4-18-2023

When Mental Health Becomes Physical

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SENIOR THESIS APPROVAL

This Honors thesis entitled:

“When Mental Health Becomes Physical”

written by **Piper Fain**

and submitted in partial fulfillment of the requirements for completion of the Carl Goodson Honors Program meets the criteria for acceptance and has been approved by the undersigned readers.

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April 18, 2023

"When Mental Health Becomes Physical"

2023 Honors Senior Thesis Piper

Fain

Introduction

Tonometry, a diagnostic test measuring intraocular pressure (IOP) is a component of almost any standard eye examination. There are a few methods of performing this test, though most are more familiar with the famous “puff of air” tonometry test – a noncontact method – or the use of a handheld tonometer which comes into contact with the cornea. As optometrists and their technicians learn to perform these tests on patients, many implement the use of verbal reassurance alongside it. “This may tickle your eyelashes a bit,” they may warn, or “take a deep breath for me,” they might encourage after obtaining a higher-than-normal measurement. Though this strategy of verbal reassurance can be utilized in several different ways, the purpose is the same; to ensure an accurate measurement of IOP the first time, thus saving time and keeping exams running smoothly.

These harmless tricks become routine for those performing tonometry tests as they utilize them dozens of times a day, however upon learning of them for the first time, they may seem unimportant. Why does it matter if the patient holds their breath for the split second their pressure is being taken? Can it really impact their results that much? In practice, many observe that as patients anticipate of the “puff of air”, or experience discomfort due to the close proximity of a handheld tonometer, there is some physiological influence that serves to elevate their IOP readings. The implementation of soothing techniques, such as gentle reminders to breathe, can thus make all the difference in obtaining accurate measurements.

Glaucoma is a group of common ocular diseases that, if left untreated, can cause permanent vision loss (American Journal of Health-System Pharmacy, *Glaucoma and its treatment*). Though there are several different types of Glaucoma, an exceedingly common symptom is elevated IOP, which may contribute to the damage of the optic nerve that is

characteristic of these diseases. Although an elevated IOP measurement is not always indicative of these diseases, it is a major risk factor, so obtaining such a measurement may raise concern enough to prompt further testing. This might explain why optometrists and their technicians are so careful to ensure that patients are calm when having their IOP taken, as an abnormally high measurement will most certainly warrant further investigation. This investigation typically begins with repetition, the tonometry test is performed again in hopes the first measurement was a fluke. This re-measurement is often taken more seriously than the first, and if the optometrist or technician did not ensure the patient was calm the first time, they will often do so during the retest. Making certain that the patient's elevated reading is accurate allows optometrists to discern the root cause more clearly.

If the stress of a pretest during a routine eye exam is cause enough to raise IOP measurements in an otherwise healthy patient, it is not unreasonable to question the correlation between glaucoma and anxiety. One might theorize that chronic anxiety could be enough to produce a chronically elevated IOP, thus mimicking the physiological conditions that lead to glaucoma. Recent studies of have shown that 17.1% of patients with glaucoma also presented with anxiety (American Journal of Ophthalmology, *The Association Between Glaucoma, Anxiety, and Depression in a Large Population*). The purpose of this research is to explore the possibly correlative relationship between glaucoma and anxiety. Through it, researchers hope to either accept or refute the correlation between the two diagnoses.

Background Information - Glaucoma

Intraocular pressure (IOP) measures the fluid pressure within the eye. The ciliary body, found behind the iris, produces two kinds of fluid within the eye: the vitreous humor and the aqueous humor. Vitreous humor is a colorless, gelatinous substance that fills the vitreous chamber between the lens and retina. Aqueous humor is also colorless, though it is more fluid and is found in the anterior and posterior chambers of the eye, between the cornea and the lens. In a healthy eye, the ciliary body constantly produces small amounts of aqueous humor, and equal amounts of older aqueous humor are drained through the iridocorneal angle. (American Academy of Ophthalmology, *Eye* Pressure). This angle is formed by the cornea, sclera, and iris, and contains the ocular structures responsible for facilitating the export of the majority of the aqueous humor from the eye. The drainage of aqueous humor from the eye is essential to ocular health, and when it does not occur or occurs improperly, the excess of aqueous humor may elevate IOP which can damage to the optic nerve (American Academy of Ophthalmology, *Aqueous Humor).*

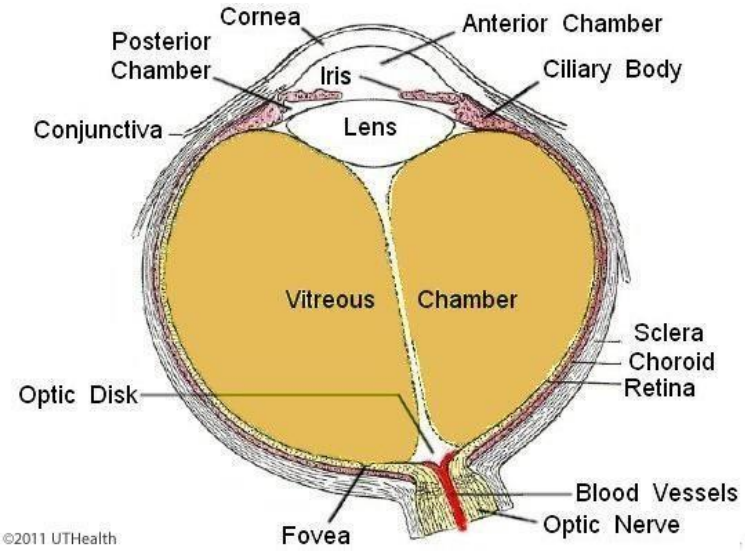


Figure 1. University of Texas Health Sciences Center at Houston, Gross Anatomy of the Eye

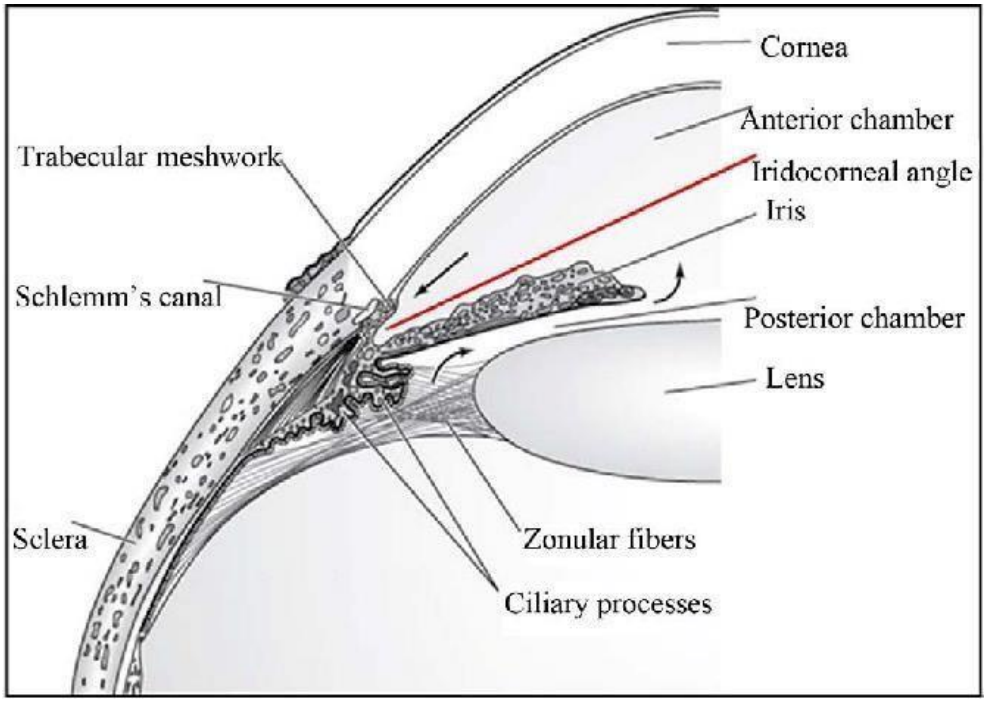


Figure 2. Kallmark & Sakhi, Diagram of the Anatomical Structures Forming the Iridocorneal Angle

Glaucoma, though often assumed to be a singular disease, is actually a group of chronic ocular diseases, all associated with progressive damage to the optic nerve. The optic nerve itself is responsible for transmitting visual signals from the eye to the brain, and it is composed of over one million nerve fibers. These nerve fibers are incapable of regenerating, so vision loss associated with their damage is permanent (U.S. National Library of Medicine, *Neuroanatomy, Cranial Nerve 2 (Optic)*). Pressure-induced damage to the optic nerve like that observed in glaucoma patients may result in optic nerve cupping, in which the center portion of the optic disc, the "cup", increases in size as compared to the rest of the disc. Some degree of cupping is normal, however for those without optic nerve damage the cup portion is generally much smaller than the disc as a whole. Optic nerve damage can occur when IOP is elevated, or when there is a loss of blood flow to the optic nerve, causing nerve fibers to die. Without the structural support of these nerve fibers, the cup becomes larger in comparison to the disc. The relationship between

cup and disc is measured in a cup-to-disc ratio, which can be useful for monitoring general eye health and the progression of glaucoma (Cohen & Quigley, *Optic nerve cupping*).

