of glaucoma is a major risk factor in the development of glaucoma, implicating a substantial genetic factor in the disease (Ellish & Higginbotham, 2002; Mori et al., 2000). There is an increased prevalence of glaucoma (by a factor of seven) if there is a parent, child or sibling who has the eye disease (Distelhorst & Hughes, 2003). Elevated IOP is also associated with a family history of glaucoma (Bonomi et al., 1998; Klein et al., 1992; Mori et al.; Rochtchina & Mitchell, 2002).

*Race or ethnicity, ancestry.* There are numerous issues with the appropriate use of race or ethnicity as a risk factor for glaucoma. These issues have been noted in a variety of contexts. For instance, the failure to diagnose sickle-cell disease, one of the
most common genetic diseases among African-Americans, in an individual with European ancestry can lead to diagnostic errors or inappropriate treatment or drug prescription (Laurence, George, & Woods, 2006).

Among individuals of African ancestry, glaucoma is the leading cause of blindness (Distelhorst & Hughes, 2003). African-Americans have an increased prevalence, by a factor of four, of developing glaucoma (Distelhorst & Hughes). POAG appears approximately 10 years earlier and more rapidly in African-Americans than in European-Americans (Distelhorst & Hughes). However, it is estimated that by the year 2010, persons in Asian regions will represent 47% of OAG persons worldwide; due to larger number of older people in the region (Quigley & Broman, 2006).

Other risk factors. Previous literature, has indicated that insults to the eye, including trauma, uveitis, and steroid therapy can cause elevated IOP, which in turn may lead to OAG (Distelhorst & Hughes, 2003). Optic nerve fiber sensitivity to damage and its tolerance to the presenting IOP, even in a normal range, is a major factor in the pathogenesis of OAG (Le, Mukesh, McCarty, & Taylor, 2003). Myopia (nearsightedness) is a risk factor for POAG (Kroese & Burton, 2003). IOP also has been shown to be related to ambient temperature. IOP and ambient temperature display an inverse relationship. IOP measurements are higher with cooler temperatures (average temperature high 28.7°C and low 22.9°C, November-April) and lower when the average temperature is high (30.4°C and low 24.6°C, May-October) (Klein et al., 1992; Qureshi et al., 1996; Wu & Leske, 1997). Therefore, the average IOP measurements are lower during the warmer season than during the cooler season.
Health status. Research has also shown that IOP is higher among persons with lower educational and income levels (Yip et al., 2007). Smoking has been shown to have significant (A. Lee, Rochtchina, Wang, Healey & Mitchell, 2003; Wu & Leske, 1997) and no significant (Klein et al., 1992; Nomura, Ando, Niino, Shimokata, & Miyake, 2004) effect on IOP. Persons with diabetes or a family history of diabetes have a significantly higher mean IOP (Klein et al.; Nomura et al.; Wu & Leske). Hypertension has been shown to be related to IOP values (Nomura et al.). Persons with the lowest material resources seem to be at greatest risk of going blind from glaucoma (Fraser et al., 2001).

Health access. Health status has been shown to vary as a result of ethnicity, marital status, seasons, social status and a variety of physical characteristics (Eaker, Sullivan, Kelly-Hayes, D'Agostino & Benjamin, 2007; Fraser et al., 2001; Klein et al., 1992; LaRosa, Gross, & Orengo-Nania, 2001; Mori et al., 2000; Rochtchina & Mitchell, 2002; Wu & Leske, 1997). In areas such as rural Alabama, there are few health care providers and inadequate access to ocular and physical care, probably at least partially due to a lack of dependable transportation [Center for Disease Control and Prevention (CDC): Prevention Research Center, 2006]. Those without dependable transportation to a vision and/or health care provider may settle for care from persons who are not properly trained in the patients’ area of need or may receive no care at all. This has the potential of being more detrimental than no treatment. Many people may not have vision and/or health care insurance, leading to a lack of annual exams. Often these residents have no family practitioner because of the cost and they only visit the doctor when there is a significant change in vision and health (which may be too late). In addition, those persons
who receive vision and/or health care before their condition worsens may be unable to afford the proper medication needed to treat and/or manage their condition.

Culture may also contribute to the presence of decreased vision and the low use of health care. For instance, some older people who have a decline in vision may not visit an eye doctor because they may assume that the problem is a common, uncorrectable, age-related disease. However, the problem could be as simple as cataracts, which can be corrected. Additionally, research has shown that residential segregation may play a role in hypertension differences among races (Thorpe, Brandon, & LaVeist, 2008). The relationship between these factors has been shown to vary with the population being studied.

Rural Black Belt of Alabama

Definition. The Black Belt is a region of the southern United States that has been variously defined. The Black Belt counties of Alabama are known not only for being an area of rich soil, but also as an area of poor material resources (Anderson & Fortson, 2000; CDC: Prevention Research Center, 2009). Many communities in the Black Belt are predominately composed of African-Americans and are concentrated in unfavorable economic conditions with female-headed households—conditions known to be strongly related to enduring poverty (Snyder & McLaughlin, 2004). This region has the social problems of poverty, lower educational levels and high unemployment levels (Coughlin & Thompson, 2002).

The traditional counties of the Black Belt are as follows: Greene, Sumter, Hale, Perry, Marengo, Choctaw, Dallas, Wilcox, Lowndes, Butler, Montgomery, Pike,
Crenshaw, Bullock, Macon, Russell and Barbour (CDC: Prevention Research Center, 2009). There is limited access to health care in these areas and some counties are without optometrists and/or physicians. Many people in these areas are without transportation. Even those with transportation may have to travel an extended distance (50 miles or more) to the nearest doctor. This area also has limited education, deprived employment, a high unemployment rate, high prevalence of single parenthood, and profound dependency on public assistance programs (Zekeri, 2003).

