The prevalence of legal blindness and visual impairment due to refractive error from a humanitarian vision clinic in Ghana, Africa

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Abstract
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Methods: A humanitarian eye clinic was established for 5 days in surrounding villages of Kumasi, Ghana. 1125 patients were evaluated for refractive error and ocular health. An entering visual acuity was taken both at distance and near and an exiting visual acuity was taken after a spectacle correction was dispensed, at both distance and near.

Results: Out of the 1125 patients, a total of 923 records were complete. 182 distance spectacle corrections and 264 near corrections were dispensed within the usable study sample. Hyperopia and presbyopia were the foremost causes of reduced entering acuity in the patient population. The most prevalent ocular disease was cataracts, totaling 145 patients. Of this population, 50 (34.5%) demonstrated improved acuity with spectacle correction. Average entering acuity of the patients with cataracts was 20/87.5, exiting with a mean of 20/78.4. The mean of the reduced distance entering acuity group was 20/59.2, with a mean exiting acuity of 20/29.7 after spectacle correction. The mean of the reduced near entering acuity group was 20/62.0, with a mean exiting acuity of 20/24.9 after spectacle correction. Of the 923, 68 (7%) patients had an entering distance acuity that met the criteria for legal blindness, while 53 (6%) exited with legal blindness after spectacle correction. Eighty-six (9%) patients entered as visually impaired in the distance and only 49 (5%) exited as visually impaired. Those with 20/70 or worse vision at near made up 196 (21%) patients, while only 73 (8%) exited as visually impaired.

Conclusion: With the provision of spectacle corrections at near and far, the prevalence of preventable visual impairment and blindness was markedly reduced in this underserved population. These results, especially the improvements in near vision, add to the mounting body of evidence that uncorrected refractive error accounts for a larger proportion of visual impairment in underserved populations worldwide than ocular disease conditions.

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THE PREVALENCE OF LEGAL BLINDNESS AND VISUAL IMPAIRMENT DUE TO REFRACTIVE ERROR FROM A HUMANITARIAN VISION CLINIC IN GHANA, AFRICA

By: J.P. LOWERY O.D.,M.Ed., ASHLEY BEMENT, ERIN SUNDSTROM, AND CARLA DREHER

July, 2006

A thesis submitted to the faculty of the College of Optometry
Forest Grove, Oregon
For the degree of Doctor of Optometry
May 2007

Advisor:
J.P. Lowery O.D.,M.Ed.
Biography

Erin Sundstrom completed her undergraduate work at Casper College through the University of Wyoming and Pacific University with a Bachelor of Visual Science. Honors received at Pacific University College of Optometry include Beta Sigma Kappa for the years of 2005-2006. She plans to further her education with an optometric residency program in primary care and return to Wyoming to practice.

Carla Dreher was born and raised in McHenry, North Dakota. She attended college at Casper, Wyoming and completed her Bachelor of Science degree in Zoology and Physiology and Mathematics/Science through the University of Wyoming. She was a member of Beta Sigma Kappa at Pacific University College of Optometry for the years of 2004-2005. Upon graduation, she plans to return to the Midwest to practice optometry.

Ashley Bement will graduate from Pacific University College of Optometry in May, 2007. She completed her undergraduate work at the University of North Dakota and received a Bachelors of Science in Biology. Ashley was the “Eyeball” Chair for Amigos for 2005-2006 and volunteered with Americorp tutoring high school students during optometry school.
Change in Visual Status of People in Ghana, Africa

Thesis Advised by J.P. Lowery, O.D., M.Ed.

Background:
The purpose of this study was to assess the efficacy of a humanitarian eye clinic and with this data determine the prevalence of legal blindness and visual impairment due to refractive error in Ghana, Africa.