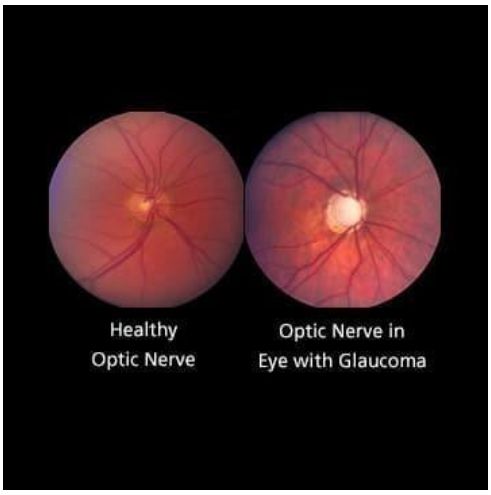


Figure 3. Glaucoma Research Foundation, Optic Nerve Cupping

To evaluate glaucoma, the appearance of the iridocorneal angle is often used to discern the cause of optic nerve damage. Different forms of glaucoma are classified by the appearance of this angle, categorized anatomically as open-angle if there is no obstruction, or closed-angle if an obstruction is present. Similarly, glaucoma sometimes occurs as a result of other ocular issues, so it is also categorized etiologically as primary, in which there is no underlying cause, or secondary, in which there is an identifiable underlying cause. (Dietze, Blair, & Havens, *Glaucoma*)

Open-angle glaucoma occurs when the iridocorneal angle is unobstructed, but the outflow of aqueous humor from the eye is nonetheless diminished. This form of glaucoma is also categorized by the presence of elevated IOP, typically caused by the buildup of aqueous humor within the eye. Etiologically, open-angle glaucoma may either be primary, in which there is no underlying cause for elevated IOP, or secondary, in which there is an identifiable underlying cause for this issue such as other disorders or inflammation (Wills Eye Hospital, *Secondary*

Open Angle Glaucoma). If IOP is normal, it is instead termed normal tension glaucoma (NTG), which is a form of primary open-angle glaucoma (POAG) (American Academy of Ophthalmology, *Normal tension glaucoma*). POAG is the most common form of glaucoma and serves as the second leading cause of blindness in the United States (Kwon, Fingert, Kuehn, & Alward, *Primary Open-Angle Glaucoma*). Most patients with open-angle glaucoma appear asymptomatic, experiencing very gradual vision loss that begins at the peripherals and goes unnoticed until severe nerve damage has occurred. The associated nerve damage is slow and painless, though the vision loss associated with it is irreversible. Some of the risk factors for open-angle glaucoma include elevated IOP, those with a family history of open-angle glaucoma, advancing age, African ancestry, myopia, diabetes, and hypertension. (American Academy of Ophthalmology, *Primary open-angle glaucoma*.)

Angle-closure glaucoma (ACG) occurs when there is a blockage of the iridocorneal angle, inhibiting the normal outflow of aqueous humor and causing elevated IOP. It may be etiologically primary, in which the cause of angle closure is usually a pupillary block, or secondary, in which there are other underlying causes contributing to the blockage. Pupillary blocks occur when the iris makes contact with the anterior surface of the lens, preventing aqueous humor from flowing through the pupil (Glaucoma Information, *Angle closure glaucoma*). Secondary angle-closure glaucoma results from other underlying issues such as injury or inflammation causing the iris to be pushed forward or pulled backward to come into contact with and block the trabecular meshwork (American Academy of Ophthalmology, *Primary vs. secondary angle closure glaucoma*). Though far less common than open-angle glaucoma, angle-closure glaucoma is more severe and develops much more quickly. In ACG, the iridocorneal angle is completely blocked, which causes IOP to increase quickly and thus damage

the optic nerve more suddenly. Patients with ACG, unlike those with open-angle glaucoma, may experience symptoms such as eye pain, nausea, and more rapid and noticeable vision loss. (American Academy of Ophthalmology, *Primary vs. secondary angle closure glaucoma*). Some of the risk factors for angle-closure glaucoma include female gender, advancing age, Inuit or East Asian ethnicity, and genetic factors.

Ocular hypertension is not a form of glaucoma, though it does occur under similar conditions. Like primary open-angle glaucoma, the iridocorneal angle is unobstructed, yet aqueous humor drains improperly, elevating intraocular pressure. There is not, however, damage to the optic nerve or vision loss. Patients experiencing ocular hypertension are often considered "glaucoma suspects", as the conditions for developing glaucoma are present, but the optic nerve appears normal. Those with a family history of ocular hypertension or glaucoma, diabetes or high blood pressure, African American or Hispanic descent, long-term steroid medication use, history of eye injuries or surgery, and people over the age of 40 are at higher risk for developing ocular hypertension (American Academy of Ophthalmology, *What is Ocular Hypertension?*).

Background – Glaucoma and Anxiety

I. Bodily Effects of Chronic Anxiety

Anxiety disorders are the most common mental health disorders, affecting around 30% of adults at some point throughout their lives (American Psychiatric Association, *What are anxiety disorders?*). When the body experiences anxiety, its first act is often to initiate the "fightorflight" response, in which a swift sequence of hormonal changes prepare the body to fight or flee a threat. This response likely evolved to ensure survival in life-threatening situations, however, it may take place in the presence of much smaller stressors. Repetitive activation of this response can have important psychological and physiological consequences.

Before the fight-or-flight response can begin, the brain must perceive a stressor. The amygdala, a portion of the brain that helps facilitate emotion processing, interprets auditory and visual information provided by the eyes and ears. If it perceives a threat, it sends a distress signal to the hypothalamus, which communicates this threat to the rest of the body through the autonomic nervous system. The autonomic nervous system is comprised of the sympathetic nervous system and the parasympathetic nervous system, which each function differently in the fight-or-flight response (Harvard Health, *Understanding the stress response*).

The sympathetic nervous system is responsible for triggering the fight-or-flight response, which occurs almost instantaneously. As the hypothalamus relays the distress signal through the autonomic nerves, the adrenal glands begin to produce epinephrine, also known as adrenaline. The release of adrenaline into the bloodstream increases heart rate, blood pressure, respiration rate, and prompts the body to release glucose and fats from temporary storage sites. These

physiological changes prepare the body to fight or flee and occur quickly, often before the mind has time to fully process the situation (Harvard Health, *Understanding the stress response*).

As the effects of the initial adrenaline spike wear off, the HPA axis is activated. The hypothalamus, pituitary gland, and the adrenal glands function to proliferate the stress response, so long as the brain continues to perceive a threat (Harvard Health, *Understanding the stress response*). This is accomplished through a hormonal cascade: the hypothalamus releases corticotropin-releasing hormone, which signals the pituitary gland to release adrenocorticotropic hormone, which stimulates the adrenal glands to release cortisol. Cortisol, the final result of the cascade, stimulates the liver to release glucose and elevate blood sugar. This provides an energy boost that elongates the effects of the fight-or-flight response (Mayo Foundation for Medical Education and Research, *Chronic stress puts your health at risk*).

The parasympathetic nervous system is responsible for terminating the fight-or-flight response and is often referred to as the "rest and digest" response. When the brain no longer perceives a threat, the HPA axis is deactivated, and the body ceases to produce cortisol. The parasympathetic nervous system facilitates the "cool-down" of the body, lowering heart rate, respiration rate, blood pressure, and blood sugar (Harvard Health, *Understanding the stress response*).

The autonomic nervous system maintains a balance between stress and recovery states and is typically self-limiting (Mayo Foundation for Medical Education and Research, *Chronic stress puts your health at risk*). However, when an individual is exposed to frequent or chronic stress, such as a chronic anxiety disorder, long-term activation of the sympathetic nervous system may occur. In this case, the parasympathetic nervous system would not produce its normal counteractive effects, essentially leaving the body in "fight or flight mode" for extended periods

of time. Such an imbalance in the autonomic nervous system has physiological consequences. Overexposure to cortisol puts stress on the body, and may cause cardiovascular issues such as heart disease, heart attack, high blood pressure, and strokes (Mayo Foundation for Medical Education and Research, *Chronic stress puts your health at risk*).

II. Ocular Effects of Chronic Anxiety

Chronic illnesses, while often recognized primarily for their adverse physiological effects, may also elicit psychological disturbances. Receiving any kind of diagnosis can be a stressful experience, however due to the longevity of chronic conditions, these feelings of stress may continue and result in anxiety disorders (National Library of Medicine, *Chronic illness: Sources of stress, how to cope*). These disorders may manifest in very physical symptoms such as increased heart rate, fatigue, irregular sleeping patterns, and muscle tension (Mayo Foundation for Medical Education and Research, *Generalized anxiety disorder*). Chronic anxiety may even produce frequent spikes in blood pressure, damaging the blood vessels, heart, and kidneys in a manner that mimics the effects of hypertension (Sheps, *Can anxiety cause high blood pressure*?).

