Gender, Blindness, and Cataracts: An Analysis of 11 Rapid Assessment of Avoidable Blindness Surveys in Africa

By

Daniel Dewey-Mattia

Master of Public Health

Epidemiology

Carolyn D. Drews-Botsch, PhD
Committee Chair

Paul Courtright, PhD
Committee Member

Gender, Blindness, and Cataracts: An Analysis of 11 Rapid Assessment of Avoidable Blindness Surveys in Africa

By

Daniel Dewey-Mattia

B.A.

Colby College

2008

Thesis Committee Chair: Carolyn D. Drews-Botsch, PhD

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2012

Abstract

Gender, Blindness, and Cataracts: An Analysis of 11 Rapid Assessment of Avoidable Blindness Surveys in Africa

By Daniel Dewey-Mattia

Purpose: The objective of this study was to examine the prevalence of blindness, causes of blindness, and the possible association between gender, blindness, and cataract across 11 regions of Africa.
Methods: Raw data were analyzed from Rapid Assessment for the Avoidable Blindness (RAAB) surveys conducted in Eritrea, The Gambia, Kericho Kenya, Kilimanjaro Tanzania, Southern Malawi, Koulikor Mali, Nakuru Kenya, Western Rwanda, South Africa, South Nyanza Kenya, and Sudan among individuals age 50 and older.
Results: The overall (all 11 surveys) prevalence of bilateral blindness (presenting visual acuity <3/60 in the better eye) was 5.7% (95% CI: 5.2-6.2) for males and 5.0% (95% CI: 4.6-5.5) for females. Comparing male blindness to female blindness, the unadjusted odds ratio (OR) was 1.14 (95% CI: 1.05-1.25) and the age-adjusted OR was 1.07 (95% CI: 0.97-1.17). The overall prevalence of untreated cataract was 9.4% (95% CI: 8.8-9.9). The unadjusted odds ratio (OR) of male cataract to female cataract was 1.00 (95% CI: 0.93-1.07, p=0.9846), while the adjusted OR of male to female cataract controlling for age group was 0.91 (95% CI: 0.85-0.98, p=0.0129). Overall cataract surgical coverage at visual acuity level <6/60 in the better eye was 60.5% for males and 54.5% for females.
Conclusions: The RAAB provides a relatively quick, cost-effective method for estimating the prevalence of blindness, visual impairment, and cataract within district populations. Further validation of the RAAB survey methodology is needed to determine the extent to which previous estimates of blindness and visual impairment may or may not have been overestimated in previous large population-based surveys.

Gender, Blindness, and Cataracts: An Analysis of 11 Rapid Assessment of Avoidable Blindness Surveys in Africa

By

Daniel Dewey-Mattia

B.A., Colby College, 2008

Thesis Committee Chair: Carolyn D. Drews-Botsch, PhD

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Public Health
in Epidemiology
2012

Table of Contents

Chapter I: Background/Literature Review

Gender, Blindness, and Visual Impairment

A 2011 systematic review published by the World Health Organization (WHO) analyzing surveys from 39 countries estimated that 285 million people worldwide are visually impaired, defined as a presenting visual acuity (PVA) less than 6/18. Of these, approximately 39 million are blind (PVA less than 3/60) according to the report (1). In addition, the authors cite that 32 million of blind persons are 50 years or older and 80% of all visual impairment is due to what are deemed to be "preventable causes", primarily refractive error (43% of visual impairment) and cataract (33%).

In contrast to industrialized countries where the primary cause of blindness is age related macular degeneration, the predominant cause of blindness in developing countries is cataract(2, 3). While cataract is estimated to cause 51% of global blindness in the 2011 WHO report, this proportion is believed to be higher in African countries and among women (4). A 2000 meta-analysis found an age-adjusted odds for women to be blind compared to men was 1.39 (95% CI: 1.20-1.61) within population based surveys conducted in Africa (5). However, in Africa (and many developing countries) women generally account for fewer than half of cataract operations and there is considerable evidence that barriers exist which prevent access to eye care and cataract services by women. These barriers vary by region and include limitations related to access to transportation, distance to services, lack of outreach, cost, and other factors (6, 7).