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Key Words: acuity, refractive error, visual impairment, legal blindness, World Health Organization

Introduction:
Current trends in humanitarian vision clinics indicate that refractive error may be the leading cause of blindness in under-developed countries. This suggests that eye care services in these populations are inadequate since treatment of refractive error is a very
fundamental and treatable part of eye care. Recent evidence shows that if the total number of people with visual impairment worldwide includes impairment due to uncorrected refractive error the percentage of people is actually 61% higher (259 million) than the commonly quoted World Health Organization estimate. However, available eye care services do not guarantee accessibility. A recent study estimates that 11 million people in the United States could improve their vision with eye glasses or contact lenses. According to one study, visual impairment was highest among those who were Hispanic, poor, had Diabetes Mellitus, lacked private health insurance or had fewer years of education. Even in a developed country with proper eye care, many individuals lack the financial means to utilize the eye care services. There are many barriers to adequate eye care for those in developing countries also, including low socioeconomic standing, geographic isolation, lack of education about vision and health, as well as paucity of eye care providers.

Kumasi, Ghana is home of KNUST (Kwame Nkrumah University of Science and Technology) College of Optometry. Efforts by the students of KNUST are being made to provide eye care services to the surrounding areas. Special attention to the specific needs of the population such as affordable, accessible transportation for those living in rural areas is an important step to reducing the burden of visual impairment in this population. Donated prescription lenses and free screenings would facilitate routine eye care to low socioeconomic individuals. Continuing education that imparts public knowledge of the optometrist’s role as a primary care provider is also required to ensure long term success of future eye care in Ghana, Africa.

Amigos (Student VOSH) a student organization of Pacific University College of Optometry teamed up with doctors, faculty and optometric students of KNUST to conduct a one week clinic providing eye care services to under-privileged individuals in Ghana, Africa. The purpose of this study was to determine the prevalence of legal blindness and visual impairment caused by refractive error via a humanitarian eye clinic.

Methods
Data was gathered during five days of clinical care to 1125 people in surrounding villages of Kumasi, Africa. Patients were triaged who required immediate medical attention, but otherwise examined on a "first come, first serve basis". A brief case history including chief complaint, ocular history and medical history was performed on each patient. Visual acuities at distance and near were assessed along with chief complaint to determine need for further evaluation. To screen for hyperopia, a +1.00 diopter lens was used to monitor a change in acuity. Retinoscopy and ophthalmoscopy were performed on those with reduced acuities. Spectacle corrections were dispensed from the lens library consisting of donated prescription lenses. Aucities were taken at both distance and near with a prescription that best matched their refractive error. Referrals were made for ocular conditions not treatable with lenses and therapeutics. Therapeutic agents were dispensed as per patient need. Entering and exiting acuities were analyzed to evaluate the efficacy of a spectacle correction and to determine the prevalence of visual impairment (20/70-20/160 in the best corrected eye) and legal blindness (20/200 or worse in the best corrected eye). It is important to note that the definition of visual impairment and legal
blindness consider only distance acuities, however, these definitions were applied to near acuities as well.

Acuity Measurement
Using a Standard Snellen letter chart and Tumbling E chart, acuities, both entering and exiting, were taken monocular and binocular at 20 feet and binocular at the near standard of 40 cm. Letter sizes on both distance charts ranged from 20/200 (MAR=10’) to 20/20 (MAR=1’). Letter sizes at near ranged from 20/200 to 20/20. All acuity measures were obtained by optometry students aided by Kumasi Optometry school students. Entering and exiting acuities were taken inside the clinic areas with equal amount of window lighting, however, lighting varied with the time of day.

Population Profile
Of the 923 completed records, 412 (44.6%) were males and 511 (55.4%) were females. Ages ranged from one year to 102 years old, with a mean age of 37.1. The number of persons over the age of 40 was 376, accounting for 40.7% of all patients. Below is a distribution of all ages in Figure 1.

FIGURE 1
Total Population (N=923) consists of all persons who received an exam. Age distribution was as follows: 80 (9%) patients were 0-10 years old, 279 (30%) were 11-20, 101 (11%) were 21-30, 87 (9%) were 31-40, 134 (15%) were 41-50, 102 (11%) were 51-60, 140 (15%) were greater than 60 years old.