**Rural Alabama Diabetes and Glaucoma Initiative (RADGI) Database.** The focus of the Rural Alabama Diabetes and Glaucoma Initiative Database (RADGI) was vision, glaucoma, and diabetes evaluation and treatment among both adults and children. RADGI sought to improve access to eye care facilities, education concerning routine vision evaluations, financial support for eye services, and treatment of glaucoma and diabetes for some of Alabama’s most at-risk citizens. It also provided evaluations for hypertension and high cholesterol. The project began in medically underserved areas (the Black Belt Counties of Alabama) and has since expanded into a contiguous county (Bibb) of the state. RADGI has received grants from the Healthy Eyes Healthy People 2006 and 2007 programs of the American Optometric Association and has been able to provide high quality eye glasses without cost to about 750 persons in 2006-7.

The Rural Alabama Diabetes and Glaucoma Initiative (RADGI) involves a partnership of participants from the University of Alabama at Birmingham (UAB) School of Optometry, the Department of Ophthalmology from the UAB School of Medicine, the UAB Minority Health and Research Center, Alabama Lions Sight Conservation, Inc., the Central Alabama Community Foundation, EyeSight Foundation of Alabama, Pinnacle
Optical Laboratory, the Alabama Department of Public Health, Auburn University Extension Centers, VSP, the American Diabetes Association, and the UAB Ronald E. McNair Scholars Program. RADGI provided vision and health care to rural Alabama from May, 2002 until November, 2004. RADGI received major funding from the Center for Disease Control (CDC) and from UAB McNair Scholars Program in 2004 and Fight for Sight in 2006 & 2007. RADGI has evolved into the Consortium for Vision Care in the Black Belt and continues to operate.

Objective

The aim of this study is to develop multi-variant models to evaluate IOP based on the following variable domains (and variables): socioeconomic status (SES; i.e., gender, ethnicity, marital status, education level, currently smoking and health insurance), and demographic and systemic, physical characteristics (i.e., season of evaluation, ethnicity, BMI, systolic blood pressure and HbA1C levels) separately and combined. This will assist researchers in this area to determine which data are most related and their level of significance. These models will assess the relationship of the variable domains to IOP in an adult population drawn from Rural Alabama.

Hypotheses

Univariate analysis may not demonstrate the relationship between the variables in question because of the complexity of the relationships among these variables and IOP. Multivariate analysis may be essential in demonstrating factors significant in the generation of IOP. Compared to previous work, multivariate analysis may show a
decreased significance of the apparent relationship between demographic variables and elevated IOP and at the same time, suggest a significant relationship between SES (e.g., educational level and health insurance) and physical systemic factors (e.g., blood pressure and BMI) in the prediction of IOP. The hypothesis of this study was that IOP should be statistically significantly related to BMI, educational levels and systolic blood pressure. Also, there should be a positive significant correlation between elevated BMI, elevated systolic blood pressure and lower educational attainment with elevated IOP levels.

Significance

There are no studies of the potential risk factors for IOP in the Black Belt of Alabama. This lack of knowledge hinders insight into the challenge of decreasing the prevalence of glaucoma and may have an impact on further understanding the progression, treatment, and prevention of this condition. The modeling process may also apply to similar communities elsewhere. This study could provide evidence that physical conditions (e.g., blood pressure, BMI and/or HbA1C) are an important factor in determining whether or not patients will develop glaucoma. At the same time, this study also has the potential to demonstrate that other classes of factors (e.g., health insurance and marital status) play a significant role in IOP levels. If the hypothesis is correct, clinicians should not only measure IOP, but also note the patient’s health history and economic and social status, because these factors may all contribute to a patient’s IOP and consequent risk for glaucoma.
CHAPTER 2

METHODS

Subjects, inclusion and exclusion criteria. Adult volunteers 19 yrs of age or older were included in the study. Children were excluded in this evaluation because of the low likelihood of glaucoma and the susceptibility to certain types of glaucoma. Any individual 19 yrs or older who was able and willing to complete the informed consent and the evaluation process was admitted to the evaluation. No other exclusion criteria were used.

Exclusions prior to data analysis. Persons with missing and/or unknown ages were excluded from the evaluations.

Health evaluations. RADGI solicited 2,446 volunteers 19 years of age and older from several counties in rural Alabama, particularly the Black Belt (Table 1), through word-of-mouth, utility bill inserts, public service radio announcements, posters and newspaper articles. Participants completed a survey/history questionnaire and a wide variety of health and visual testing (Table 2). All demographics, social economic status and health history variables were self-reported (Table 2). Body mass index (BMI) was subsequently calculated from height and weight data (Sitzman, 2004). Individuals (40 years of age or greater) at risk for glaucoma also completed frequency-doubled threshold visual fields and central corneal thickness measurements. The data collected from the evaluations was classified into the following areas: demographic, health history, socioeconomic status, systemic health and ocular health (Tables 2 & 3).
All evaluations were held from 10 a.m. to 6 p.m. or until the last patient was finished. Table 1 lists the location (city), site (Health Department, University, or Hospital), county and dates that evaluations were conducted.

Table 1.

*Location and Dates of Vision and Health Evaluations in Rural Alabama.*

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SITE</th>
<th>COUNTY</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camden</td>
<td>Wilcox County Department of Health</td>
<td>Wilcox</td>
<td>November 22-23, 2004</td>
</tr>
<tr>
<td>Camden</td>
<td>Wilcox County Department of Health</td>
<td>Wilcox</td>
<td>August 31-September 1, 2004</td>
</tr>
<tr>
<td>Tuskegee</td>
<td>Kellogg Center, Tuskegee University</td>
<td>Macon</td>
<td>August 24-25, 2004</td>
</tr>
<tr>
<td>Centerville</td>
<td>Bibb County Department of Health</td>
<td>Bibb</td>
<td>August 16-18, 2004</td>
</tr>
<tr>
<td>Camden</td>
<td>Wilcox County Department of Health</td>
<td>Wilcox</td>
<td>May 25-26, 2004</td>
</tr>
<tr>
<td>Linden</td>
<td>Marengo County Department of Health</td>
<td>Marengo</td>
<td>May 19-20, 2004</td>
</tr>
<tr>
<td>Livingston</td>
<td>Sumter County Department of Health</td>
<td>Sumter</td>
<td>March 23-24, 2004</td>
</tr>
<tr>
<td>York</td>
<td>York Community Hospital</td>
<td>Sumter</td>
<td>November 1, 2003</td>
</tr>
<tr>
<td>Montgomery</td>
<td>Montgomery County Health Department</td>
<td>Montgomery</td>
<td>January 27-31, 2003</td>
</tr>
<tr>
<td>Hayneville</td>
<td>Lowndes County Health Department</td>
<td>Lowndes</td>
<td>November 5-7, 2002</td>
</tr>
<tr>
<td>Selma</td>
<td>Dallas County Health Department</td>
<td>Dallas</td>
<td>October 28-30, 2002</td>
</tr>
<tr>
<td>Hayneville</td>
<td>Lowndes County Health Department</td>
<td>Lowndes</td>
<td>August 26-28, 2002</td>
</tr>
<tr>
<td>Marion</td>
<td>Perry County Health Department</td>
<td>Perry</td>
<td>August 13-14, 2002</td>
</tr>
<tr>
<td>Selma</td>
<td>Dallas County Health Department</td>
<td>Dallas</td>
<td>July 23-25, 2002</td>
</tr>
<tr>
<td>Marion</td>
<td>Perry County Health Department</td>
<td>Perry</td>
<td>May 14-16, 2002</td>
</tr>
</tbody>
</table>
Table 2.