Glaucoma is considered a chronic disease, and though not life-threatening, it requires lifelong management that can be stressful for those experiencing it. Feelings of stress and anxiety are not an unreasonable response to the prospect of permanent vision loss, and much research has been done surrounding this relationship. However, because stress responses such as anxiety may produce very physical symptoms, it is also plausible that anxiety may exacerbate the progression of glaucoma (Shin, Jung, H. Park, & C. Park, *The effect of anxiety and depression on progression of glaucoma*).

When the body experiences chronic anxiety, it is possible for the effects of the fightorflight response to occur continually. This disruption in the typical equilibrium established by the sympathetic and parasympathetic nervous systems may interfere with the function of ocular vasculature. Decreases in ocular blood flow may occur, a symptom associated with glaucoma progression. Disturbances in this function may also intensify the progression of disc

hemorrhage, a risk-factor associated with glaucoma progression (Shin, Jung, H. Park, & C. Park, *The effect of anxiety and depression on progression of glaucoma*).

In a study conducted by Shin, Jung, H. Park, & C. Park, 251 patients with primary open angle glaucoma or normal tension glaucoma were monitored over a two year period. The psychological status of these individuals was measured using Beck's Anxiety Inventory (BAI) and Beck's Depression Inventory-II (BDI-II). The results of this study indicate that anxiety is significantly associated with the rate of retinal nerve fiber layer (RNFL) thinning in glaucoma patients. RNFL analysis is useful for evaluating the progression of glaucoma; as the nerve layer thins, more nerves die, and glaucoma progresses further. Therefore, the findings of this study suggest the possibility of anxiety serving as a risk factor for glaucoma (Shin, Jung, H. Park, & C. Park, *The effect of anxiety and depression on progression of glaucoma*).

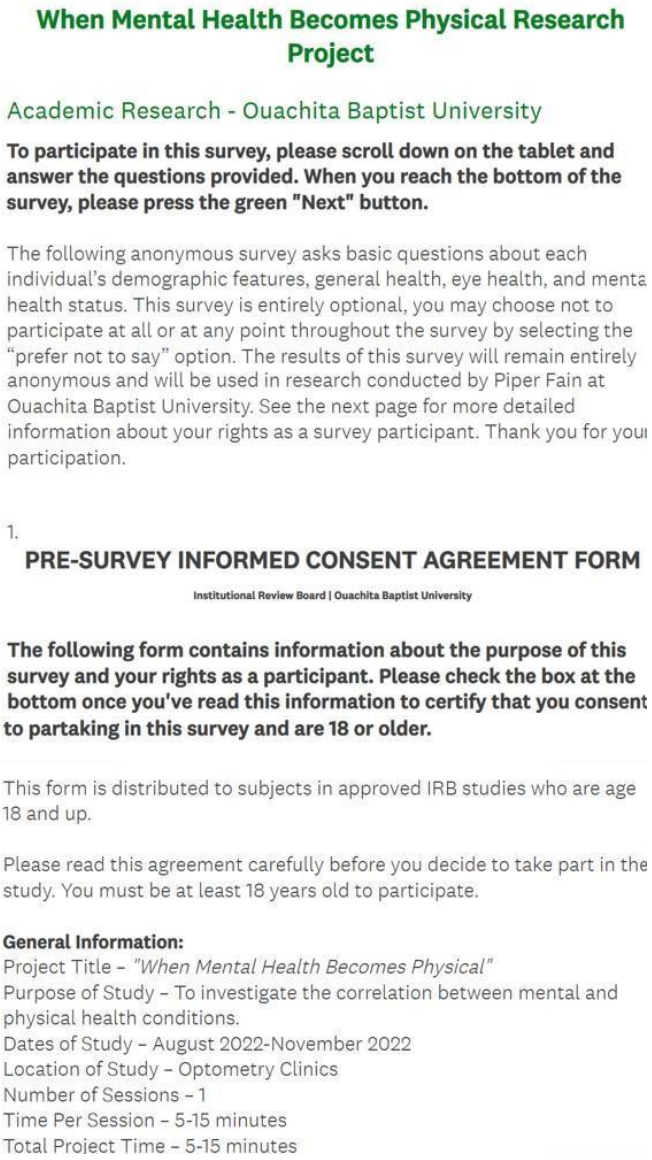
Survey Setup

To assess the correlation between glaucoma and anxiety in a noninvasive manner, researchers utilized a survey to gather participant-reported data. The participants in this study were chosen in a convenience sampling, as the survey was conducted exclusively in optometry clinics and all participants were patients visiting their respective clinics. Researchers chose this setting, while possibly misrepresentative of the population, for the relevance of participants experiencing ocular issues to this study.

This survey was administered on a mobile tablet using the platform SurveyMonkey. Clinic staff administered the survey by asking patients if they would like to participate while they waited for their appointment to begin. If patients agreed, they were given the tablet and completed the survey in the lobby, with staff available at the front desk to answer questions and help participants operate the tablet. To ensure patient participation was optional and only available to adults, clinic staff asked only patients of age 18 or older if they would like to participate in the survey. It is important to note that while clinic staff was aware of the identity of the participants, they were unable to access the results of any survey once it had been submitted. Similarly, researchers with access to the results of the survey were not present while the surveys were being administered and were not provided with any participant information not included in the results of the survey.

A pre-survey informed consent agreement form was presented on the tablet before the survey began, and to proceed to the survey patients were asked to check a box indicating they were of the age of 18 or older, had read and understood the form, were given the opportunity to ask questions, and agreed to participate in the research being conducted. Participants were also provided with a paper copy of this agreement upon request. The form patients were asked to read

was approved by the institutional review board of Ouachita Baptist University, and was presented on the tablet as follows:



When Mental Health Becomes Physical Research Project

Academic Research - Ouachita Baptist University

To participate in this survey, please scroll down on the tablet and answer the questions provided. When you reach the bottom of the survey, please press the green "Next" button.

The following anonymous survey asks basic questions about each individual's demographic features, general health, eye health, and menta health status. This survey is entirely optional, you may choose not to participate at all or at any point throughout the survey by selecting the "prefer not to say" option. The results of this survey will remain entirely anonymous and will be used in research conducted by Piper Fain at Ouachita Baptist University. See the next page for more detailed information about your rights as a survey participant. Thank you for your participation.

1.

PRE-SURVEY INFORMED CONSENT AGREEMENT FORM

Institutional Review Board | Ouachita Baptist University

The following form contains information about the purpose of this survey and your rights as a participant. Please check the box at the bottom once you've read this information to certify that you consent to partaking in this survey and are 18 or older.

This form is distributed to subjects in approved IRB studies who are age 18 and up.

Please read this agreement carefully before you decide to take part in the study. You must be at least 18 years old to participate.

General Information:
Project Title – *"When Mental Health Becomes Physical"*
Purpose of Study – To investigate the correlation between mental and physical health conditions.
Dates of Study – August 2022-November 2022
Location of Study – Optometry Clinics
Number of Sessions – 1
Time Per Session – 5-15 minutes
Total Project Time – 5-15 minutes

Participation:
During the study, you will be asked to do the following:
Complete a short survey.

Risks and Inconveniences:
There are minimal risks and inconveniences to participating in this study.
These include:
Time commitment to complete a survey.

Benefits of Participation:
This study may help us understand the correlation between mental health and physical health.

Compensation:
You will not receive payment for participating in the study.

Confidentiality:
No information that could be used to identify you such as your name or the name of the clinic you've visited will be collected or correlated with your survey response. Data collected from the study will be stored securely on a computer only accessible by Piper Fain and Angela Douglass. The data will be retained for 1 year after the study and will then be deleted electronically.

Voluntary Participation:
Your participation in the study is completely voluntary, and you have the right to withdraw from the study at any time. If you wish to withdraw after completing the survey, please contact the principal researcher with the approximate date and time you completed the survey.

Contacts:
For questions and concerns about the study, contact:

Piper Fain, Principal Researcher
Carl Goodson Honors Program
Ouachita Baptist University
OBU Box [3518]
410 Ouachita Street
Arkadelphia, Arkansas 71998-0001

Angela Douglass, Faculty Sponsor
(870)-245-5532

For questions regarding your rights in this study, contact:
Jeanie Curry, Chair
Institutional Review Board
Ouachita Baptist University
OBU Box 3671
410 Ouachita Street
Arkadelphia, Arkansas 71998-0001
(870) 245-5248

You will receive a copy of this completed form upon request.
If you would like a summary of the results of this study, please contact the principal researcher.

☐ I have read and understand this document and have had the opportunity to have my questions answered. I agree to participate in the research study described above. I also certify that I am 18 years of age or older.