778 (69%) patients of the total sample population (1125) had refractive error recorded. Of this population, 348 (31%) did not receive a spectacle correction, entered with 20/25 vision or better at distance and near, and were classified as emmetropic. Emmetropia was defined on the basis of entering acuity at distance and near of 20/25 or better, a decrease of visual acuity with the +1.00 diopter lens test, and had no visual complaints. The refractive distribution was as follows: 111 (10%) cases of myopia, 51 (4.5%) myopic astigmatism, 234 (20.8%) hyperopia, and 78 (6.9%) patients with hyperopic astigmatism, 520 (46.2%) patients with presbyopia. 217 of the presbyopic patients overlap with other
refractive error conditions. The distribution of refractive errors is illustrated in Figure 2. It should be noted that any astigmatism measured was considered astigmatic error.

FIGURE 2
Refractive error distribution (N=1125).
M=Myopia, E=Emmetropia, MA=Myopic Astigmatism, H=Hyperopia, HA=Hyperopic Astigmatism, P=Presbyopia.

Ocular Disease Conditions
A multitude of ocular disease conditions were diagnosed on examination. Patients with incomplete data such as exiting acuities were included in this data to gather as much information regarding variety and quantity of disease. It should be noted that ocular diseases which are not likely to distort vision and/or threaten visual acuity were not included in the list below. For example, a high prevalence of pingueculae and allergic conjunctivitis were recorded, but not included in sight-threatening data. Patients with pingueculae approximate almost 1/3 of the entire sample population (1125). The following disease conditions make up 23.4% (264) patients of entire population sample (1125). Specific conditions recorded on examination included: cataract(145), pterygium(70), corneal opacification(10), diabetic retinopathy(5), strabismus(5), ARMD(4), toxoplasmosis(4), dry eye(3), onchocerciasis(3), aphakia(2), retinopathy(2), trauma(1), asteroid hyalosis(1), posterior synechiae(1), chorioretinitis(1), disc pallor(1), glaucoma(1), hypertensive retinopathy(1), macular scar(1), retinal detachment(1), vitamin A deficiency(1), vitreal opacities(1).

Data Analysis and Criteria
The definition of legal blindness and visual impairment according to the U.S. standard were used in this study to assess the impact refractive error had on those classified as visually disabled or legally blind. The primary data used to evaluate improvement with a spectacle correction were binocular entering and exiting acuities at distance and near. The data was separated by distance and near spectacle corrections. Both of these categories were then analyzed for visual acuity improvement. Included within the near data were those who received bifocals and/or near prescriptions only. The bifocal group was also
included in the analysis of distance acuity. LogMar conversions were used to make Snellen fractions linearly comparable to each other. A small group of those who received a near spectacle had asthenopic complaints without reduced entering acuity and were analyzed separately from the reduced near acuity group. It is important to note that the current WHO definition of visual impairment uses best corrected acuities only. In determining the change in visual status, we use presenting visual acuity to define legal blindness or visual impairment. In this way, we are able to evaluate relative contribution of refractive error to visual impairment in our sample. Presenting visual acuity is a more valid means of determining the true magnitude of visual impairment in a population that has limited access to refractive care.

Results
923 complete exam records were available for analysis of the original 1125 patients. There were 202 incomplete records due to an absence of exiting acuities. At the end of each clinic day, there was a high demand of patients awaiting visual attention, thus, exiting acuities were ceased in order to expedite care. Reduced illumination at the end of the day was also a factor for missing data. A total of 182 spectacles were dispensed for distance correction, and 264 spectacles were dispensed for near correction. 62 patients with cataracts received spectacles and are included in the analysis of distance and near vision. Cataract patients were separated out for further analysis to determine the efficacy of spectacle correction within this group. 312 patients entered with good visual acuity, had no visual complaints, and were not given glasses, thus, no exiting acuities were measured. 110 patients were diagnosed with an ocular disease condition that was not correctable with spectacles, and therefore no exiting acuities were taken. The patients who did not receive correction, regardless of cause, were evaluated in the overall analysis of the prevalence of visual impairment of the whole population, but not within the data of groups receiving spectacles.