Demographic, Social Economic Characteristics and Specific Variables of Individuals Participating in Visual and Health Evaluations in Rural Alabama.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SPECIFIC VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic</strong></td>
<td><strong>Evaluation Location:</strong> Bibb County, Dallas County, Lowndes County, Macon County, Marengo, Montgomery County, Perry County, Sumter County and Wilcox County. <strong>Gender:</strong> male (♂) or female (♀) <strong>Ethnicity:</strong> European-American/White, African American/Black, Hispanic/Latino, Asian and Other <strong>Age:</strong> Reported as age at their last birthday <strong>Season:</strong> IOP effects during the relatively warmer season and cooler season. These seasons were chosen to mirror seasons in a previous study (Qureshi et al., 1996).</td>
</tr>
<tr>
<td><strong>Social Economic Status</strong> (SES)</td>
<td><strong>Marital Status:</strong> Single, Married, Living with partner, not married and Divorced <strong>Smoking:</strong> “Do you currently smoke cigarettes?” was coded as follows: Every day, Some days, Not at all <strong>Drugs:</strong> “How many alcoholic drinks do you usually have? Per” was coded as follows: Per day, Per week, Per month, Never <strong>Education:</strong> “Highest educational level completed” was coded as follows: 6th grade or less, 7th to 11th grade, high school graduate or GED, some college, college graduate, some graduate school, master's degree and doctorate degree <strong>Income:</strong> $5,000 to less than $10,000, $10,000 to less than $15,000, $15,000 to less than $20,000, $20,000 to less than $25,000, $25,000 to less than $35,000, $35,000 to less than $50,000, $50,000 to less than $75,000, $75,000 or more <strong>Per Capita:</strong> Determined for each person in the household by taking the midpoint of recorded income category and dividing that number by the number of people living in the household <strong>Car or Truck:</strong> Yes or No <strong>Working:</strong> “Are you currently working in a job outside the home and/or have a home-based business?” recoded as Yes, full time and Yes, part time = Yes and codes No, Retired, Disabled, Student = No <strong>Per Capita ODs:</strong> The number of practicing optometrist (OD) in the county/ The county seat population <strong>Mean Per Capita OD/MD:</strong> The number of practicing optometrist (OD) in the county/ The county seat population <strong>Mean Miles to Eye Care:</strong> The average miles to the nearest practicing OD or practicing ophthalmologist. <strong>INSURE (Health Insurance):</strong> private, public, insured unspecified, not insured <strong>Last Saw Eye DrED2 (Last Saw Eye Doctor):</strong> Within last month, Within last 6 months, Within last year, More than 1 year ago, Never and Don’t remember. <strong>Last Saw HC ProvED2 (Last Saw Health Care Provider):</strong> Within last 3 months, Within last 6 months, Within last year, More than 1 year ago, Never and Don’t remember.</td>
</tr>
<tr>
<td><strong>Health History</strong></td>
<td><strong>Glaucoma:</strong> Do you have glaucoma? Do you have a family history of glaucoma? <strong>Blood Pressure:</strong> Do you have high blood pressure? Do you take medication for high blood? <strong>Diabetes:</strong> Do you have diabetes? Do you take medication for diabetes? <strong>Cholesterol:</strong> Do you have high cholesterol? Do you take medication for cholesterol?</td>
</tr>
</tbody>
</table>

Note: All Demographics, Social Economic Status (SES) and Health History variables were self-reported.
Table 3.

Physical (Ocular and Systemic) and Specific Variables of Individuals Participating in Visual and Health Evaluations in Rural Alabama.

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>SPECIFIC VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical, Ocular</td>
<td>IOP Test: Goldmann, Perkins, NCT, Tonopen IOP; OD (right eye) &amp; OS (left eye) (in mm Hg) Optic Cup Disk Ratio; OD &amp; OS Central Corneal Thickness (CCT); OD &amp; OS μm</td>
</tr>
<tr>
<td>Physical, Systemic</td>
<td>Height; Inches(-1 inch correction for shoes) Weight; Pounds (-1 pound correction for clothes) Body Mass Index (BMI) kg/m²; weight (kg)/ height²(m²) Pulse; Beats per minute Blood Pressure (Systolic) mm Hg Blood Pressure (Diastolic) mm Hg Glucose mg/dL HBA1C % of total hemoglobin Total Cholesterol (TC) mg/dL High-density lipoprotein (HDL) mg/dL TC/HDL</td>
</tr>
</tbody>
</table>

*Health evaluation survey, demographics and socioeconomic status.* The RADGI intake health evaluation collected participant information in 6 categories. Demographic/Socioeconomic (SES), vision, blood pressure, diabetes, cholesterol and general (Tables 2 & 3).