Vision 2020 – The Right to Sight

"VISION 2020 – the right to sight" is a joint initiative launched in 1999 by the World Health Organization and the International Agency for the Prevention of Blindness to eliminate avoidable blindness by the year 2020 (8). The first phase of the Vision 2020 initiative is focused on the preventable and treatable conditions of cataract, refractive error, childhood blindness, onchocerciasis, and trachoma which together constituted over 75% of blinding diseases worldwide in 2002 (4).

Large-scale population based surveys of blindness are rarely conducted as they are expensive, time-consuming, and require extensive expertise and resources. Cheaper and faster methodologies are necessary to adequately monitor the success of Vision 2020 programs. Thus, researchers have turned to district level surveys to estimate the prevalence of eye disease and visual impairment, track the success of eye care programs, and measure their achievements.

Rapid Assessment of Avoidable Blindness

The Rapid Assessment of Avoidable Blindness (RAAB) survey is a standardized rapid survey methodology conducted at the district level using a selection of 2500-5000 people over the age of 50 years. Adapted from the Rapid Assessment of Cataract Surgical Services (RACSS) (9, 10), the RAAB has been used in several developing nations to estimate the causes of blindness in a population, under the assumption that the proportion of blindness due to different causes among those over 50 years old is similar to that of the total population. In addition, since the prevalence of blindness among people below the age of 50 is very low, extremely large sample sizes would be needed to provide accurate estimates of prevalence in these age groups.

Survey areas for a RAAB can be entire country or parts of a country (province or district). The survey area typically contains a population between 0.5 and 5 million people. The generalizability of the results may be compromised if the population base is too small. Additionally, if the population base is too large, there may be too high a variation in prevalence across localities to obtain the desired level of precision. The appropriate sample size for a RAAB survey also relies upon the expected prevalence of bilateral blindness (best corrected visual acuity [BCVA] <3/60), the precision of the estimate required (typically 20%), and the desired confidence in the precision (typically 95%) (11).

Clusters are selected from the sampling frame using probability according to size, a self-weighting process that ensures that clusters are evenly spread over the population base. National census data or other available population data is used to estimate the total population of the survey area that is 50 years or older. This figure is divided by the number of clusters required to achieve the desired sample size yielding the sampling interval. The sampling interval is then multiplied by a random number between 0 and 1 and the resulting number is then traced in the cumulative population column of population units (such as polling stations) in the survey area. Additional clusters are selected by adding the sampling interval to the previous number. All clusters selected within the population base will ideally be exactly the same size, and are typically 50 people (range of 40 to 60 depending on the study) aged 50 or older which are sampled in one day by a single team of RAAB personnel (11).

Since most clusters will contain more than the desired number people aged 50 years or older, compact segment sampling is used to select households within clusters. Villages are divided into 8 segments of approximately equal size. These segments are ordered at random and all households in each selected segment are surveyed until enough individuals over 50 years old have been examined and the desired cluster size has been met.

Ophthalmic examinations in RAAB surveys use basic ophthalmic equipment (at most a direct ophthalmoscope and a portable slit lamp) and an automated software package has been developed for data entry and data analysis. The use of cluster sampling rather than simple random sampling in the RAAB survey methodology requires an adjustment of the sampling error called the design effect (DEFF). The SE of prevalence is usually higher in cluster sampling compared to simple random sampling because individuals within a cluster tend to have similar characteristics.

Cataract Surgical Rate and Coverage

RAAB surveys also allow for the estimation of cataract surgical rates and cataract surgical coverage among a population/sub-population. The cataract surgical rate is the number of cataract operations performed per million people each year. Cataract surgical coverage, in persons, is used as a measure of use of cataract surgical services and calculated using the following equation:

$$\frac{A + B}{A + B + C}$$

Where A is equal to the number of people with one operated and one visually impaired eye, B is the number with bilateral operated eyes, and C is the number of people with bilaterally visually impairment by cataract. A 2009 meta-analysis of 23 surveys in low- and middle-income countries published since 2000 found a Peto odds ratio 1.71 (95% CI: 1.48 to 1.97) comparing surgical rates of men to women (12). Only 2 of the 23 surveys showed higher CSC for women and the authors speculate that if women received cataract surgical coverage equivalent of that of men, blindness and visual impairment due to cataract would reduce by about 11-12%.