Figure 4. Survey Question 1, Pre-Informed Consent Agreement Form Presented in Survey

After indicating their willingness to participate in the survey, patients were able to scroll down and begin answering survey questions. Researchers included a “prefer not to say” option in each question throughout the survey, allowing patients to opt out of any question. The first three questions (presented as questions 2, 3, and 4 as the pre-survey informed consent agreement was presented as question 1) inquired about basic demographic information. Participants were asked to indicate their gender, age range, and ethnicities. Age ranges were used rather than specific ages to ensure patient anonymity.

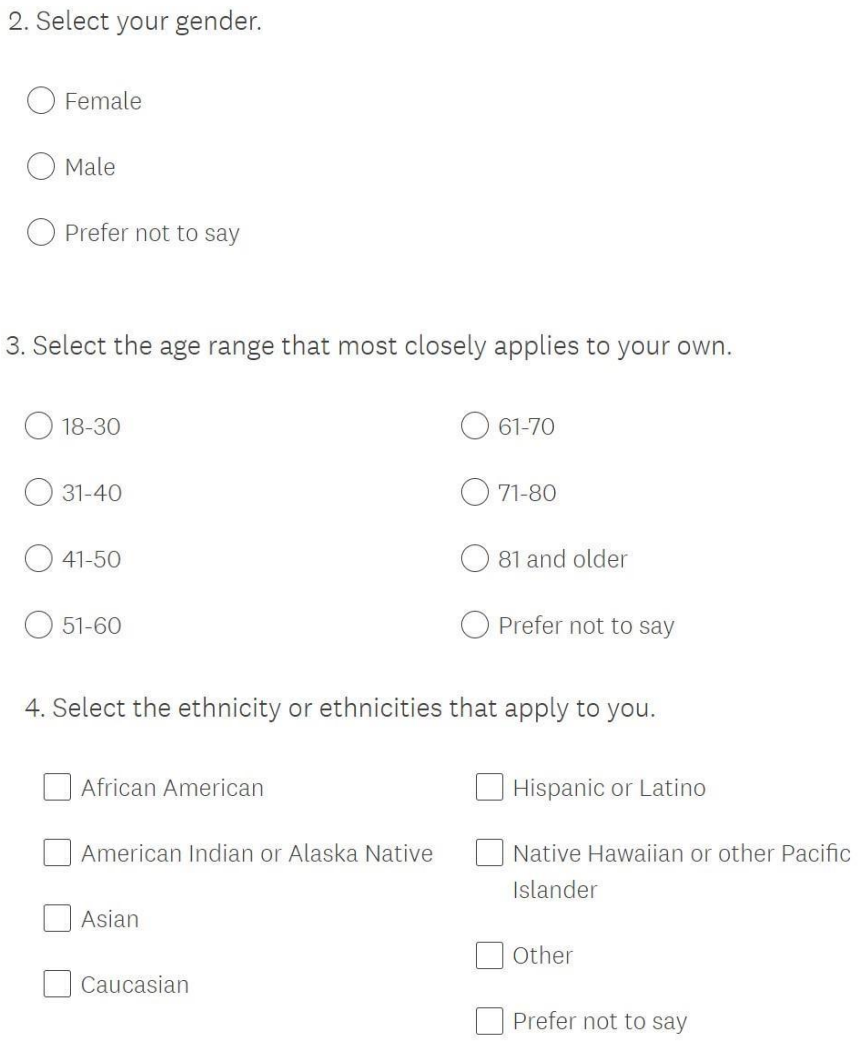


Figure 5. Survey Questions 3-4, Participant Demographics

The remaining questions in the survey pertain to participant experience and family history of select general, ocular, and mental health conditions. These questions were presented in a matrix format, allowing participants to select if the condition was one that they currently had, previously had, or had a family history of. In a separate question, participants who had experienced a condition themselves were asked to indicate the general timeframe of the onset of their condition.

Question 5 required participants to indicate if they had experienced or had a family history of cancer, heart disease, high blood pressure, rheumatoid arthritis, thyroid disorder, type I diabetes mellitus, or type II diabetes mellitus. If the participant had experienced any of these conditions themselves, they were asked to indicate the general time range of the onset of their condition in question 6. Each of these questions included a “prefer not to say” option to allow patients to opt out. Researchers chose the health conditions presented as options for their relevance to several ocular conditions, not exclusively glaucoma. Less relevant health conditions were included as options to prevent prejudiced consideration of the questions by participants, as to ensure no researcher bias was present (Pannucci & Wilkins, *Identifying and avoiding bias in research*).

5. Among the following, **select any health conditions that you currently or have previously experienced, or have a direct family history with** (i.e. an immediate family member that has experienced this condition). After selecting each relevant condition, please indicate whether it is a condition you currently have, previously had, or have a family history of.

	Currently Have	Previously Had	Family History
Cancer	◯	◯	◯
Heart Disease	◯	◯	◯
High Blood Pressure	◯	◯	◯
Rheumatoid Arthritis	◯	◯	◯
Thyroid Disorder	◯	◯	◯
Type I Diabetes Melitus	◯	◯	◯
Type II Diabetes Mellitus	◯	◯	◯
None of the Above (Select any bubble)	◯	◯	◯
Prefer not to say (Select any bubble)	◯	◯	◯

Figure 6. Survey Question 5, Participant and Family History of General Health Conditions

6. Pertaining to the previous question, for any general health conditions that you indicated **you have experienced**, please select the most appropriate time range of when the condition began (***please do not include family history on this question.***)

	Past year	Past 5 years	Past 10 years	11 years or more
Cancer	◯	◯	◯	◯
Heart Disease	◯	◯	◯	◯
High Blood Pressure	◯	◯	◯	◯
Rheumatoid Arthritis	◯	◯	◯	◯
Thyroid Disorder	◯	◯	◯	◯
Type I Diabetes Mellitus	◯	◯	◯	◯
Type II Diabetes Mellitus	◯	◯	◯	◯
Prefer not to say (Select any bubble)	◯	◯	◯	◯
None of the above (Select any bubble)	◯	◯	◯	◯

Figure 7. Survey Question 6, Timeframe of Participant General Health Conditions

Questions 7 and 8 pertained to participant history with various ocular conditions. In question 7, participants were asked to indicate if they had experienced or had a family history of glaucoma, diabetic retinopathy, cataracts, or macular degeneration. If the participant had experienced any of these conditions themselves, they were asked to indicate the general time range of the onset of their condition in question 8. Participants were able to opt out of either question by selecting the "prefer not to say" option. Resembling questions 5 and 6, researchers included ocular conditions other than and not exclusively related to glaucoma as options in order to prevent researcher bias.

7. Among the following, **select any eye conditions that you currently or have previously experienced, or have a direct family history with** (i.e. an immediate family member that has experienced this condition). After selecting each relevant condition, please indicate whether it is a condition you currently have, previously had, or have a family history of.

	Currently Have	Previously Had	Family History
Glaucoma	◯	◯	◯
Diabetic Retinopathy	◯	◯	◯
Cataracts	◯	◯	◯
Macular Degeneration	◯	◯	◯
None of the Above (Select any bubble)	◯	◯	◯
Prefer not to say (Select any bubble)	◯	◯	◯

Figure 8. Survey Question 7, Participant and Family History of Ocular Conditions

8. Pertaining to the previous question, for any eye conditions that you indicated **you have experienced**, please select the most appropriate time range of when the condition began (***please do not include family history on this question.***)

	Past year	Past 5 years	Past 10 years	11 years or more
Glaucoma	◯	◯	◯	◯
Diabetic Retinopathy	◯	◯	◯	◯
Cataracts	◯	◯	◯	◯
Macular Degeneration	◯	◯	◯	◯
Prefer not to say (Select any bubble)	◯	◯	◯	◯
None of the above (Select any bubble)	◯	◯	◯	◯

Figure 9. Survey Question 8, Timeframe of Participant Ocular Conditions

The remaining questions, questions 9 and 10, pertained to participant history with various mental health conditions. Question 9 required participants to indicate their own experience or family history of depression, any anxiety disorder, bipolar affective disorder, post-traumatic stress disorder, or attention deficit/hyperactivity disorder. If the participant had experienced any of these conditions themselves, they were asked to indicate the general time range of the onset of their condition in question 10. The "prefer not to say" option was included in each question to provide patients an opportunity to opt out of answering the question. Some of the mental health

conditions included as options are not exclusively relevant to the scope of this research but were included to ensure no researcher bias was present in the survey.

9. Among the following, **select any mental health conditions that you currently or have previously experienced, or have a direct family history with** (i.e. an immediate family member that has experienced this condition). After selecting each relevant condition, please indicate whether it is a condition you currently have, previously had, or have a family history of.