*Health evaluation, systemic physical variables.* The health examination process (e.g., height, weight, BMI, pulse rate, HbA1C, cholesterol, visual acuity and comprehensive examination of the ocular fundus) measured a variety of visual and health characteristics of each participant (Tables 2 & 3). Each participant’s height (rounded to the nearest inch) and weight (pounds) were measured. Participants did not remove clothing or shoes when their height and weight were measured and a -1 inch correction for height and a -1 pound correction for weight were used. Body Mass Index (BMI) was used to adjust bodyweight for height. BMI was calculated as weight in kilograms divided
by height in meters squared (Nomura, Shimokata, & Ando, 1999). Underweight adults are defined as having a BMI (kg/m²) of < 18.5; healthy weight adults, as a BMI of ≥ 18.5 or <25; overweight adults, as a BMI of ≥ 25-29.9; and obese adults, as a BMI of ≥ 30 (Gonzage dos Santos, Makk, Berghold, Eckhardt, & Hass, 1998; Lethbridge-Çejku, Rose, & Vickerie, 2006; Lethbridge-Çejku, Schiller, & Bernadel, 2004; Lethbridge-Çejku & Vickerie, 2005; Mora & Yanek, 2005). Height and weight data were not included in the present analysis.

Participants’ pulse was determined by their number of heart beats per minute. Random blood pressure (mmHg, systolic and diastolic) was performed on the right arm of non-fasting participants while they were seated using a standard mercury sphygmomanometer. Participants received physician referrals and a diagnostic impression of hypertension if their systolic blood pressure was ≥ 140 and/or their diastolic blood pressure was ≥ 90 (Diaz, Mainous, Koopman, & Geesey, 2004; Thorpe et al., 2008). Pulse data were not included in the present analysis.

HbA1C (Glycosylated Hemoglobin, %) [HbA1c only: DCA 2000 by Bayer Corp. (utilizing a drop of blood); combined cholesterol, triglycerides, glucose, LDL, HDL, and HbA1c: CholestTech (utilizing three capillary tubes of blood)] is a measure that represents the average blood sugar level over prolonged periods of time (i.e., past two to three months) and provides an estimate of how well blood sugar (and/or diabetes) is being managed over that timeframe (Cholestech-GDX System Test, 2008). If the HbA1C value is higher than the normal range, then the average blood sugar has been elevated during the past two to three months. More importantly, recent reductions in HbA1C may indicate better control of blood glucose levels (Cholestech-About A1C &
Diabetes, 2008). If participants’ glucose (sugar levels) was ≥ 200mg/dL and/or their HbA1C was ≥ 7%, they received a tentative diagnosis of diabetes and were referred to a physician.

Cholesterol (mg/dL) was measured in participants (CholestTech). Cholesterol is a soft waxy substance found in the bloodstream and in all cells (Cholesterol, 2006). Low-density lipoprotein (LDL) mg/dL is generally regarded as the “bad” cholesterol. Too much LDL cholesterol increases the risk of coronary heart disease (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001). High-density lipoprotein (HDL) mg/dL is considered the “good” cholesterol. The body apparently makes HDL cholesterol for protection, since it carries cholesterol away from ones arteries. High levels of HDL cholesterol may reduce the risk of heart attack.

Random Total Cholesterol (TC; mg/dL), glucose (mg/dL), HDL (mg/dL) and HbA1C (%) were performed on non-fasting participants. TC/HDL ratio was calculated from the recorded information for each participant. If a participant’s TC was ≥240 mg/dL and/or their HDL was ≤40 mg/dL, he/she was tentatively diagnosed with hypercholesterolemia and received a physician referral. Cholesterol data were not included in the present analysis.

**Health examination, ocular physical variables.** As part of the assessment process, visual acuity (utilization of a letter chart to determine the smallest letters you can read at a specified distance), biomicroscopy (An instrument that uses a light source that allows examination of the anterior or posterior eye) and comprehensive examination of the ocular fundus via ophthalmoscopy (a handheld instrument that uses a light beam to examine the back of the eye) and/or digital fundus imaging (a digital image of the eye
used to evaluate the back of the eye) were completed on each patient. These data were not included in the present analysis.

**Referrals.** If participants were referred to see an eye care and/or health care provider, their recommended appointment timing was ‘see provider soon,’ ‘within 13 days,’ or ‘immediately.’ If participants had corrected distance and/or near visual acuity less than or equal to the criterion of 20/40 and they met the income evaluation requirement, they qualified to receive spectacles. Also, certain participants qualified for referral to Alabama Lions Sight Conservation Association, Inc. for assistance. Referral data were not included in the present analysis.

**Ocular.** The intraocular pressure (IOP) of the OD (right) and OS (left) eye of each participant was measured using either the Goldmann, Perkins, NCT or Tonopen test. Intraocular pressure is a measure of the pressure inside an eye. The test is used to screen for glaucoma. Fluorescein/Benoxinate was used on participants assessed with Goldmann, Perkins or Tonopen. Participants were given the option to have their eyes dilated. If the patient declined dilation, patients were provided with a verbal warning of the importance of dilated vision examination. Participants received a referral if they had elevated ocular hypertension, which is related to IOP, or if a slit lamp examination indicated cataract workup or age-related maculopathy workup. Only the IOP OD data was included in this analysis, as some patients only had a right eye and IOP is similar between the eyes.

**Ocular findings.** Participants’ cup disk ratios (CD) for the OD and OS were determined using digital imaging, fundus lens, BIO and/or DO. Ocular findings data were not included in the present analysis.
Central corneal thickness (CCT, micrometers) was measured in each eye of glaucoma suspects only. This test was helpful in determining the likely actual IOP at the initial examination. Visual field (Humphrey Frequency Doubled Threshold, FDT) was completed in two trials on the OD and OS and labeled as normal, questionable, abnormal, or unreliable for individuals 40 years of age or greater. This tests visual field loss. CCT data were not included in the present analysis.

**Evaluation differences, coding issues.** Ethnicity was recoded into two categories: Black/African American and non-Black/non-African American (European American/White, Hispanic/Latino, Asian, or Other). Marital Status was recoded as married (married or living with partner) or single (single, separated, divorced or widowed). Some participants indicated their educational levels in years instead of degree earned. Education was recoded into two categories as years in school: 12 years of education or more [(13, 14, 15, 16, 17, 18, 19, 20, 21), high school graduate or GED, some college, college graduate, some graduate school, master's degree or doctorate degree] and less than 12 years of education (6th grade or less, 7th -11th grade). Currently smoking was recoded as follows: No (No, not at all or n) or Yes (Yes, everyday, somedays). Insurance was recoded as insured (private, public, insured unspecified) and not insured (none).