Reduced Distance Acuity Group
The number of persons in the study sample receiving a distance prescription was 182. The average entering acuity was 20/59.2, while the average exiting acuity was 20/29.7. Within this group, 39 entered the clinic with a level of acuity that would classify them as visually impaired, while the number of people that fell into the legally blind category was 19. Exiting persons with a visual impairment was reduced to 16 while legal blindness was reduced to 8. It should be noted again that we are extending the definition of visual impairment and legal blindness to include those with uncorrected refractive error. Acuities were divided into three groups according to entering acuity. These include legally blind (≥20/200), visual impairment (20/70 to 20/180), and near normal vision (20/25 to 20/60). The ≥20/200 group attained a mean exiting distance acuity of 20/81.6. The 20/70 to 20/160 group entered with a mean distance acuity of 20/81.7, while their exiting acuity improved to a mean of 20/38.2. The 20/25 to 20/60 group entered with a mean acuity of 20/37.2 and exited with a mean of 20/21.8.

There was a group of hyperopic individuals (47) within the reduced distance acuity group that entered with visual acuities of 20/20 and had distant complaints. They are included in the analysis because most demonstrated improved distance acuities to better than 20/20
with correction. These changes in mean acuity are shown in Table 1. The change in prevalence of legal blindness, visual impairment, as well as near normal vision for the sample is shown in Figure 3 below.

Table 1: Mean Distance Acuity Improvements

<table>
<thead>
<tr>
<th>Entering Acuity Range</th>
<th>Entering Mean</th>
<th>Exiting Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 20/200 (N=19)</td>
<td>20/200</td>
<td>20/81.6</td>
</tr>
<tr>
<td>20/70-20/160 (N=39)</td>
<td>20/81.7</td>
<td>20/38.2</td>
</tr>
<tr>
<td>20/20-20/60 (N=124)</td>
<td>20/37.2</td>
<td>20/21.8</td>
</tr>
<tr>
<td>Entire Sample (N=182)</td>
<td>20/59.2</td>
<td>20/29.7</td>
</tr>
</tbody>
</table>

Near Prescription Profile
Bifocal and near prescriptions were given to the 264 patients requiring visual attention at near. Bifocals comprised 89 of the spectacles given, while 175 readers only were dispensed. There was a small number (14) of patients who received near prescriptions due to vision complaints at near despite 20/25 or better acuity.

Reduced Near Acuity Group
Refractive error and ocular disease caused reduced near acuities in 250 patients. The mean age was 54.1, with 91% being over the age of 40, indicating a high prevalence of presbyopia. As illustrated in the table 2 below, entering acuities were divided into three groups. Those falling in the worse than 20/100 vision had an entering mean of 20/147 and an exiting mean of 20/28.1. Within the group of 20/60-20/100 the entering mean was 20/74 and the exiting mean was 20/26. Patients in the 20/25-20/50 group entered with a mean of 20/34 and exited with a mean of 20/22.2. Overall acuity change for the reduced near acuity group was from a mean entering acuity of 20/62 to a mean exiting acuity of 20/24.9.
### Cataracts

One-hundred forty five patients were diagnosed with cataracts. These patients consisted mainly of persons over the age of 40, 94 patients (64.8%) of them being over the age of 60. One hundred twenty-three of the 145 cataract patients had exiting visual acuity measured. Of the 123 cataract patients, 62 received spectacles for distance and/or near vision. The remaining half of cataract patients either achieved 20/20 vision at distance and/or near, or were referred to an ophthalmologist for surgical intervention as no improvement was possible through spectacle correction. The mean entering distance acuity for this group was 20/90, and the mean exiting distance acuity was 20/54.5. The mean entering near point acuity was 20/67.0, while the mean exiting near acuity improved to 20/27.6. Looking at change in visual disability status, the number of individuals (123 patients) with cataract who entered with legal blindness (>20/200 OU) was 53 (41.1%), while those exiting with legal blindness was 34.1%. The number who entered the clinic with visual impairment (20/70-20/160) by distance acuity was 28 (22.8%) while those patients exiting with visual impairment was 26 (21.1%). The improvement in near vision was more evident. Seventy-five (60.9) of the patients with cataract entered with near acuity measuring 20/70 or worse while only 53 patients (43.1%) of these patients exited with visual impairment at near. These changes in the prevalence of legal blindness and visual impairment for patients with cataracts are summarized in Figure 4.