	Currently Have	Previously Had	Family History
Depression	◯	◯	◯
Any Anxiety Disorder	◯	◯	◯
Bipolar Affective Disorder	◯	◯	◯
Post-Traumatic Stress Disorder	◯	◯	◯
Attention Deficit/Hyperactivity Disorder	◯	◯	◯
None of the Above (Select any bubble)	◯	◯	◯
Prefer not to say (Select any bubble)	◯	◯	◯

Figure 10. Survey Question 9, Participant and Family History of Mental Health Conditions

10. Pertaining to the previous question, for any mental health conditions that you indicated **you have experienced**, please select the most appropriate time range of when the condition began (***please do not include family history on this question.***)

	Past year	Past 5 years	Past 10 years	11 years or more
Depression	◯	◯	◯	◯
Any Anxiety Disorder	◯	◯	◯	◯
Bipolar Affective Disorder	◯	◯	◯	◯
Post-Traumatic Stress Disorder	◯	◯	◯	◯
Attention Deficit/Hyperactivity Disorder	◯	◯	◯	◯
Prefer not to say (Select any bubble)	◯	◯	◯	◯
None of the above (Select any bubble)	◯	◯	◯	◯

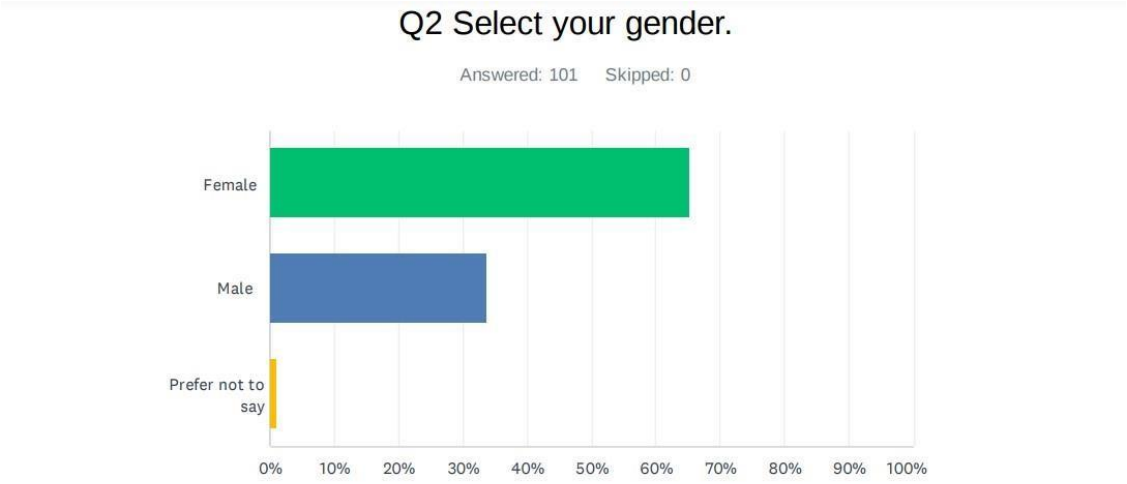
Figure 11. Survey Question 10, Timeframe of Participant Mental Health Conditions

Survey Results

The survey was administered to every willing participant from August 2 to October 28, 2022, and 101 responses were received. Researchers intended for the study to be conducted from August through November and hoped to achieve a minimum of 200 responses, however the availability of willing participants was lower than expected. General data trends can be seen in

figures 12 through 26 below. In the results that follow, percentages represent the prevalence of the respective condition as compared to the entire pool of respondents.

Respondents were primarily female (65%, *Figure 12*) and ages 31-50 were the most common (~48%, *Figure 13*). Two ethnicities were represented in the majority of results, Caucasian (67%, *Figure 14*) and African American (26%, *Figure 14*).

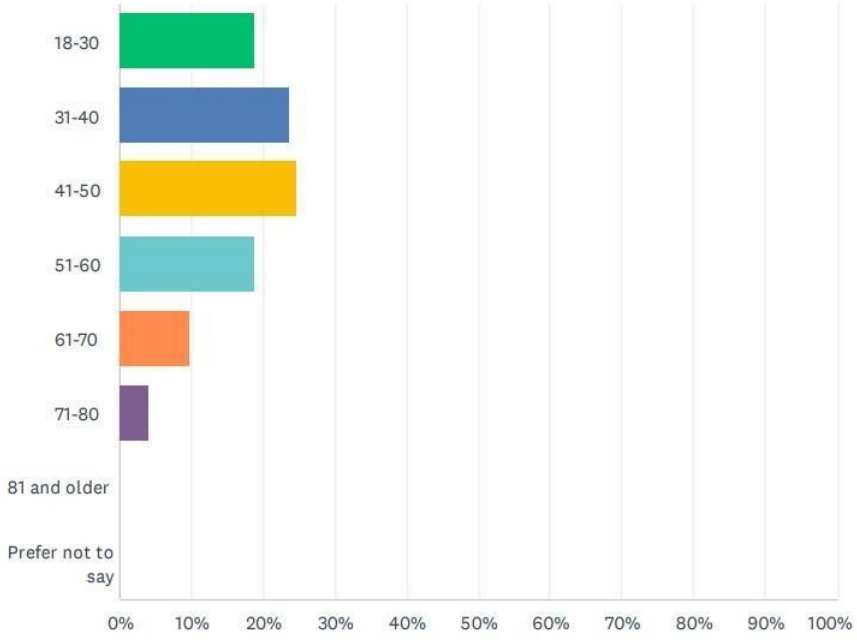


ANSWER CHOICES	RESPONSES	
Female	65.35%	66
Male	33.66%	34
Prefer not to say	0.99%	1
TOTAL		101

Figure 12. Question 2 Survey Results

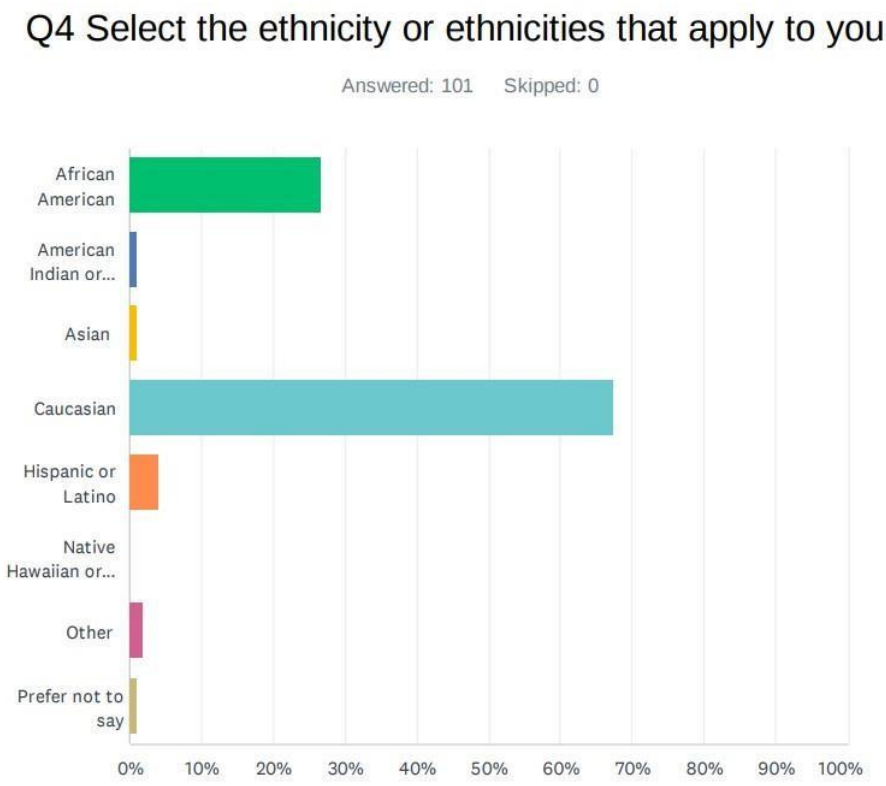
Q3 Select the age range that most closely applies to your own.

Answered: 101 Skipped: 0



ANSWER CHOICES	RESPONSES	
18-30	18.81%	19
31-40	23.76%	24
41-50	24.75%	25
51-60	18.81%	19
61-70	9.90%	10
71-80	3.96%	4
81 and older	0.00%	0
Prefer not to say	0.00%	0
TOTAL		101

Figure 13. Question 3 Survey Results



ANSWER CHOICES	RESPONSES	
African American	26.73%	27
American Indian or Alaska Native	0.99%	1
Asian	0.99%	1
Caucasian	67.33%	68
Hispanic or Latino	3.96%	4
Native Hawaiian or other Pacific Islander	0.00%	0
Other	1.98%	2
Prefer not to say	0.99%	1
Total Respondents: 101		

Figure 14. Question 4 Survey Results

Question 5 pertained to current health conditions, the most commonly reported of which was high blood pressure (36%, *Figure 16*). Most participants indicated on question 6 that they'd experienced this condition for the past 5 years (18%, *Figure 17*), though several also indicated a timespan of the past year (13%, *Figure 18*) or the past 11 years or more (12%, *Figure 17*). Other

significant reports of current conditions included type II diabetes mellitus (17%) for a timespan of the past 5 (6%) or 11+ (6%) years (*Figure 17*). Also reported were thyroid disorder (8%) (past 10 or 11+ years, each 4%), rheumatoid arthritis (7%) (past 11+ years, 5%), and heart disease (4%) (past year, 4%) (*Figures 16 and 17*). Fewer respondents indicated that they'd previously had a condition, though the most common was cancer (4%, *Figure* 16). Respondents also indicated family histories of high blood pressure (40%) most frequently, though cancer (37%) and heart disease (36%) were also common (*Figure 16*).