**Statistical analysis.** Data were recorded in Microsoft Excel and analyzed with SPSS 15.0 for windows.

**Significance levels.** The statistical analysis used the traditional level of 0.05 for alpha errors, standardized beta ($\beta$) and coefficient of variation ($R^2$) for each model.
Data selection for analysis. Three stepwise multiple regression models were constructed. Model 1 consisted of IOPOD (i.e., IOP in the right eye) relationship to socioeconomic factors (gender, ethnicity, marital status, education, currently smoking, and insurance). This would identify which socioeconomic factors were most related to IOP when considered together. Also, Model 1 provided information on socioeconomic status that had not been available in this form. Model 2 consisted of IOPOD relationship to physical systemic/demographic data (season, ethnicity, BMI, systolic blood pressure and HbA1C). This would identify which physical/demographic variables were most related to IOP. Model 2 was important because it was a typical set of data for IOP related investigations and could help establish the characteristics of the data set. Model 3 consisted of IOPOD relationship to socioeconomic status and physical systemic/demographic data (all variables from Model 1 and 2). Evaluation of all variables in Model 3 would allow a determination of which data (i.e., socioeconomic or demographic and physical, systemic) were most related to IOP and in which order. Any missing variables for a participant in Model 1, 2, or 3 would result in that person being excluded from the stepwise multiple regression model. All variables that were found to be statistically significant would indicate that they played a role in increasing or decreasing IOP.

Comparison data source, U.S. Census 2000. The U.S. Census Bureau takes a census of the population every 10 years and conducts economic activity, state and local government censuses every five years (U.S. Census Bureau, 2000). The U.S. Census Bureau, the nation’s largest statistical agency, provides data about the nation’s economy
and people (U.S. Census Bureau, 2000). The U.S. Census 2000 was used as a source of comparative data for the evaluation data of the Black Belt and Rural Alabama.

*Comparison data source, Center for Disease Control and Prevention 2002-2004.*

The U.S. Census Bureau for the Centers for Disease Control and Prevention's National Center for Health Statistics conducts the annual National Health Interview Surveys (NHIS) for civilian non-institutionalized adults to provide national estimates of various health measures (e.g., chronic conditions and health behaviors and lifestyles) in the United States (Lethbridge-Čejku et al., 2006; Lethbridge-Čejku et al., 2004; Lethbridge-Čejku & Vickerie, 2005). The results are published in the annual vital health statistics bulletin. The NHIS was used as a source of comparative data for the evaluation data of the United States.

*Masking.* The health evaluation and survey process did not involve masking of data.

*IRB and informed consent.* This study was approved by the UAB Institutional Review Board (X081007003; approved 10/14/2008). All RADGI participants completed informed consent prior to participating in the evaluations.
CHAPTER 3
RESULTS

RADGI completed 15 evaluations in eight Black Belt counties and one contiguous county over the course of 38 days of vision and health evaluation (Table 1).

Model 1

*Gender.* There were 1,858 total participants in this model. There were 471 (25.35%) males and 1,387 (74.65%) female participants. According to the U.S. Census (U.S. Census Bureau, 2000), the state of Alabama had 48.30% males and 51.70% females. The United States had about 49.10% males and 50.90% females (U.S. Census Bureau, 2000).

*Ethnicity.* There were 1,493 (80.36%) African-Americans and 365 (19.65%) non-African Americans in this model. The specific breakdowns of the non-African American participant category in this model were as follows: 348 European American/White, 8 Asian, 4 Hispanic/Latino and 5 “Others.” The State of Alabama had 26% African American and 74% non-African American during the time of the RADGI evaluations (U.S. Census Bureau, 2000). The United States had 12.30% African American and 87.70% non-African American during the time of the RADGI evaluations (U.S. Census Bureau, 2000).

*Marital status.* One thousand fifty two (56.62%) participants were single, separated, divorced or widowed and 806 (43.38%) participants were married or living
with their partner. The individual breakdowns of RADGI participants for this model were as follows: 789 married, 569 single, 210 widowed, 186 divorced, 87 separated, and 17 living with their partner. According to the U.S. Census (2000), 55.60% of Alabama residents were married and 22.50% were never married, separated, widowed, or divorced at the time of this evaluation. According to the U.S. Census (2000), 54.40% of the U.S. population was married and 45.60% were never married, separated, widowed, or divorced at the time of this evaluation.

Education. The highest level of education completed by 433 (23.31%) participants was less than 12 years of education and 1,425 (76.70%) participants completed 12 or more years of education. The state of Alabama had 24.70% of people without a high school diploma and 75.40% with a high school diploma or equivalent, associate, bachelor's, graduate or professional degree at the time of the RADGI evaluations (Census Bureau, 2000). The United States had 19.60% of people without a high school diploma and 80.30% with a high school diploma or equivalent, associate, bachelor's, graduate or professional degree at the time of the RADGI evaluations (Census Bureau, 2000).

Currently smoke. There were 341 (18.35%) participants who currently smoked and 1,517 (81.17%) participants who did not smoke. According to the NHIS data 21.67% of the U.S. population smoked and 78.33% of the U.S. population did not smoke during the time frame of the RADGI evaluations (Lethbridge-Ćejku et al., 2006; Lethbridge-Ćejku et al., 2004; Lethbridge-Ćejku & Vickerie, 2005).

Health insurance. 1,277 (68.73%) participants had public, private, or unspecified health insurance and five hundred and eighty (31.27%) participants did not have health
insurance. The individual breakdowns of RADGI participant insurance coverage for this model were as follows: 669 private, 477 public, 581 none and 131 insured unspecified. According to the NHIS data 83.88% of the U.S. population had health insurance and 16.12% of the U.S. population did not have insurance during the time frame of the RADGI evaluations (Lethbridge-Ćejku et al., 2006; Lethbridge-Ćejku et al., 2004; Lethbridge-Ćejku & Vickerie, 2005).