Research Question and Implications

The goal of this secondary analysis of 11 RAAB surveys conducted in Eastern Africa is to examine the overall prevalence of blindness and causes of blindness with a specific focus on the relationship between gender and visual impairment/blindness due to cataract. The article will also address the association between CSC and gender to examine if women (or men) are disproportionately receiving a lack of services.

There are several important implications of the findings of this study. First, it estimates the burden of avoidable blindness among individuals 50 years and older among the 11 East African Regions for use in future program planning and implementation. Secondly, it provides information related to the success of the Vision2020 initiative and highlights areas which need to be targeted for future interventions. Lastly, it evaluates existing gender disparities related to both the existing burden of visual impairment and blindness due to cataract as well access/utilization of cataract surgical services.

References

1. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. The British journal of ophthalmology 2012;96(5):614-8.

2. Kocur I, Resnikoff S. Visual impairment and blindness in Europe and their prevention. The British journal of ophthalmology 2002;86(7):716-22.

3. Furtado JM, Lansingh VC, Carter MJ, Milanese MF, Pena BN, Ghersi HA, et al. Causes of blindness and visual impairment in Latin America. Survey of Ophthalmology 2012;57(2):149-77.

4. Resnikoff S, Pascolini D, Etya'ale D, Kocur I, Pararajasegaram R, Pokharel GP, et al. Global data on visual impairment in the year 2002. Bulletin of the World Health Organization 2004;82(11):844-851.

5. Abou-Gareeb I, Lewallen S, Bassett K, Courtright P. Gender and blindness: a meta-analysis of population-based prevalence surveys. Ophthalmic Epidemiol 2001;8(1):39-56.

6. Mganga H, Lewallen S, Courtright P. Overcoming gender inequity in prevention of blindness and visual impairment in Africa. Middle East African journal of ophthalmology 2011;18(2):98-101.

7. Dean WH, Patel D, Sherwin JC, Metcalfe NH. Follow-Up Survey of Cataract Surgical Coverage and Barriers to Cataract Surgery at Nkhoma, Malawi. Ophthalmic Epidemiology 2011;18(4):171-178.

8. Di Stefano AF. VISION 2020: the right to sight. A global initiative for the elimination of avoidable blindness. Optometry 2001;72(10):619-22.

9. Limburg H, Kumar R, Indrayan A. Rapid assessment of prevalence of cataract blindness at district level. International Journal of Epidemiology 1997;26(5):1049-1054.

10. World Health Organization. Rapid Assessment of Cataract Surgical Services MAPFDEAAFPBRAWPGW, 2001.

11. Limburg H, Meester W. RAAB Instruction Manual. London: International Centre for Eye Health; 2007. http://www.cehjournal.org/files/raab/RAABManualVFPV4.02.pdf

12. Lewallen S, Mousa A, Bassett K, Courtright P. Cataract surgical coverage remains lower in women. British Journal of Ophthalmology 2009;93(3):295-298.

Chapter II: Manuscript

Title: Gender, Blindness, and Cataracts: An Analysis of 11 Rapid Assessment of Avoidable Blindness Surveys in Africa

Authors: Daniel Dewey-Mattia and Paul Courtright, PhD

Abstract

Purpose: The objective of this study was to examine the prevalence of blindness, causes of blindness, and the possible association between gender, blindness, and cataract across 11 regions of Africa.

Methods: Raw data were analyzed from Rapid Assessment for the Avoidable Blindness (RAAB) surveys conducted in Eritrea, The Gambia, Kericho Kenya, Kilimanjaro Tanzania, Southern Malawi, Koulikor Mali, Nakuru Kenya, Western Rwanda, South Africa, South Nyanza Kenya, and Sudan among individuals age 50 and older.