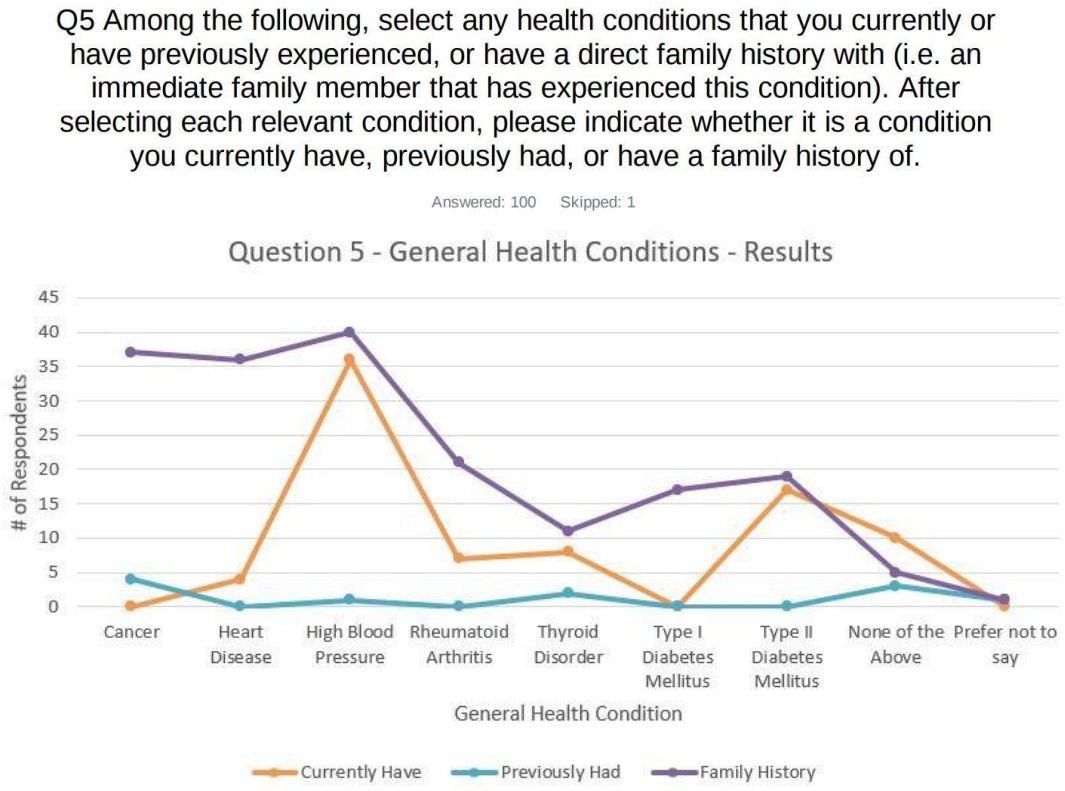


Figure 15. Question 5 Survey Results (Line Graph)

	Cancer	Heart Disease	High Blood Pressure	Rheumatoid Arthritis	Thyroid Disorder	Type I Diabetes	Type II Diabetes	None of the Above	Prefer not to say
Currently Have	0	4	36	7	8	0	17	10	0
% of Total Participants	0.0%	4.0%	35.6%	6.9%	7.9%	0.0%	16.8%	9.9%	0.0%
Previously Had	4	0	1	0	2	0	0	3	1
% of Total Participants	4.0%	0.0%	1.0%	0.0%	2.0%	0.0%	0.0%	3.0%	1.0%
Family History	37	36	40	21	11	17	19	5	1
% of Total Participants	36.6%	35.6%	39.6%	20.8%	10.9%	16.8%	18.8%	5.0%	1.0%

Figure 16. Question 5 Survey Results

Q6 Pertaining to the previous question, for any general health conditions that you indicated you have experienced, please select the most appropriate time range of when the condition began (please do not include family history on this question.)

Answered: 94 Skipped: 7

	Cancer	Heart Disease	High Blood Pressure	Rheumatoid Arthritis	Thyroid Disorder	Type I Diabetes	Type II Diabetes	Prefer not to say	None of the Above
Past Year	0	4	13	2	3	0	4	1	16
% of Total Participants	0.0%	4.0%	12.9%	2.0%	3.0%	0.0%	4.0%	1.0%	15.8%
Past 5 Years	3	2	18	2	2	1	6	0	3
% of Total Participants	3.0%	2.0%	17.8%	2.0%	2.0%	1.0%	5.9%	0.0%	3.0%
Past 10 Years	0	0	8	3	4	0	5	0	2
% of Total Participants	0.0%	0.0%	7.9%	3.0%	4.0%	0.0%	5.0%	0.0%	2.0%
11 Years or More	7	3	12	5	4	4	6	3	9
% of Total Participants	6.9%	3.0%	11.9%	5.0%	4.0%	4.0%	5.9%	3.0%	8.9%

Figure 17. Question 6 Survey Results

Very few participants indicated the presence of a current ocular condition in question 7, the most common of which was glaucoma (3%), closely followed by diabetic retinopathy (2%), cataracts and macular degeneration (each 1%) (*Figure 19*). Of the conditions participants reported that they'd previously had, cataracts were by far the most common (6%), followed by macular degeneration (1%, *Figure 19*). No respondents indicated that they'd previously had glaucoma or diabetic retinopathy. Question 8 required participants to indicate the onset time of conditions they had experienced, of which glaucoma most frequently began 11+ (3%) or 5 (2%) years prior, diabetic retinopathy for the past 5 years (2%), cataracts for the past 1, 5, or 11+ years (all 3%), and macular degeneration only for the past 5 (2%) (*Figure 20*). Cataracts remained the most common condition for family history (29%), followed by glaucoma (14%) (*Figure 19*).

Q7 Among the following, select any eye conditions that you currently or have previously experienced, or have a direct family history with (i.e. an immediate family member that has experienced this condition). After selecting each relevant condition, please indicate whether it is a condition you currently have, previously had, or have a family history of.

Answered: 98 Skipped: 3

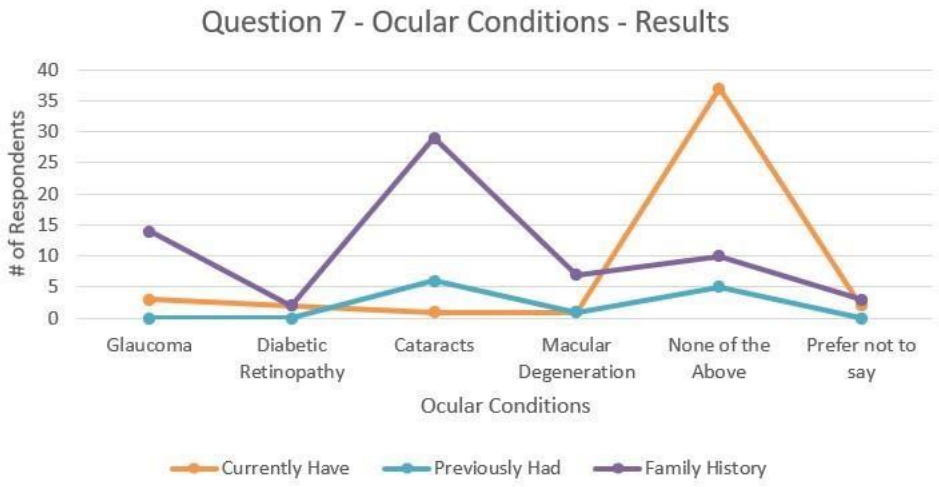


Figure 18. Question 7 Survey Results (Line Graph)

	Glaucoma	Diabetic Retinopathy	Cataracts	Macular Degeneration	None of the Above	Prefer not to say
Currently Have	3	2	1	1	37	2
% of Total Participants	3.0%	2.0%	1.0%	1.0%	36.6%	2.0%
Previously Had	0	0	6	1	5	0
% of Total Participants	0.0%	0.0%	5.9%	1.0%	5.0%	0.0%
Family History	14	2	29	7	10	3
% of Total Participants	13.9%	2.0%	28.7%	6.9%	9.9%	3.0%

Figure 19. Question 7 Survey Results

Q8 Pertaining to the previous question, for any eye conditions that you indicated you have experienced, please select the most appropriate time range of when the condition began (please do not include family history on this question.)

