# INTRAOCULAR PRESSURES IN A HONDURAN POPULATION

Danielle L. Fee
Optometry 797
Advisor: Robert Foote, O.D.
March 18, 1996

The purpose of the study was to investigate the ocular health of the Honduran population, with an emphasis in the areas of intraocular pressure and the incidence of glaucoma. Through examination, observation, research, and comparison to the US population, numerous conclusions were obtained.

The objective of this study was to compare IOP's in the Honduran population to those of similar age groups in the American population. I hypothesized that IOP's in the Honduran population would be higher than those in the American population, due in part to the limited access to health care. I also expected to see a higher incidence of probable glaucoma patients than would be present on a routine screening in the American population. It was my intent to investigate reasons for any differences in IOP that were observed. Our group also wanted to establish this study as guidelines for future VOSH trips, so as to continually improve the quality of care to the Honduran population.

Although the main purpose of this study was to investigate the IOP's in the Honduran population, there were individuals who were found to have glaucoma. In analyzing the data, the patients seen were classified into the following categories: good ocular health , glaucoma suspects, or those with probable glaucoma, who would benefit from treatment. These categories were based on IOP, VAs, optic nerve appearance, and confrontation visual fields. With limited amounts of treatment medications additional factors were considered in deciding which patients to treat. Some of these factors were: ocular pathologies, monocularity, age of the patient, and general patient health factors.

## METHOD AND DISCUSSION

Data was obtained by random sampling from the patients presenting to the eye care clinic on our VOSH mission to Honduras. The screening consisted of distance and near visual acuity, external observation of pupils and adnexa, retinoscopy, ophthalmoscopy through an undilated pupil and random screening of intraocular pressures. With limited access to advanced optometric equipment and time limitations, additional testing and treatment methods were carried out as

needed. For example, dilation was performed on pathological findings with ophthalmoscopy. Confrontation visual fields and slit lamp examination with an AO slit lamp were performed when appropriate.

Intraocular pressures were randomly completed with the Mentor Tonopen XL and a hand held Perkins tonometer. A lack of time and limited disinfection supplies prevented us from performing pressures on every patient. In the clinic setting, the tonopen proved to be a good screening instrument for sanitation, and it held up well in the dusty environment.

Research was completed to determine the reliability of the two different instruments used for IOP testing. In a study published in 1987 comparing the Oculab Tonopen to Goldmann Applanation tonometry, the tonopen proved to have overall good correlation with readings from a Goldmann Applanation tonometer when IOP's were $\leq$ 21mm Hg. There were, however, clinically significant differences in measurements at IOP's > 21mmHg. The tonopen tended to overestimate IOP's at pressures $\leq$ 9mm Hg and to underestimate IOP's $\geq$ 30 mm Hg.[1] The tonopen, compared to Goldmann applanation tonometry, had an overall sensitivity for detecting IOP's $\geq$ 21 of 62.1% to 72.4% with a corresponding specificity of 92.6 to 97.1%. In a study of Goldmann Applanation tonometers, Motolko et al found that 90% of the time, repeat single readings didn't vary more than 4.5 mm Hg and not more than $\pm$ 3.0 mmHg for the average of two readings[2] In addition, numerous studies of IOP measurements have found that IOP's vary with respiration, heart rate, heart rhythm, astigmatism, and accommodation. Therefore, in a screening atmosphere, where a reading of 21 or higher is considered abnormal, the tonopen proved to be adequate.

Another study comparing numerous portable tonometers to the Goldmann tonometer found the Perkins Tonometer to show a higher correlation to Goldmann readings than the Tonopen XL.[3] Again the tonopen was found to underestimate Goldmann pressures. This study, however, used calculated biases and the best fitting regression equation to convert readings from the various portable tonometers to predictable Goldmann readings for each instrument.

Intraocular pressures were measured on 144 patients, ranging in age from 8 to 91. Patients were selected at random, and data was not separated into male and female categories. The average IOP's for each age group are shown in Table # 1. This does not include the 70, 80, & 90 age groups in which there was only one to three subjects per group and no average was figured.

The graph shows averages of all the eyes and the averages when those presumed to have glaucoma were excluded. The range of average IOP's across the various age groups was from 14.0 mmHg to 16.52 mmHg. The percent of the patients with various IOP levels is shown in Table #2. In general, IOP's tended to be slightly higher in the 30-40 age group with no significant tendency towards an increase in IOP with age. In fact, the average IOP in the nonglaucomatous eyes even show a decrease with age in both the right and left eyes. This does not correlate with most studies in the U.S., which show an increase in IOP with age.[6] The Japanese, however, have shown a decrease in IOP's with age, like the data in this study. It is not known if this difference is ethnical or environmental. [21] The Health & Nutrition Examination Survey (HANES) data show that there may also be an ethnical basis for IOP differences in blacks and whites in the U.S. This data is shown in Table #3. When the average IOP's in different age groups are compared with the average IOP's in similar age groups in the United States using the HANES data, there is an unique tendency for nonglaucomatous Honduran IOP's to be higher, up to age 50. [10] After this age the Honduran IOP's show a decline, while the average American IOP's show a tendency to rise with increasing age.