### Table: Entering and Exiting Visual Acuity

<table>
<thead>
<tr>
<th>Entering Acuity Range</th>
<th>Entering Mean</th>
<th>Exiting Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;20/100 (N=53)</td>
<td>20/200</td>
<td>20/28.1</td>
</tr>
<tr>
<td>20/60 - 20/100 (N=114)</td>
<td>20/74</td>
<td>20/26</td>
</tr>
<tr>
<td>20/25 - 20/50 (N=86)</td>
<td>20/34</td>
<td>20/22.2</td>
</tr>
<tr>
<td>Entire Sample (N=253)</td>
<td>20/62</td>
<td>20/24.9</td>
</tr>
</tbody>
</table>

### Figure 4: Change in Visual Status of Cataract Patients (N=123)

Overall Change in Visual Status
923 patients had complete data for the usable study sample to evaluate overall change in acuities. This includes all patients who did not receive spectacles due to either excellent entering acuities or ocular disease that precluded spectacle correction. Of the 923, 68 (7%) patients had an entering distance acuity that met the criteria for legal blindness, while 53 (6%) exited with legal blindness after spectacle correction. Eighty-six (9%) patients entered as visually impaired in the distance and only 49 (5%) exited as visually impaired. Those with 20/70 or worse vision at near made up 196 (21%) patients, while only 73 (8%) exited as visually impaired.

Figure 5 summarizes these changes in the prevalence of legal blindness and visual impairment.

![Figure 5: Change in Visual Status for Entire Sample (N=923)](image)

Discussion

Overall Findings & Epidemiology

Within the sample population of villages neighboring Kumasi, Ghana, the most prevalent etiology of decreased visual acuity is uncorrected refractive condition(s). Refractive error correction was most significant in the near population group evaluated. Cataract formation plays a moderate role in the ability to improve vision by spectacle correction at distance particularly; however, the percentage of patients found with cataracts, regardless of visual acuity, is less than that of uncorrected refractive error within the entire sample of 1125 patients.

The prevailing refractive conditions were found to be presbyopia and hyperopia. The nature of hyperopia and presbyopia certainly explains the quantity of patients entering with near vision complaints and reduced near visual acuity. Of the usable sample population, 264 near point corrections were dispensed. Using legal definitions of blindness, 1/5 of patients in this near population sample entered legally blind or performing worse than a 20/200 acuity level. Furthermore, approximately 43% (114 patients) entered at a level of acuity defined as visual impairment. This concludes that almost two-thirds of all patients receiving a near spectacle correction either by readers, single-vision, or bifocals, have a moderate to severe near disadvantage. It should be
noted that the average age of this near sample population is 54.1, with 91% of the population over 40 years old. This correlates well with the high prevalence of near visual impairment and presbyopia as the leading cause of correctable blindness within the villages surrounding Kumasi, Ghana.

A small population of asthenopes deserves mention; although, this group is not included in the near population profile receiving spectacle correction. Fourteen patients, presenting with 20/20 vision at near, were given near spectacles in the exiting dispensary. A common complaint among this population was eyestrain when reading. Because the average age of this asthenopic group was 34.2 years old, pre-presbyopia is the presumed cause of their near vision complaints.

The most prominent disease relating to vision found in this population appeared to be cataract formation, though 23.4% of the entire sample population had some form of disease or another. To maintain a balance between the prevalence of uncorrected refractive error versus vision-related disease affecting vision, incomplete records lacking exiting acuity data but containing disease information were retained. It should be noted that 202 patients received corrective lenses but had no exiting acuities taken. Excluding these patients from our sample effectively eliminates about 30% of the patients with refractive error as the primary reason for decreased acuity in the sample. Therefore, we cannot evaluate the relative contribution of disease vs. refractive error in our sample. Other pertinent diagnosis (by quantity) included pingueculae and allergic conjunctivitis. For the sake of relative comparison between refractive error and disease, visual acuity affected by cataract was the only disease analyzed in detail for this study.