Answered: 92 Skipped: 9

	Glaucoma	Diabetic Retinopathy	Cataracts	Macular Degeneration	Prefer not to say	None of the Above
Past Year	1	0	3	0	4	46
% of Total Participants	1.0%	0.0%	3.0%	0.0%	4.0%	45.5%
Past 5 Years	2	2	3	2	0	5
% of Total Participants	2.0%	2.0%	3.0%	2.0%	0.0%	5.0%
Past 10 Years	1	0	2	0	1	2
% of Total Participants	1.0%	0.0%	2.0%	0.0%	1.0%	2.0%
11 Years or More	3	1	3	0	1	17
% of Total Participants	3.0%	1.0%	3.0%	0.0%	1.0%	16.8%

Figure 20. Question 8 Survey Results

On question 9, participants were asked to indicate their current, previous, or family history with several mental health conditions. Most respondents of this question currently had an anxiety disorder (23%), though several also had depression (15%) (*Figure 22*). Depression was also the most frequently reported previous condition among respondents, 14% indicated a personal history of depression while only 4% indicated a history of anxiety (*Figure 22*). Question 10 required patients to indicate the chronology of the onset of their conditions, in which depression most commonly began within the past 5 (9%) or 11+ (8%) years, and anxiety within the last 11+ years (11%) (*Figure 23*). The most common conditions of which participants had a family history were depression (11%), ADHD (11%), and anxiety (10%).

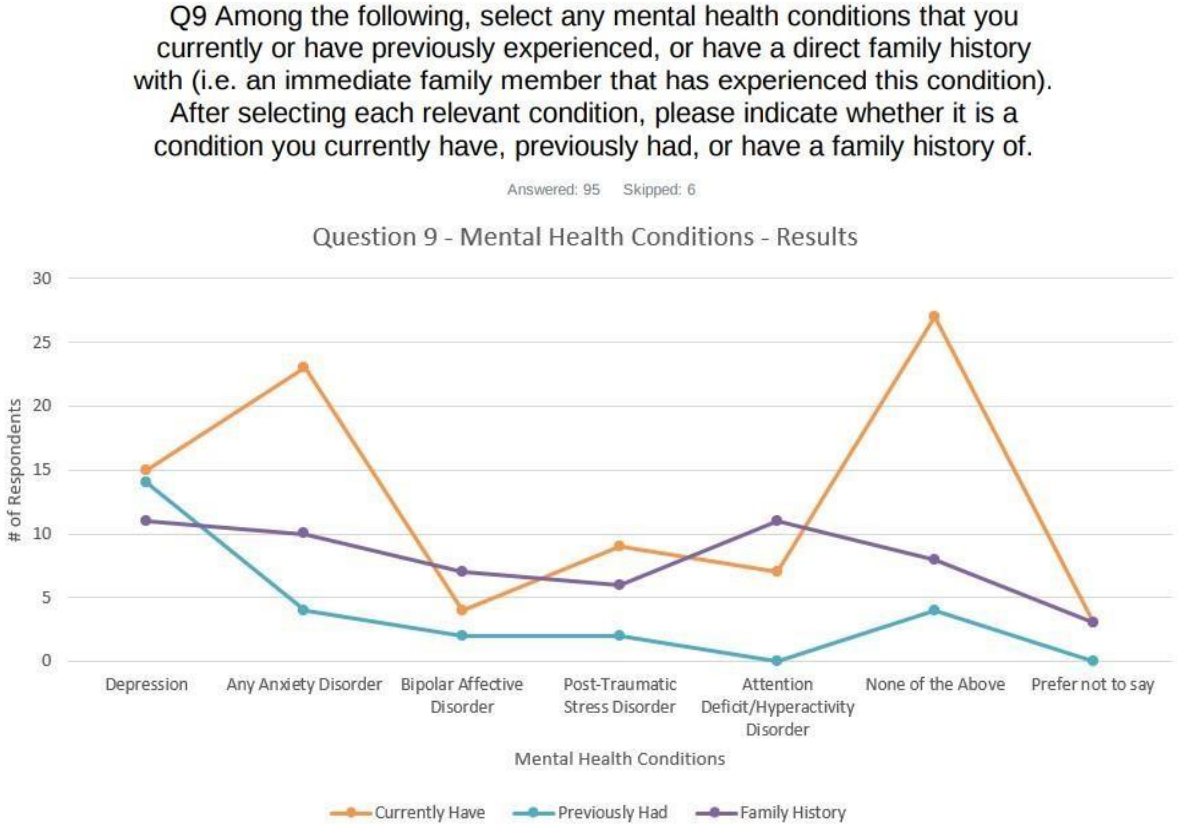


Figure 21. Question 9 Survey Results (Line Graph)

	Depression	Any Anxiety Disorder	Bipolar Affective Disorder	Post-Traumatic Stress Disorder	Attention Deficit/Hyperactivity Disorder	None of the Above	Prefer not to say
Currently Have	15	23	4	9	7	27	3
% of Total Participants	14.9%	22.8%	4.0%	8.9%	6.9%	26.7%	3.0%
Previously Had	14	4	2	2	0	4	0
% of Total Participants	13.9%	4.0%	2.0%	2.0%	0.0%	4.0%	0.0%
Family History	11	10	7	6	11	8	3
% of Total Participants	10.9%	9.9%	6.9%	5.9%	10.9%	7.9%	3.0%

Figure 22. Question 9 Survey Results

Q10 Pertaining to the previous question, for any mental health conditions that you indicated you have experienced, please select the most appropriate time range of when the condition began (please do not include family history on this question.)

Answered: 94 Skipped: 7

	Depression	Any Anxiety Disorder	Bipolar Affective Disorder	Post-Traumatic Stress Disorder	Attention Deficit/Hyperactivity Disorder	Prefer not to say	None of the Above
Past Year	6	7	3	5	3	4	30
% of Total Participants	5.9%	6.9%	3.0%	5.0%	3.0%	4.0%	29.7%
Past 5 Years	9	8	0	1	1	0	5
% of Total Participants	8.9%	7.9%	0.0%	1.0%	1.0%	0.0%	5.0%
Past 10 Years	6	3	1	2	1	2	1
% of Total Participants	5.9%	3.0%	1.0%	2.0%	1.0%	2.0%	1.0%
11 Years or More	8	11	2	3	3	2	11
% of Total Participants	7.9%	10.9%	2.0%	3.0%	3.0%	2.0%	10.9%

Figure 23. Question 10 Survey Results

It is worth noting that there seemed to be some confusion among participants in question sets 5-6 and 7-8. For example, although only 37 respondents indicated a current or previous personal history of high blood pressure on question 5 (*Figure 16*), 51 indicated a timeframe of the onset of this condition on question 6 (*Figure 17*). Similar trends occurred for almost all other conditions surveyed in both question sets. This error will be considered further in the discussion of results, however it is worth identifying because it does lead to an overrepresentation of the prevalence of these conditions in both questions 6 and 8. There was no overrepresentation on question set 9-10, however there was a miniscule underrepresentation (1-2 respondents) on some conditions.

Researchers observed several trends, however due to the lack of data for all other ethnicities, trends were only calculated for African American and Caucasian demographics. All

of the following percentages represent the prevalence of the respective condition as compared to the entire pool of respondents of the indicated demographic. Current high blood pressure was most common amongst women (36%), though men were not far behind (32%), and was reported most by African Americans (52%). All individuals who reported currently having glaucoma were African American, and 67% of them were men. Every respondent who currently had diabetic retinopathy was African American and female, with ages ranging from 41-60. Depression was most prevalent among Caucasians (18%) and women (21%), as was anxiety (18% women and Caucasians).

The most common general health condition that participants indicated that they'd previously had was cancer, and all respondents were Caucasian females, aged 51-70. Cataracts were another common previous condition, which were most frequently reported by African American individuals (7%) and women (7%). A previous depression diagnosis was most common amongst Caucasians (16%), though was evenly distributed among men and women (12% each).

A family history of high blood pressure was somewhat more common for all races and sexes than most other conditions, however it was most prevalent among women (39%) and Caucasians (41%). Family histories of cataracts, too, were most common amongst Caucasians (31%), however they were equally common for men and women (both 26%). Depression was also equally prevalent (both 12%) in the family histories of both men and women, and still more frequently reported by Caucasians (16%) as compared to African Americans (3%). Anxiety was most common in the family histories of women (9%) and Caucasians (10%).

High blood pressure was by far the most common condition of all, with 35 current cases and 36 family histories (though only one previous case). Of the current cases, 31% (11) also

currently had anxiety, only 17% (6) had depression, and 34% (12) had type II diabetes mellitus. Of the 36 individuals with a family history of high blood pressure, 20% (7) also had a family history of glaucoma, another 20% (7) had a family history of depression, and 17% (6) had a family history of anxiety.

Of the 101 respondents, 13 indicated a family history of glaucoma, and 3 indicated that they currently had glaucoma. Of those 3, none indicated any history of anxiety, depression, or any other mental health condition. However, 100% of respondents who currently had glaucoma also currently had high blood pressure, and 67% (2) also had type II diabetes mellitus. Of the 13 respondents who have a family history of glaucoma, 46% (6) indicated that they currently had anxiety and 31% (4) currently had depression. 23% (3) of respondents with a family history of glaucoma had a family history of anxiety, and 38% (5) had a family history of depression.