*Stepwise multiple regression model 1.* The mean IOP was 16.10 for RADGI Model 1 population. Stepwise multiple regression models were conducted to determine the relationship between IOP and SES variables. Persons who were single (i.e., single separated, divorced or widowed) and/or persons with less than 12 years of education had a positive significant correlation to elevated IOP levels (Table 4). Education and marital status were the only domains that were found to have a positive statistically significant relationship to IOP (Table 4). The model (p<.001) accounted for a 0.9% prediction of IOP levels in this population.
Table 4.

*Results from Model 1 stepwise multiple regression.*

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>SE b</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>15.929</td>
<td>.099</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>.748</td>
<td>.205</td>
<td>.084***</td>
</tr>
<tr>
<td>Step 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>15.728</td>
<td>.139</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>.734</td>
<td>.205</td>
<td>.083***</td>
</tr>
<tr>
<td>Marital Status</td>
<td>.361</td>
<td>.175</td>
<td>.048*</td>
</tr>
</tbody>
</table>

Note. $R^2=.007$ for Step 1: $R^2=.009$ for Step 2. *p<.05, **p<.01, ***p<.001.

Model 2

*Seasonality.* Of the 1,961 participants in this model, 1,437 (72.28%) were evaluated during the warmer season and 524 (26.72%) were evaluated during the cooler season.

*Age.* There were 1, 492 (76.08%) participants 40 years of age and older. There were 469 (23.92%) participants that were less than 40 years of age.

*Ethnicity.* There were 1,567 (80.10%) African-Americans and 394 (20.09%) non-African Americans in this model. The specific breakdowns of the non-African American participant category were as follows: 365 European American/White, 16 Asian, 6 Hispanic/Latino and 7 “Others.”
**Body Mass Index (BMI).** The mean BMI was 32.39 (obese). Of the 1,916 participants, 20 (1.02%) were considered underweight if their BMI was < 18.5, 315 (16.06%) were considered a healthy weight if their BMI was ≥ 18.5 or < 25, 510 (26.01%) participants were considered overweight if their BMI was ≥ 25-29.99 and 1,116 (56.91%) participants were labeled as obese if their BMI was ≥ 30. According to the NHIS data 38.13% of the U.S. population was a healthy weight, 34.30% of the U.S. population was overweight and 22.72% of the U.S. population was considered obese during the time frame of the RADGI evaluations (Lethbridge-Čejku et al., 2006; Lethbridge-Čejku et al., 2004; Lethbridge-Čejku & Vickerie, 2005).

**Systolic blood pressure.** The mean systolic blood pressure of participants in this model was 139.89 (obese). Nine hundred and thirty (47.18%) participants had elevated systolic (≥ 140). According to the NHIS data, 21.56% of the U.S. population had been told on two or more occasions that they had hypertension during the time frame of the RADGI evaluations (Lethbridge-Čejku et al., 2006; Lethbridge-Čejku et al., 2004; Lethbridge-Čejku & Vickerie, 2005).

**HbA1C.** Two hundred and fifty one (12.80%) participants had elevated blood HbA1C levels (≥ 7%). According to the NHIS data 7% of the U.S. population had been told that they had diabetes during the time frame of the RADGI evaluations (Lethbridge-Čejku et al., 2006; Lethbridge-Čejku et al., 2004; Lethbridge-Čejku & Vickerie, 2005).

**Stepwise multiple regression model 2.** The mean IOP was 16.18 for RADGI Model 2 population. Stepwise multiple regression models were conducted to determine the relationship between IOP and demographic and physical systemic variables. Cooler season had a negative significant correlation with elevated IOP levels (Table 5). Systolic
blood pressure, HbA1C and season were the only variables found to have a positive statistically significant relationship to IOP (Table 5). The model (p<.001) accounted for a 6.9% prediction of IOP levels for this population.

Table 5.

*Results from Model 2 stepwise multiple regression.*

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>SE b</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>10.992</td>
<td>.558</td>
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</tr>
<tr>
<td>BPSYS</td>
<td>0.37</td>
<td>.004</td>
<td>.208***</td>
</tr>
<tr>
<td>Step 2</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>9.191</td>
<td>.608</td>
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<tr>
<td>BPSYS</td>
<td>0.031</td>
<td>.004</td>
<td>.172***</td>
</tr>
<tr>
<td>HbA1C</td>
<td>.452</td>
<td>.065</td>
<td>.157***</td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td></td>
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<tr>
<td>Constant</td>
<td>9.323</td>
<td>.611</td>
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<td>BPSYS</td>
<td>0.030</td>
<td>.004</td>
<td>.170***</td>
</tr>
<tr>
<td>HbA1C</td>
<td>.458</td>
<td>.065</td>
<td>.159***</td>
</tr>
<tr>
<td>Season</td>
<td>-.401</td>
<td>.200</td>
<td>-.044*</td>
</tr>
</tbody>
</table>

Note. $R^2=.043$ for Step 1: $R^2=.067$ for Step 2: $R^2=.069$ for Step 3. *p<.05, **p<.01, ***p<.001.

Model 3

*Gender.* There were 1,631 total participants in this model. There were 421 (25.81%) males and 1,210 (74.19%) female participants in this model.
Ethnicity. There were 1,303 (79.89%) African-Americans and 328 (20.11%) non-
African Americans in this model. The specific breakdowns of the non-African American
participant category in this model were as follows: 314 European American/White, 6
Asian, 3 Hispanic/Latino and 5 “Others.”

Marital status. Seven hundred and nine (43.47%) participants were single,
separated, divorced or widowed and 922 (55.53%) participants were married or living
with their partner. The individual breakdowns of RADGI participants for this model
were as follows: 696 married, 494 single, 188 widowed, 165 divorced, 75 separated, and
13 living with their partner.

Education. The highest level of education completed by 376 (23.05%)
participants less than 12 years of education and 1,265 (77.56%) participants completed 12
or more years of education.

Currently smoke. There were 307 (18.82%) participants who currently smoked
and 1324 (81.18%) participants who did not smoke.