In the 1990's the Baltimore Eye Study found the average IOP of whites in Baltimore to be 17.8 mmHg. [5] The Beaver Dam Eye Study, however, found an average IOP of 15 mm Hg in nonglaucomatous eyes.[18] Our findings show an average IOP of all eyes screened to be $16.77 \pm 6.23$. However, when averages were calculated without those who were presumed to have glaucoma or abnormally high IOP's, the average was $15.5 \pm 3.3$. This number is slightly lower than the averages found for white Americans in the Baltimore study, but correlates well with the findings in the Beaver Dam Eye Study. While the observed differences are not highly significant, the question still remains: what could cause a possible difference in the Honduran IOP's.

Studies have tried to find an association between IOP and various factors such as environmental, behavioral, systemic or ocular factors. Other studies have investigated factors such as sunlight exposure, blood pressure, refractive status, lens nuclear sclerosis, iris texture, and their relation to IOP. Using previous research and personal observations of the Honduran population, some correlations for the observed IOP's are provided.

In general we found the Honduran lifestyle to be quite different from the fast paced society we're used to here in the U.S. With few motorized vehicles and work equipment, the Honduran lifestyle consists of lots of physical labor and transportation by foot. Of the patients presenting to our clinic, many had reported traveling miles or long distances to have their eyes checked. It is believed that this may be the reason many of the elders were unable to get to the clinic for care. With the increased amount of physical labor, many of the Hondurans undergo long hours of exposure to UV light and sun exposure. Evidence of this was also seen in the high amounts of pterygiums and cataracts. The use of their eyes for intense close work, such as for reading or computers, was not highly observed in this population. The Honduran diets, in comparison to the diets of many Americans, contain very little fats, various fruits, vegetables and beans. All these factors, combined with the limited access to health care, contribute to the overall health of the Honduran people.

With all the advances in our technology, the American work force requires very little physical labor for most job related tasks. In addition, many Americans report very little time for physical exercise, turning the U.S. into a rather sedentary population. This factor alone leads to conditions such as cardiovascular disease and an increase in systemic blood pressure, which has been linked to an increase in IOP.

One study shows that the level of physical exercise an individual receives can be a major reason for an observable difference in IOP levels between the U.S. and the Honduran populations.[7] This study followed nine subjects who were basically sedentary through a twelve week physical training session. These individuals ranged in age from 25-60 years of age, were basically healthy, free of any type of medication, but were glaucoma suspects. Through this study, it was shown that both a single exercise session, and regular physical conditioning, have an ocular hypotensive effect. This study showed a mean IOP decrease of $4.6 \pm 0.4$ mm Hg through the end of the twelve week period. It was also shown that upon cessation of physical activity, IOP measurements returned to presedentary levels in three weeks.

One of the possibilities this study explored was the mechanism by which exercise training lowers IOP, and the use of exercise in the treatment of glaucoma patients. Physical activity has an effect similar to that of B- adrenergic antagonists such as Timoptic, which are often used first in

the treatment of intraocular hypertension and glaucoma.[8] Regular exercise has also been shown to increase levels of norepinephrine and to enhance parasympathetic-sympathetic input ratios at rest.[10] These effects of regular exercise cause a lowering of IOP in much the same ways that B-blockers, adrenergics and miotics work.[10] The one to three week recession of IOP to pretraining levels also closely resembles the results following B-blocker withdrawal.[9]

In effect, high physical activity can lead to a reduction in blood pressure. Klein and Klein found a positive correlation between blood pressure and IOP in the HANES data. This study showed that the "mean IOP is consistently higher in those whose blood pressure is classified as high."[10] Correlating this with data from the Framingham Heart and Eye Studies, Leske and Podgor found that in persons with IOP readings > 21mmHg, there was an increased prevalence of systemic hypertension and risk for cardiovascular disease.[11] It is believed that an elevated systolic blood pressure can have an effect on ultrafiltration and, therefore, a relation to elevated IOP. [6] It is not clear whether high blood pressure causes an increase in IOP or if hypertension compromises capillary circulation at the optic disc leading to the diagnosis of glaucoma. [19] Wilson et al found that the risk of open angle glaucoma increased by a factor of 5.8 when systolic blood pressure was left untreated at levels of 160 mmHg or more. Studies, such as the Casteldaccia Eye Study, however, didn't find an association between IOP and hypertension. Their study only completed IOP measurements and not blood pressure measurements, however. It only used a case history of hypertension, which could have left a lot of under diagnosed cases out. Our study didn't complete blood pressure measurements as part of the screening, so no direct comparison can be made. It could be hypothesized that the increased cardiovascular activity may lead to a lower blood pressure and therefore lower IOP.

Some studies have tried to link increased iris pigmentation to an increase in IOP. Through the HANES data, Hiller et al found a probability of association of IOP with iris pigmentation to be $P<0.0001$. [12] The significance of this finding may suggest that iris pigmentation is a risk factor in glaucoma. The Barbados Eye Study, however, found an association of skin pigmentation to IOP that again did not seem to be prevalent in our findings.[13] If these factors are true, it could partly explain the prevalence of glaucoma in the black population, which is 4 times the rate of white populations.[13] Our findings, however, with the Honduran population's predilection for dark

complexions and dark irides, didn't show an overall tendency for an increase in IOP. This correlates to findings in the Casteldaccia Study and the Beaver Dam Eye Study in which eye color was not deemed a risk factor for increased IOP.