Cataract patients made up 12.8% (145 patients) of the total population (1125) and 85% of these patients with cataracts had full data including entering and exiting distance acuity. Of the 85%, the mean distance acuity entering was approximately 20/90 while the mean entering acuity at near was 20/67.

Efficacy of a humanitarian vision clinic

Looking at only those patients who received glasses, the change in visual status is impressive, even with lost data.

In the near population group, the average entering acuity was 20/62 with average exiting acuity of 20/24.9 with single vision or bifocal glasses. Furthermore, those classified as legally blind at near, exited with a mean visual acuity of 20/28.1. Those considered visually impaired at near exited with a mean visual acuity of 20/26.

The following trend was not only found in the near population, but also in the distance sample being evaluated. Nineteen patients entering as legally blind, or worse than 20/200 vision, had an average exiting acuity of 20/81.6, a significant improvement upon acuity outcome. Those considered visually impaired exited with a mean acuity of 20/38.2.

As previously discussed, cataract formation appeared to be the prevailing cause of disease-related vision disadvantage and thus was used for analysis of efficacy of spectacle correction. Improvement with spectacle correction was less effective with complication of cataract, but found to give an acceptable outcome as far as improved visual acuity. Of 123 patients, the overall mean entering acuity at the distance was 20/90.
with improvement by spectacles to 20/54.5. A much more impressive change was found at near as the mean entering acuity was 20/67.0 with improvement to 20/26.7.

Humanitarian vision clinics have shown the need for increased provision of refractive care. The number of patients requiring spectacle correction to improve refractive error was almost 1.5 times the quantity of patients entering with cataract even without the 30% of refractive patients who could be analyzed. Moreover, often significant improvement of visual acuity can be made with spectacle correction for cataract patients. Thus without spectacle correction, many patients are left with a disadvantage affecting their standard of living, and in some cases considered legally blind or visually impaired.

Improvements to Humanitarian Vision Clinic

A few suggestions can be made to broaden the aid of a humanitarian vision clinic in Kumasi, Ghana. The common chief complaint among patients regardless of age, refractive error, and disease was dry and itchy eyes. Pingueculae were found in at least 1/3 of the population sample believed to be related to the arid temperatures. With the provision of lubricating drops and sunglasses, relief of many chief complaints could be alleviated. Additional treatments need to be made available on a local basis for these chronic conditions.

Factors affecting outcomes

The outcome of findings may have been affected by several variables. The sample population represents only a small fraction of the population in the villages surrounding Kumasi. Refractive error and disease may vary between villages in which data was not collected. Therefore, generalization of findings found in the villages visited may give skewed results. Furthermore, two of five villages consisted mostly of school-aged children. Since this ratio does not represent the overall population age range of Kumasi, other considerations need mentioning. Greater disease findings, more presbyopes, and more refractive errors may have resulted in a larger population sample.

On examination, lighting conditions between entering and exiting acuities varied throughout the day depending on testing rooms available with windows, and the time of day a patient proceeded through examinations. With brighter conditions, pupils constrict to give a greater depth of focus and perhaps altering visual acuity results.

Furthermore, language barriers and learning curves in reading Snellen charts or the tumbling E chart may have dampened visual acuity results in either entering or exiting acuities. Malingering was a common finding in the dispensary, which may have altered results as well. Trial framing with plano lenses was performed for some patients thought to be malingering to eliminate sources of error; however, this could not be done on every patient due to time constraints.

Records without exiting acuities were the primary drawback of this study, and ultimately, limited our ability to draw any epidemiological implications. Collecting valid data in a challenging clinical setting is difficult. The demand for examinations was high in every village and with the rush of patients, exiting acuities were not recorded for some patients. Furthermore, disease information may have been altered had every patient been seen for ocular health evaluation. In order to expedite care to the most needy, any patient
that had 20/20 vision at distance and near without symptoms and without signs of obvious disease were released without further evaluation.

Regardless of lost data, the study does show that there is a tremendous need for refractive services in the population seen. Future efforts should take into account the relative need for refractive correction at near as well as the need for surgical care for cataracts.
References