Pertaining to mental health conditions, 15 respondents currently had anxiety and 8 had a family history of it, while 15 respondents had depression but 12 had a family history of depression. Not all participants who had depression also had anxiety, though 67% (10) of those with depression also had anxiety, and vice versa. Of the 15 participants who currently had anxiety, 73% (11) also currently had high blood pressure and 40% (6) had a family history of glaucoma. For those with a family history of anxiety, 75% (6) had a family history of high blood pressure, and 38% (3) had a family history of glaucoma. From the 15 respondents who currently had depression, 40% (6) currently had high blood pressure and 27% (4) had a family history of glaucoma.12 individuals had a family history of depression, of whom 58% (7) had a family history of high blood pressure and 42% (5) had a family history of glaucoma.

Survey Discussion

As a consequence of the discrepancy between the predicted and actual availability of participants, researchers were only able to achieve approximately half of their desired minimum requirement of 200 respondents. Therefore, the results obtained are likely not an accurate depiction of the population as a whole.

Of the 101 respondents, only 3 indicated that they currently had glaucoma. None of these three had any history of any mental health condition whatsoever. While researchers had hoped for more respondents with glaucoma and hypothesized that a larger percentage would have a mental health history, these results are not surprising. Based on previous studies, it is unlikely that anxiety would be the primary cause of glaucoma, rather than a mere aggravating factor (Sabel & Lehnigk, *Is Mental Stress the Primary Cause of Glaucoma?*). Therefore, researchers did not expect every participant with glaucoma to also have anxiety. Glaucoma is the second leading cause of blindness globally, but only around 1% of Americans (roughly 3 million) actually have the disease (Centers for Disease Control and Prevention, *Don't let glaucoma steal your sight!*). Furthermore, one recent study found that only around 13-30% of glaucoma patients have anxiety (Shin, Jung, H. Park, & C. Park, *The effect of anxiety and depression on progression of glaucoma*). Due to the small portion of the population with both glaucoma and anxiety, and the limited scale of this study, it is likely that researchers achieved an insufficient amount of responses to accurately portray the true population.

All 3 glaucoma patients were African American, aged 51-80, with high blood pressure. This data indicates relationships between African American ethnicity and glaucoma, African American ethnicity and high blood pressure, as well as high blood pressure and glaucoma, as seen in other research (Ou Y., *Glaucoma in the African American and Hispanic communities*),

(American Heart Association, *High blood pressure among black people*), (Leeman & Kestelyn, *Glaucoma and blood pressure*). Glaucoma is the leading cause of irreversible blindness for individuals of African American ethnicity; its prevalence was estimated to be 4% in individuals aged 50-59 and 13% in individuals aged 80-89 in a study conducted by the University of California (Ou Y., *Glaucoma in the African American and Hispanic communities*). Similarly, high blood pressure is disproportionately common in African Americans, with estimates for the U.S. reaching up to 55% (American Heart Association, *High blood pressure among black people*). High blood pressure also puts individuals who have it at higher risk for glaucoma due to its effect on ocular pressure (Leeman & Kestelyn, *Glaucoma and blood pressure*).

Two of the three respondents with glaucoma also had type II diabetes mellitus. Although conducted with only Latino participants, a 2007 study conducted by the Los Angeles Eye Study group found that longer duration type II diabetes mellitus was independently associated with a higher risk of having open-angle glaucoma (Los Angeles Latino Eye Study Group Et. All, *Type 2 diabetes mellitus and the risk of open-angle glaucoma the Los Angeles Latino Eye Study*). Each respondent with both glaucoma and type II diabetes mellitus indicated that their diabetes had begun 11 or more years prior, congruous with the Los Angeles Eye Study group's findings.

There were additional limitations to this study alongside the lack of respondents. As previously discussed, several participants who had not indicated a personal history with a condition (but rather a family history) selected a timeframe for the onset of their condition. This was likely due to the lengthy nature of the questions or the confusing matrix of answer options. Due to the length of questions, participants may have chosen not to read each question in its entirety, possibly missing the question's specification to not include family history. As participants were likely trying to complete the survey quickly, before their appointments began,

this is a very plausible explanation. Similarly, the way the questions were presented may also have been confusing, and the proximity of answer "bubbles" to one another coupled with the use of a touch-screen tablet to distribute surveys may have led to accidental selections. This constraint may have been avoided by simplifying question presentation or splitting them into several individual and less lengthy questions.

Researchers also chose to only include one "glaucoma" option rather than several options specifying types of glaucoma. Though the latter was considered prior to the beginning of the study, it seemed likely that some participants may have been uncertain of the specifics of their condition, possibly choosing an option that did not pertain to them and skewing results. Researchers also reasoned that if participants were uncertain of what type of glaucoma they had, they may ask clinic staff. Ultimately it was decided that only the generalized "glaucoma" would be included to avoid distorting results or imposing additional inconveniences on the clinic staff who were kind enough to administer the survey. Though this may have prevented participants from recognizing the purpose of the study and becoming victim to researcher bias, it also provided vague results. Without knowing what type of glaucoma participants have, it is hard to draw concrete conclusions about the correlation between the disease and any other condition. This flaw may have been corrected by including answer options for several types of glaucoma alongside a general "glaucoma – unsure of type" option, however in that case researcher bias may have been present.

Due to the nature of this study and its relevance to glaucoma it would have been wise to survey only individuals of age 40 and older. A glaucoma diagnosis received by an adult under 40 is typically referred to as "early-onset glaucoma" and is vastly uncommon. Several risk factors of glaucoma are associated with increased age, such as the presence of comorbidities (U.S. National

Library of Medicine, *Early-onset glaucoma*). Early-onset glaucoma typically occurs as a result of hereditary factors, which are beyond the scope of this study (U.S. National Library of Medicine, *Early-onset glaucoma*).

The final and perhaps most immeasurable limitation of this study is its non-invasive nature. Due to HPPAA rules and the small scale of this investigation, researchers relied on the method of self-reports. As previously discussed, this led to confusion and possible misreporting among respondents in regard to the timeframe of the occurrence of conditions. Participant identities also remain anonymous, thus it is impossible to know whether all self-reports were entirely accurate. This error might be corrected in a much larger-scale study by utilizing participant medical records, however that method was implausible within the bounds of this study.

Conclusions:

Due to a lack of responses, the data obtained in this study is insufficient to establish a statistically significant correlative relationship between glaucoma and anxiety. Nevertheless, the responses that were obtained could provide insight into some other conditions surveyed. All patients that indicated they had glaucoma were African American, aged 51-80, and glaucoma is most common among African Americans of advanced age (Ou Y., *Glaucoma in the African American and Hispanic communities*). Similarly, the prevalence of high blood pressure among current glaucoma sufferers was 100%. As high blood pressure is disproportionately common among African Americans, and serves as a risk factor for glaucoma, this was to be expected (American Heart Association, *High blood pressure among black people*). Two-thirds of those who indicated they had glaucoma also had type 2 diabetes, which serves as another risk factor for glaucoma (Los Angeles Latino Eye Study Group Et. All, *Type 2 diabetes mellitus and the risk of open-angle glaucoma the Los Angeles Latino Eye Study*).

Within this study, there were several limitations contributing to the lack of responses and the inconsistencies within the responses that were obtained. This study utilized a self-report method of obtaining data to maintain the anonymity of participants. This method did not allow researchers to verify participant information. Researchers noticed some participants provided information that was incomplete or inconsistent with their previous answers. These discrepancies might be explained by the excessive length of questions, complex answer matrixes, and the proximity of answer choices to one another on the touch screen. Similarly, participants were limited to pre-determined answer choices, with no ability to include specific information. Only one “glaucoma” option was provided, therefore participants were incapable of specifying what type of glaucoma they had. Finally, the participant pool sampled in this study ranged in age from

18 to 80, although glaucoma diagnoses are typically only provided to individuals aged 40 and older. Therefore the results of this study are skewed towards the general population rather than the population of individuals typically capable of developing glaucoma.

In the future, a much larger participant pool should be surveyed. This could be achieved by conducting the study in more locations simultaneously, or in fewer locations for longer periods of time. If medical records could be legally and ethically obtained, those might serve as a better, more accurate source of data. If self-reports must be utilized, researchers may improve the quality of responses by shortening the length of questions and using a simpler matrix of response options. Furthermore, surveying only individuals of age 40 or older would allow future researchers to isolate a population of individuals capable of receiving a glaucoma diagnosis. In order for researchers to draw more specific conclusions, it may also be beneficial to include several options for each type of glaucoma.

Although a positive correlation between glaucoma and anxiety could not be proven, it was not disproven, either. There were several limitations to this study, rendering researchers unable to draw definitive conclusions. However, the information gathered during this study did provide insight into the relationships between glaucoma, high blood pressure, type II diabetes, and the association between each of these conditions with African American ethnicity. The previously discussed alterations to this study might correct several issues and increase the quality of information attained in future research.

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