Additional studies have tried to link environmental and seasonal factors to IOP. There has been some evidence presented that suggest a seasonal variation in IOP which is higher in winter months.[6] It is not known, however, if this variation may actually be due to latitude or to ethnicity of the patients in the study. The difference may be related to changes in light, temperature, or humidity, which all affect the annual rhythms and physiological body and ocular processes. [6] The Casteldaccia Eye Survey claims no association between levels of sun exposure to ocular hypertension or glaucoma. Our study didn't show trends towards these conditions either, considering the tendency of the Honduran population to spend many hours in the sunlight. Clarke predicted an environmental influence for the difference in the presentation of POAG found in the African and Caucasian populations. He purposed that direct exposure to sunlight, such as that of the tropics, was associated with the early onset of glaucoma in Africans. In addition he stated "in Iceland, the average age of onset of glaucoma is 60 years, while in Africa, it is as early as 20."[22] These observations, he believed, may mean there was a correlation of glaucoma to sun exposure.

One of the reasons sun exposure may be associated with an increase in glaucoma is the increase in nuclear sclerosis caused by UV exposure. This increase in nuclear sclerosis has been associated with an increase in IOP. The mechanism behind this effect appears to be a mechanical effect. The increase in nuclear sclerosis causes a larger, thicker lens, which then leads to a compromise of aqueous out flow.[6] IOP's with aphakia and following IOL implantation, however, tend to be lower, due to a decreased resistance from the lens. Ultra violet light exposure in the Honduran population leads to high prevalence of cataracts and pterygia.

Other factors that have been researched, but were not proven with investigation in our study, are factors such as obesity, height, refractive error, and their relation to IOP. A positive correlation with IOP has been recorded for obesity. It was suggested that an increase in orbital pressure may be caused by an increase in fat, which leads to an increase in episcleral venous pressure and a decrease in outflow facility, creating a rise in IOP.[6] A negative correlation with height has been recorded which once again was not measured in our study.[20] Much controversy

exists over the relation of IOP to refractive error. Due to the high prevalence of disease, trauma, cataracts and the rough estimation of refractive error with retinoscopy, no statement could be made on the association of IOP with refractive error in our study.

An article in a 1989 issue of Survey of Ophthalmology discussed IOP screening for glaucoma.[4] This article mentioned past data which had shown 26 mmHg was the level which gave the fewest false positives and false negatives. This article mentioned that the main reason 21mmHg is used as a reference point is that most studies also use 21 mmHg. It was believed that a higher cutoff would be more valid in screenings if tonometry were combined with ophthalmoscopy and visual fields. In addition, a cutoff below 26 mmHg, such as 21 mmHg, would increase the number of false positives in order to decrease the number of false negatives. Even if a high number of false positives are accepted, in order to find the true positives, the real problem with glaucoma suspects is still in patient compliance, which they found to be about 40% in possible glaucoma cases. The article mentioned that glaucoma screenings performed by the Society for the Prevention of Blindness in the United States only have a 20% follow up rate with probable glaucoma patients. The article also mentioned the concern for the transmission of the AIDS virus through contact tonometry in screenings. The CDC has regulations regarding the contact of mucous membranes or bodily fluids (especially those which carry the AIDS virus) which have limited the number of IOP screenings that are carried out in the U.S.

In our study, a patient with an IOP < 21mm Hg and good healthy nerves was considered to have normal eyes. An IOP of 21 was considered borderline and C/D ratios were examined with precaution. With C/D asymmetry, suspicious optic nerve heads, or a large difference in IOP's, a confrontation visual field was completed, and treatment was pursued with demonstrable constriction. If these patients weren't treated, they were classified as glaucoma suspects. The third category of patients was those with probable glaucoma who were treated.

Based on our data, the prevalence of glaucoma in the Honduran population was 6.25% in those screened. Two patients, or 1.4%, were also temporarily treated for high pressures. Seven patients were classified as glaucoma suspects, which made up an additional 4.86% of those screened. Three patients, or 2.08%, were considered to have end stage glaucoma and no treatment was given. The total of all those treated for high IOP's , probable glaucoma, glaucoma

suspects and end stage glaucoma, totaled 13.19% of the population screened for IOP. A breakdown of these percentages is found in Table #4. These numbers are considerably higher than the prevalence of glaucoma found in the American population. The Beaver Dam Eye Study reports a 2.1% prevalence of glaucoma while the Framingham Eye Study found a prevalence of 1.9%[6,11] When this study included eyes with questionable glaucomatous changes this number increased to 9.8%.[11] Once again this number is considerably less than the 13.19% found in the Honduran population. The higher percentage found in our study is partially due to the prevalence of other pathologies.

Of the patients screened, 6.25%, or ten patients, were presumed to have glaucoma. Three of them were presumed to have end stage glaucoma, and no treatment was given. Of these patients, one was presumed to have lost an eye due to trauma, and another patient had severe keratic precipitates with dense cataracts in both eyes. The third patient had severe KP's with bullous keratopathy in one eye. The patients who were treated for glaucoma were given a supply of Timoptic in either .25% or .5% and they were instructed to use them on a bid basis. There were a variety of causes for glaucoma in those who were treated, including a case of angle closure. One patient was believed to have traumatic glaucoma and four patients were treated on the combination of IOP and suspicious C/D's. The last patient was treated for glaucoma but was also referred to a near by ophthalmologist for additional differential testing for herpes and syphilis. In addition, one infant presented to the clinic with congenital glaucoma. (Data from this patient is unavailable.) There were also seven patients who were classified as glaucoma suspects that did not receive treatment for various reasons. Of these patients, three were considered because of large C/D's, two on the basis of high IOP's and two because of asymmetric IOP's. Table #5 Two additional patients were temporarily treated for high IOP's with hypermature cataracts in each eye and were then placed on the list for possible cataract surgery. Table #4