Health insurance. 1,106 (68.42%) participants had public, private, or unspecified
health insurance and 515 (31.58%) participants did not have health insurance. The
individual breakdowns of RADGI participant insurance coverage for this model were as
follows: 577 private, 419 public, 515 none and 120 insured unspecified.

Seasonality. In this model, 1,170 (71.74%) participants were evaluated during the
warmer season and 461 (28.27%) participants were evaluated during the cooler season.

Age. There were 1, 245 (76.33%) participants 40 years of age and older. There
were 386 (23.67%) participants that were less than 40 years of age.
Body Mass Index (BMI). The mean BMI of participants was 32.51 (obese). Of the 1,631 participants, 16 (0.98%) were considered underweight if their BMI was < 18.5, 266 (16.31%) were considered a healthy weight if their BMI was ≥ 18.5 or < 25, 428 (26.24%) participants were considered overweight if their BMI was ≥ 25-29.99 and 922 (56.53%) participants were labeled as obese if their BMI was ≥ 30.

Systolic blood pressure. The mean systolic blood pressure of participants in this model was 139.88. Seven hundred and seventy two (47.33%) participants had elevated systolic blood pressure (≥ 140).

HbA1C. One hundred and ninety eight (12.14%) participants had elevated HbA1C levels (≥ 7%).

Stepwise multiple regression model 3. The mean IOP was 16.10 for RADGI Model 3 population. Stepwise multiple regression models were conducted to determine the relationship between IOP and demographic and physical systemic variables. Cooler season had a negative significant correlation with elevated IOP levels (Table 6). Systolic blood pressure, HbA1C, season and BMI were the only variables found to have a positive statistically significant relationship to IOP (Table 6). The model (p<.001) accounted for a 6.4% prediction of IOP levels for this population.
Table 6.

*Results from Model 3 stepwise multiple regression.*

<table>
<thead>
<tr>
<th>Step 1</th>
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<tr>
<td>Constant</td>
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<td>.034</td>
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<td>.205***</td>
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<td>Constant</td>
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<td>BPSYS</td>
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<td>.004</td>
<td>.177***</td>
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<tr>
<td>HbA1C</td>
<td>.340</td>
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<td>.125***</td>
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<table>
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<tr>
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<td>BPSYS</td>
<td>.029</td>
<td>.004</td>
<td>.173***</td>
</tr>
<tr>
<td>HbA1C</td>
<td>.350</td>
<td>.067</td>
<td>.128***</td>
</tr>
<tr>
<td>Season</td>
<td>-.569</td>
<td>.200</td>
<td>-.069**</td>
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<table>
<thead>
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<th>β</th>
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<td>.004</td>
<td>.163***</td>
</tr>
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<td>HbA1C</td>
<td>.328</td>
<td>.068</td>
<td>.120***</td>
</tr>
<tr>
<td>Season</td>
<td>-.583</td>
<td>.200</td>
<td>-.070**</td>
</tr>
<tr>
<td>BMI</td>
<td>.023</td>
<td>.011</td>
<td>.050*</td>
</tr>
</tbody>
</table>

Note. $R^2=.042$ for Step 1: $R^2=.057$ for Step 2: $R^2=.061$ for Step 3: $R^2=.064$ for Step 4. *p<.05, **p<.01, ***p<.001.
CHAPTER 4
DISCUSSION

*Model 1 comparative analysis.* There was a smaller percentage of married persons than the national averages predicted. Studies have shown that healthy marriages affect the physical health of a person (Eaker et al., 2007), which might play a role in the poorer physical, systemic health of the population. The majority of participants had an educational attainment level of 12 years of education or higher, which was similar to the national average. There is a possibility that the population was uneducated about healthy eating and fitness activities. For instance, some high schools may allow students the option of health education courses or other electives. If students do not take this course, they may be less aware of the importance of a healthy diet and proper exercise. A larger percentage of the population had health insurance than the national average. This could be due to the possible RADGI bias towards a health conscious population.

*Model 1 stepwise multiple regression.* Educational attainment and marital status were the only two variables that were found to be statistically significant to variation in IOP levels. There was a positive significant correlation between being single (i.e., single, separated, divorced or widowed) and/or having less than 12 years of education and elevated IOP levels. This emphasizes the importance of an education and a potential benefit of a healthy marriage. Also there is a possibility that the correlation to marital status is an indication that having close friends will also reduce IOP levels. Friendship is a difficult measure, whereas marital status is easily defined in a binary manner, and thus was not evaluated in the RADGI study. However, research has shown that older adults
who have close friends for emotional support have a better health related quality of life (CDC, 2005). Additionally, having close friends that encourage you to participate in healthy diet and exercise activities may also increase your overall health and wellbeing. Also, the model only accounted for 0.9% of IOP variation; therefore, there are other variables that are influencing IOP in this population.

*Model 2 comparative analysis.* There was an oversample of African Americans in comparison to the U.S. national averages. A high percentage of participants were obese in comparison to the national average. Participants from the Black Belt counties, known for their rich black soil (Anderson & Fortson, 2000), may be likely to have their own vegetable garden. These persons may also be more likely to prepare home grown vegetables from their gardens; however, traditions have been passed down to add salt to food prior to tasting the food and prepare these foods in unhealthy manners, contributing to elevated systolic blood pressure levels and BMI, respectively. Also, the population was well-educated and the more education an individual has, the higher income they have and this may be related to less time to prepare healthy home cooked meals and result in unhealthy habits regarding food selection. The HbA1C levels and systolic blood pressure levels of participants were higher than the national average. We speculate that this may be due to the eating habits and lack of exercise of persons in this area.

*Model 2 stepwise multiple regression.* Systolic blood pressure, HbA1C and seasons were found to be statistically significant to variations in IOP levels. After Model 2 stepwise multiple regressions accounted for all demographic and physical systemic variables, those persons who were evaluated in RADGI during the cooler season tended to have lower IOP. Previous research has shown that IOP is related to climate changes
and to the number of hours of daily sunlight exposure (Qureshi et al., 1996). Researchers have also shown that IOP levels decrease with 5 or more hours of daily sunlight (Qureshi et al., 1996). Since there has been no known research of the impact of climate or sun exposure on the RADGI population, there is a possibility that the comfortable cooler season versus the extremely uncomfortable warmer season might encourage rural Alabama residents to spend more time outdoors exposed to sunlight. Additionally, there may be some form of seasonal stress associated with the warmer season in rural Alabama. Also, since the model only accounted for 6.9% of IOP variation, there are other variables that are influencing IOP in this population.