The screening method for glaucoma, which generally consists of IOP measurements and examination of the optic disc, fails to detect 1/3 to 1/2 of those with damage from glaucoma in a given population.[15] Studies have shown that IOP is not the best indicator of glaucoma suspects. A study determined the probability of having glaucoma at an IOP of 18 mm Hg was zero. Additional data showed a probability of .5 and 1 at pressures of 27-28 mm Hg and 30 mm Hg respectfully.[16]

The Baltimore Eye Study also showed that >1/2 of all the eyes diagnosed with glaucoma had a screening pressure below 21.[17] It is, therefore, recommended that some form of visual fields be completed as the third determining factor. In our clinic, confrontations were used due to a lack of availability of other portable efficient testing methods.

One clinical screening in rural Tanzania was completed in an attempt to identify those with visual field damage from glaucoma.[15] The study took into account the need for portable, efficient, battery powered testing equipment, in rural screenings. The study utilized two trial test methods to determine the level of damage from glaucoma. One of the tests consisted of a lap-top computer version of a visual field test. It took five minutes per patient to train them to use the system, and an average of two minutes per eye to take the test. The patient sat 30cm from a computer screen, and was asked to press the space bar one or two times to signal how many lines they saw flashing at different locations on the screen. In addition, they needed to be fit with the proper lenses for that test distance, and one test monitor was needed per patient to encourage fixation on a central target. In general, this test provided some useful information, however, results were not highly repeatable. Had this testing method been available to us on our mission, it wouldn't have been applicable, due to the time frame to run the test, and a limited number of interpreters to administer it.

A second method tried in the pilot study in Tanzania involved scotopic sensitivity testing. This test involved a 25 min./eye dark adaptation time. It utilized an instrument firmly held against the eye with a white light projected onto a Ganzfeld surface, which stimulated the entire visual field evenly. The test lasted less than five minutes, once they had done practice tests to be sure the patient understood the test procedure. However, many of the patients they had presumed to have glaucoma, based on screening, were either blind, or had additional factors such as a dense cataract which prevented scotopic screening. Once again, had this test equipment been made available in our screening, the lack of time and interpreters would have prevented the use of these techniques.

In the above pilot study they found no correlation between results of the two tests, however, both correlated with cup to disc ratios.[15] The data collected in the study, relied on the detection of different abnormalities caused by glaucoma. It suggested that numerous computer based games involving motion perception could be utilized to detect field loss. They would be

detecting early glaucoma changes, with loss to the larger ganglion cells, which are responsible for motion. Confrontations were the only field available under our testing conditions.

## CONCLUSION

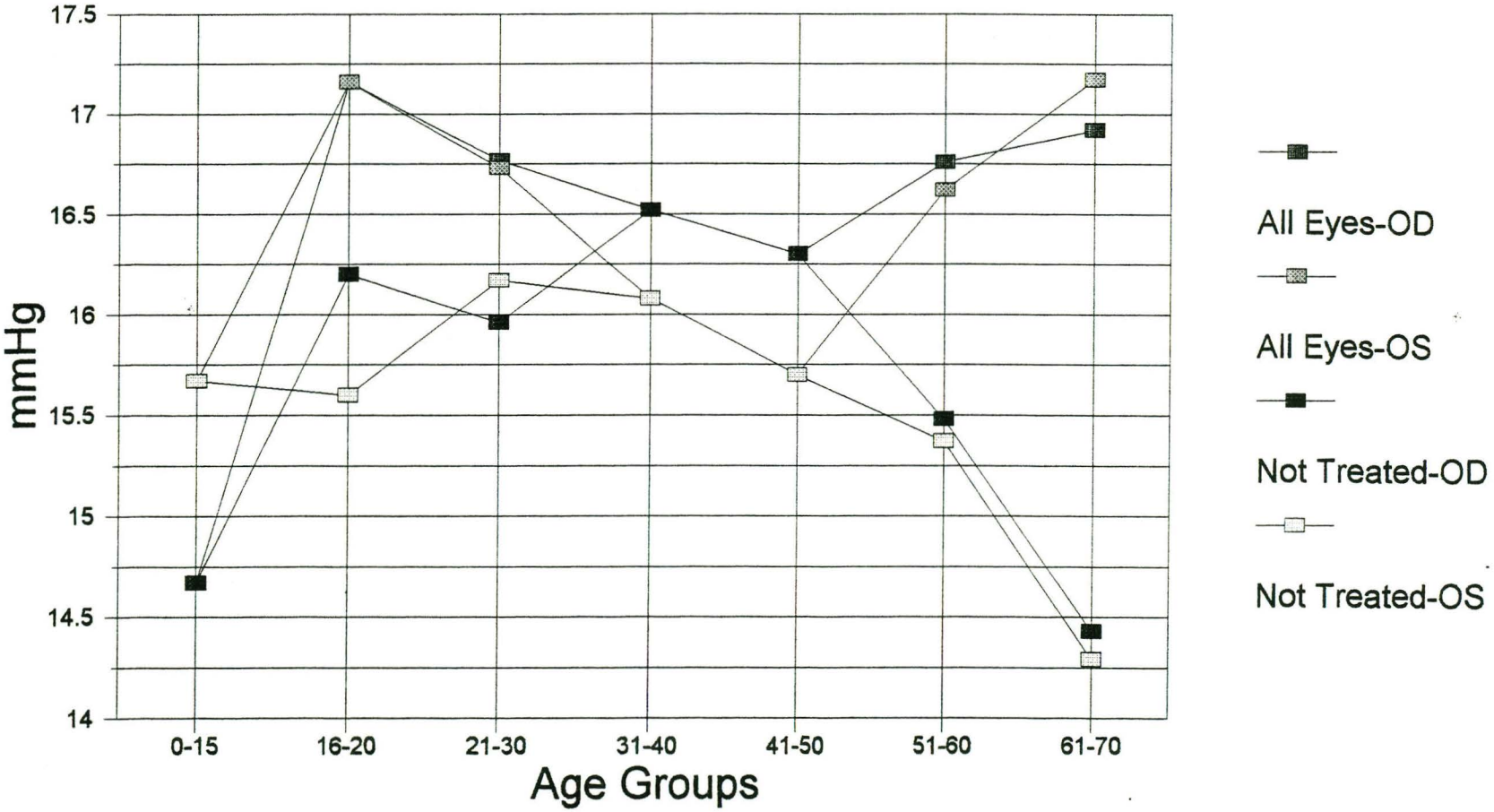
This study made a comparison between Honduran and American IOP's and investigated many different factors which can affect IOP. While there wasn't a significant difference between IOP's in various age groups up to age 50, there was a rather unique trend that was observed after age 50. Americans tend to show an increase in IOP with age while the Honduran population showed a decrease in IOP in nonglaucomatous eyes. This study explored the various factors which affect IOP in an attempt to better understand its relationship to various physical, ocular and systemic factors.

While there was not a significant difference in the average IOP's between the Honduran and American populations, there was a rather large difference in the presentation and prevalence of glaucoma between the two populations. Different studies have reported a prevalence of glaucoma in the U.S. population to be 1.9%-2.1% , while we found a prevalence of glaucoma to be 6.25%. An additional 6.94% presented with pathological high IOP's or were classified as glaucoma suspects. This could raise the incidence of glaucomatous changes to 13.19% in the Honduran population. It is believed that this number is extraordinarily high because of the large amounts of pathology and cataracts which are often present in the patients who present to the clinic for care.

Data from this study is based on a one time screening in the Honduran population. It was an intent to establish this data as a guideline for future reference in dealing with the care of the Honduran population, in order to provide continuous quality care to their people.

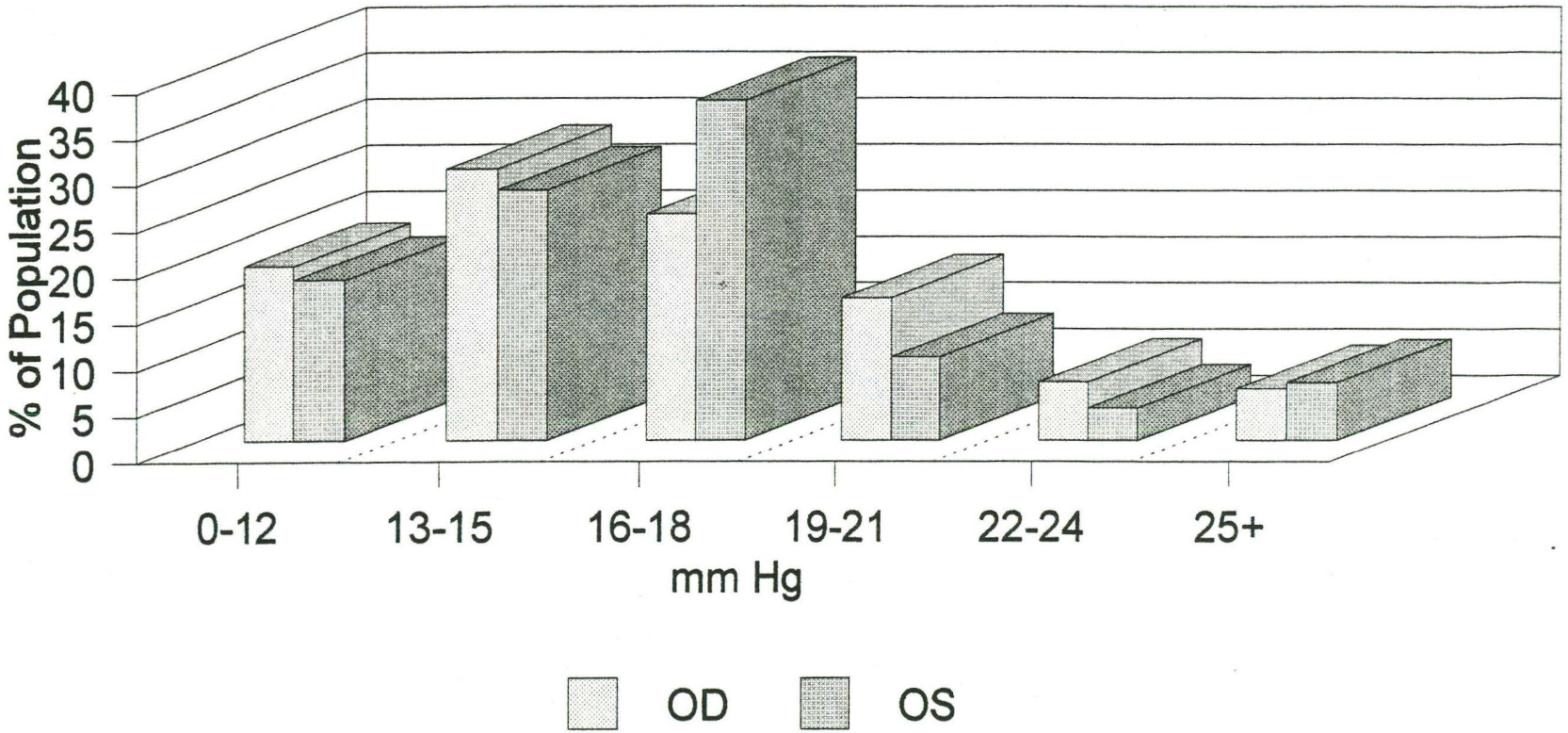
# Average IOP's in Different Age Groups

Table #1



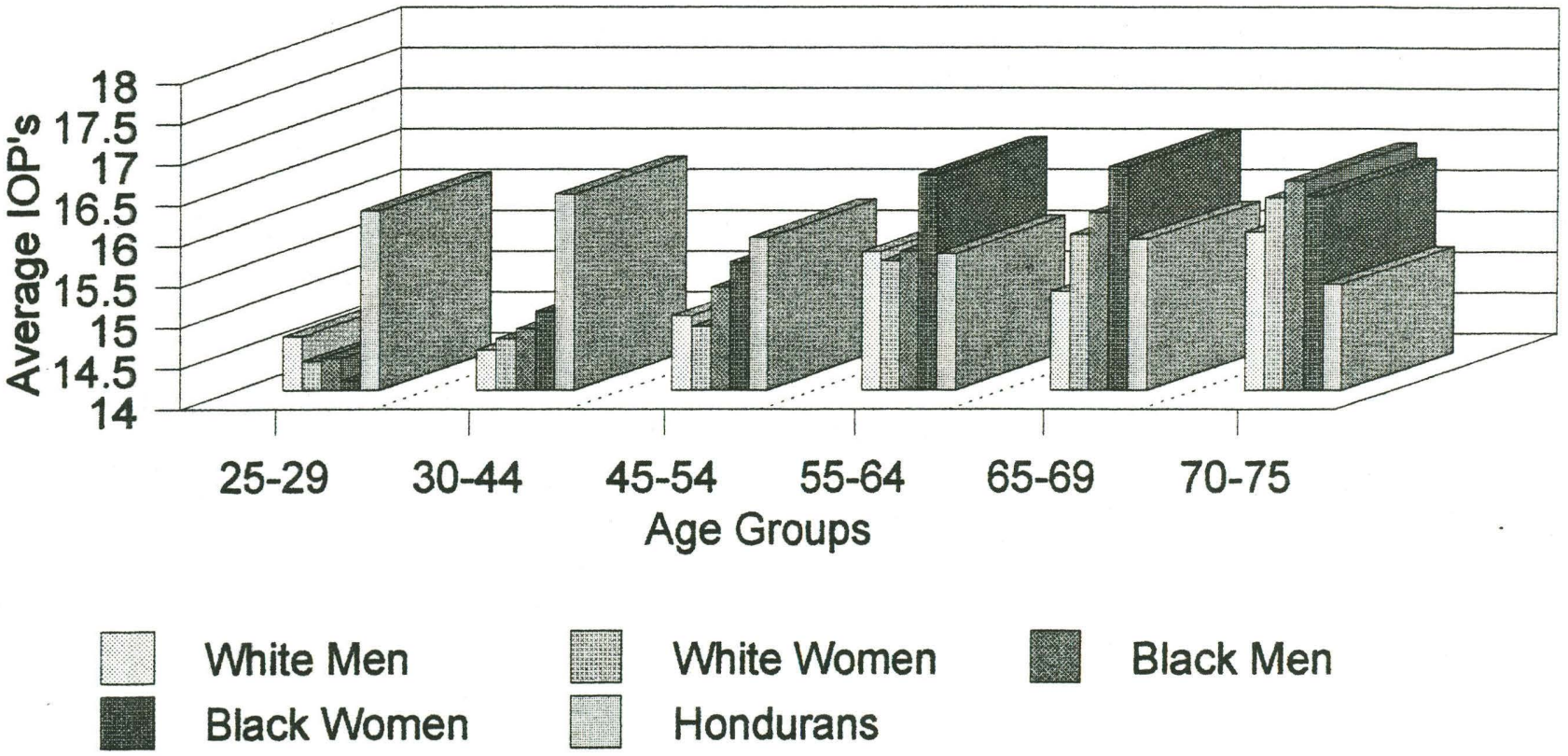
# % of Population with Various IOP's

Table #2



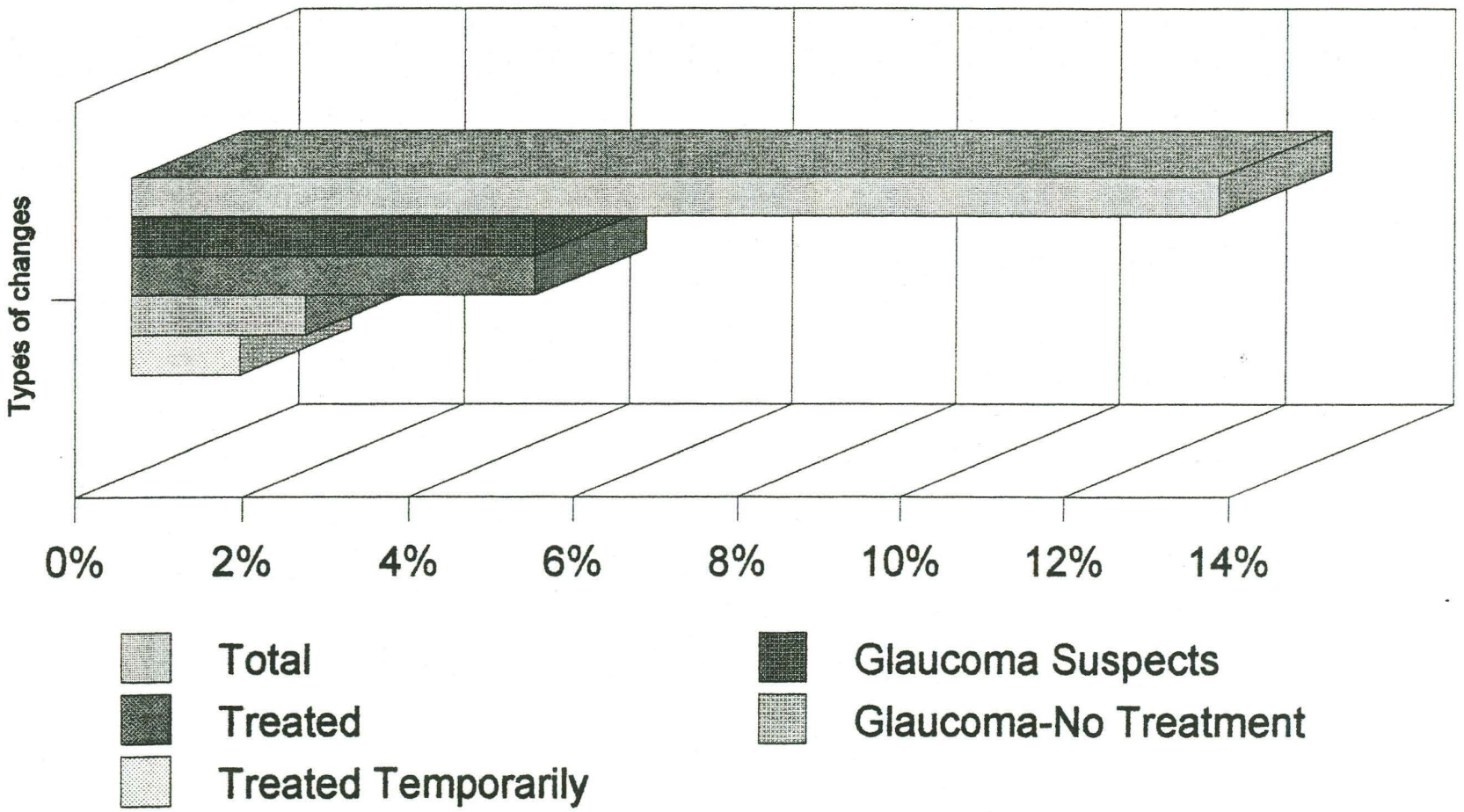
# Honduran vs. American IOP's

Table #3



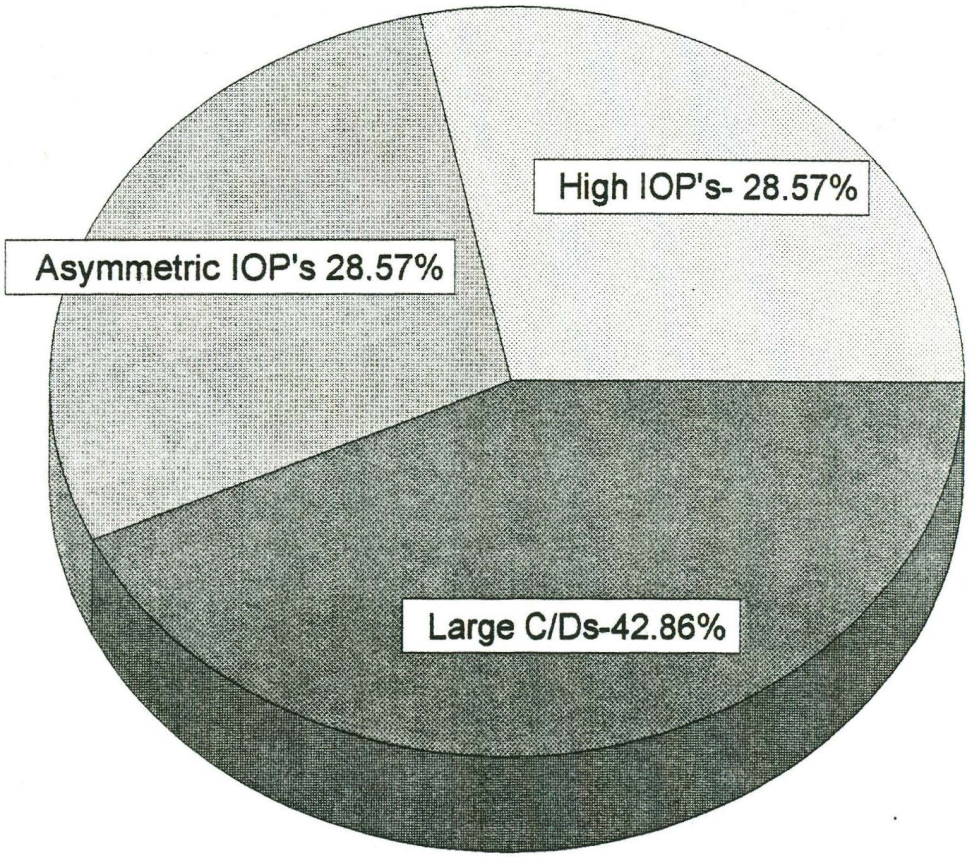
# % of Patients With Glaucomatous Changes or High IOP's