**Model 3 stepwise multiple regression.** Systolic blood pressure, HbA1C, season and BMI were the only four variables that were found to be statistically significant to variations in IOP levels. No socioeconomic variables were found to be statistically significant. Also, as with model 2, the cooler season was found to have a positive statistical significance to elevated IOP, possibly due to climate issues. Also, since the model only accounted for 6.4% of IOP variation, other variables are influencing IOP in this population.

**Final conclusions.** None of the three models were able to adequately predict IOP levels. There is a possibility that other physical, systemic and socioeconomic variables (e.g., cholesterol levels, alcohol consumption and income levels) may be more representative. Additional research has shown that genes such as the secreted protein, acidic and rich in cysteine (SPARC) gene is associated with proper outflow of aqueous humor (Haddadin et al., 2009). SPARC is an example of a gene that appears to only be causal to glaucoma in some cases, but not in others, implying that glaucoma is not driven
by the same mechanisms in all patients (Kirwan, Wordinger, Clark, & O'Brian, 2009). There are potentially many causes of elevated IOP, leading to the possibility that socioeconomic status, demographic and physical, systemic factors may only be useful in predicting elevated IOP driven by particular mechanisms. In other words, the models may be failing because we are considering all people with elevated IOP as one big group, whereas it may be more appropriate to consider different types of elevated IOP. We do not know enough to do that yet, but it is a possibility as we move forward.

Limitations. There was an over sample of African Americans in this model as a function of the majority of RADGI evaluations being conducted in the Black Belt counties of Alabama. There was also an over sample of females in this model. This may be related to many households being single income households with males often the major income earners. Persons, i.e., men who work during the week, may have been unable to attend the evaluations due to work schedule conflicts.

There were missing data for all models. This resulted in the exclusion of numerous participants that could have provided a better insight into the contributing factors of IOP in this area. Also, missing data led to less statistical power in the stepwise multiple regression models. Additionally, estimates were made in the population as it relates to the height and weight of participants. Because of limitations of the protocol, participants were allowed to keep their shoes on and were not required to wear a light gown to be weighed, which would result in a more accurate weight. Therefore, one inch and one pound was subtracted from all individuals. This is may have possibly resulted in a higher BMI for participants due to people having more than one pound of clothing on and shoes
being higher than one inch, particularly during the cooler season when heavier clothing is more frequently worn.

Comparative data for marital status from the U.S. Census included persons who were 15 years of age and older (U.S. Census Bureau, 2000). However, this analysis only included persons who were 19 years of age or older. Additionally, the U.S. Census only included persons 25 years of age and older in the educational attainment category, while this analysis included persons 19 years of age and older. Also, the NHIS considered adults as persons who were 18 years of age and older (Lethbridge-Ćejku et al., 2006; Lethbridge-Ćejku et al., 2004; Lethbridge-Ćejku & Vickerie, 2005) while this analysis considered adults as persons 19 years of age and older. Due to these differences in the age requirement between these data, the U.S. Census, and NHIS there is a possibility that the U.S. Census and NHIS may not be the most accurate comparative datasets for this population.

This sample was also a convenience sample because it was the easiest and least expensive manner to collect data for this population. This method was selected for this study because of a concern with determining the relationships between various variables and IOP instead of an estimate of population values (Cozby, 2001). However, this possibly resulted in an oversample of persons who had extreme poor health conditions and/or those who are health conscious and had financial difficulties, which was not the most representative of the population of interest. Conclusions about the economic standing of the RADGI population are unclear. The best option for sampling this population would be random sampling, in which every person has an equal probability of being selected for the sample (Cozby). This would ensure that the sample was
representative of the population of interest. However, this would have required a larger budget than was available to RADGI during that time frame.

Also, there is a possibility that the difference in units of measurement among the dependent and independent variables may have resulted in inaccurate data results. For instance, a systolic blood pressure change of 10 mm Hg could possibly increase IOPOD by 0.2895 units.

Accounting for these differences would be a difficult process. Future studies should consider taking these unit differences into account.

Future research. More research conducted in the Black Belt area of Alabama may be valuable in determining the current health activities of the population. Additionally, based on the findings from this study, future evaluations may benefit from the inclusion of other physical, systemic (e.g., cholesterol), lifestyle [e.g., alcohol consumption (Qureshi et al., 1996)], activities, climate differences and daily sunlight exposure in comparison to other areas of the community. Researchers should be encouraged to control for missing data by double-checking all forms and evaluations before participants leave. Also, due to the high prevalence of elevated BMI, elevated systolic blood pressure levels and elevated HbA1C levels, theory-driven fitness and wellness interventions should be considered in this population in an attempt to improve the overall health in the Black Belt counties and Rural Alabama.
LIST OF REFERENCES


APPENDIX

IRB APPROVAL FORM
Principal Investigator: IRBY, ALICE
Co-Investigator(s):
Protocol Number: X081007003
Protocol Title: Social Economic Status Association with Intracocular Pressure in Rural Alabama

The IRB reviewed and approved the above named project on 07/06/08. The review was conducted in accordance with UAB’s Assurance of Compliance approved by the Department of Health and Human Services. This Project will be subject to Annual continuing review as provided in that Assurance.

This project received EXPEDITED review.

IRB Approval Date: 10/14/08
Date IRB Approval Issued: 10/14/08

Marilyn Doss, M.A.
Vice Chair of the Institutional Review Board for Human Use (IRB)

Investigators please note:

The IRB approved consent form used in the study must contain the IRB approval date and expiration date.

IRB approval is given for one year unless otherwise noted. For projects subject to annual review research activities may not continue past the one year anniversary of the IRB approval date.

Any modifications in the study methodology, protocol and/or consent form must be submitted for review and approval to the IRB prior to implementation.

Adverse Events and/or unanticipated risks to subjects or others at UAB or other participating institutions must be reported promptly to the IRB.

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