Table #4



# Breakdown of Glaucoma Suspects

Table # 5



References


1. Kau S, Lichter P, Bergstrom T, Rowe S, Musch D. Clinical Comparison of the Oculab Tono-Pen to the Goldmann Applanation Tonometer. Ophthalmol 1987: 94: 1541-4.

2. Motolko MA, Deldmen R, Hyde M, Hudy D. Sources of Variability in the Results of Applanation Tonometry. Can J Ophthalmol 1982; 17: 93-5.

3. Wingert T, Bassi C, McAlister WH, Galanis J. Clinical Evaluation of Five Portable Tonometers. JAOA. 1995: 66: 670-4.

4. Henson D, Kzauo I, LeBlanc R, Sommer A. Discussion: Screening for Glaucoma. Surv Ophthalmol 1989; 33:(suppl) 449-450.

5. Tielsch JM, Sommer A, KatzJ, et al. Racial Variations in the Prevalence of Primary Open Angle Glaucoma: the Baltimore Eye Survey. JAMA 1991; 266: 369-374.

6. Klein BEK, Klein R, Linton KLP. Intraocular Pressure in an American Community. The Beaver Dam Eye Study. Invest Ophthalmol Vis Sci 1992; 33: 2224-8.

7. Passo MS, Goldberg L, Elliot DL, Van Buskirk EM. Exercise Training Reduces Intraocular Pressure Among Subjects Suspected of having Glaucoma. Arch Ophthalmol 1991; 109: 1096-8.

8. Ekblom B, Kiblom E, Soltysiak J. Physical Training, Bradycardia, and Autonomic Nervous System. Scand J Clin Lab Invest. 1973; 32: 251-256.

9. Brubaker RF, Schlecht LP. The effects of Withdrawl of Timolol in Clinically Treated Glaucoma Patients. Invest. Ophthalmol Vis Sci. 1987; 28(suppl): 377.

10. Klein BE, Klein R. Intraocular Pressure and Cardiovascular Risk Variables. Arch Oophthalmol 1981; 99: 837-9.

11. Marshall EC. Racial Differences in the Presentation of Chronic Open-Angle Glaucoma. JAOA 1989; 60: 760-767.

12. Hiller R, Sperduto RD, Krueger DE. Race, Iris Pigmentation and Intraocular Pressure. Am J Epidemiol. 1982; 115: 674-83.

13. Wormald RPL, Basauri E, Wright LA, Evans JR. The African Caribbean Eye Survey. Risk Factors for Glaucoma in a Sample of African Caribbean People Living in London. Eye 1994; 8: 315-20.

14. Clarke EE. A comparative Analysis of the Age Distribution and Types of Primary Glaucoma Among Populations of African and Caucasion Origins. Ann Ophthalmol 1973; 5: 1055-71.

15. Quigley HA, West S, Munoz B, Mmbaga BBO, Glovinsky Y. Examination Methods for Glaucoma Prevalence Surveys. Arch Ophthalmol 1993; 111: 1409-1415.

16. Davanger M, Ringvold A, Blika S. The Probability of having Glaucoma at Different IOP levels. Acta Ophthalmol Coenh. 1991; 69(5): 365-8.

17. Sommer A, Tielsch JM, Katz J, Quigley HA, gottsch JD, Javitt J, Singh K. Relationship Between Intraocular Pressure and Primary Open Angle Glaucoma Among White and Black Americans. Arch Ophthalmol. 1991; 109(8): 1090-5.

18. Klein BEK, Klein R, Sponsel W, Franke T, Cantor L, Martone J, Menage M. Prevalence of Glaucoma The Beaver Dam Eye Study. Ophthalmol 1992; 99: 1499-1504.

19. Bulpitt CJ, Hodes C, Everitt MG. Intraocular Pressure and Systemic Blood Pressure in the Elderly. Br J Ophthalmol 1975; 59: 717-20.

20. Carel RS, Korczyn AD, Rock M, Goya I. Association Between Ocular Pressure and Certain Health Parameters. Ophthalmol (Rochester) 1984; 91: 311-4.

21. Krieger N, Ketcher G, Fulk GW. Physiological Varibles Affecting Intraocular Pressure in a Population
Study. Am J Optom & Physiol Opt 1988; 65: 739-44.

22. Clarke EE. A Comparative Analysis of the Age Distribution and Types of Primary Glaucoma Among Populations of African and Caucasion Origins. Ann Ophthalmol 1973; 5: 1055-71.