Results: The overall (all 11 surveys) prevalence of bilateral blindness (presenting visual acuity <3/60 in the better eye) was 5.7% (95% CI: 5.2-6.2) for males and 5.0% (95% CI: 4.6-5.5) for females. Comparing male blindness to female blindness, the unadjusted odds ratio (OR) was 1.14 (95% CI: 1.05-1.25) and the age-adjusted OR was 1.07 (95% CI: 0.97-1.17). The overall prevalence of untreated cataract was 9.4% (95% CI: 8.8-9.9). The unadjusted odds ratio (OR) of male cataract to female cataract was 1.00 (95% CI: 0.93-1.07, p=0.9846), while the adjusted OR of male to female cataract controlling for age group was 0.91 (95% CI: 0.85-0.98, p=0.0129). Overall cataract surgical coverage at visual acuity level <6/60 in the better eye was 60.5% for males and 54.5% for females.

Conclusions: The RAAB provides a relatively quick, cost-effective method for estimating the prevalence of blindness, visual impairment, and cataract within district populations. Further validation of the RAAB survey methodology is needed to determine the extent to which previous estimates of blindness and visual impairment may or may not have been overestimated in previous large population-based surveys.

Introduction

A recent report from the World Health Organization (WHO) estimates that 285 million people are visually impaired, defined as a presenting visual acuity (PVA) less than 6/18, and 39 million are blind (PVA less than 3/60) (1). The majority of these individuals are people 50 years and older, who represent 65% and 82% of the visually impaired and blind, respectively. In order to combat global blindness, the WHO launched the "VISION 2020" campaign in 1999 (2). The goal of Vision 2020 is to eliminate blindness due to avoidable causes, which attribute to as much as 80% of impairment, by the year 2020 (1). The initiative has since grown to include more than 60 partnering organizations with programs planned in 40% of all countries (3).

Prior studies, primarily large population-based surveys, have found that women bear a greater burden of blindness than men. A 2001 systematic review and meta-analysis including 44 surveys from 22 countries found an overall age-adjusted odds ratio of blind women to blind men of 1.43 (95% CI: 1.33-1.53) (4). The age-adjusted odds ratio of blind women to blind men was 1.39 (95% CI: 1.20-1.61) in Africa, 1.41 (95% CI: 1.29-1.54) in Asia, and 1.63 (95% CI: 1.30-2.05) in industrialized countries. 64.5% of all blind people (defined as best eye presenting vision of <3/60 in Asian and African countries and

<6/60 in industrialized countries) in the meta-analysis were female and this excess was not found to be only due to gender differences in life expectancy. Recent studies conducted in India, Nepal, Brazil, and China however, have not found a significant association between gender and blindness (5-9).

Cataract remains the leading cause of global blindness, responsible for an estimated 47.8% of cases (10). This proportion is reportedly larger in developing countries and among women (10). However, in Africa (and many developing countries) women generally account for fewer than half of cataract operations and there is considerable evidence that barriers exist which prevent access to eye care and cataract services by females. A population-based survey conducted within a 10-mile radius of Nkhoma Eye Hospital in Malawi found that among women with cataract and VA less than or equal to 6/60, the major barrier to surgery was cost (58.3%) (11). Lack of awareness (18.6%) and fear of surgery (15.4%) were also commonly referenced as primary reasons for a lack of prior surgery (11). In this population, cataract surgical coverage among men was 100% but only 73% among women. The cataract surgical coverage (CSC) is defined as the proportion of individuals who have had cataract surgery on at least one eye relative to the total number of people with cataract in at least one eye.

Access to cataract surgery has been shown to be associated with overall quality of life and economic status. Thus, it is important to estimate the gender-specific prevalence of both blindness and cataract, and whether women are at a disadvantage with respect to treatment for cataract. Such information will help to guide future public health strategies and allocation of medical resources.

Since large population based surveys are costly, time-consuming, and require expertise often unavailable in developing countries, a more rapid and cost-effective survey methodology is needed to estimate blindness in these regions and evaluate the impact of the Vision 2020 and other initiatives. The Rapid Assessment of Avoidable Blindness (RAAB) survey uses population proportional-to-size sampling to select a representative group of people aged 50 years or older in districts of 0.5 to 5 million people. These administrative districts are defined as part of the Vision 2020 initiative.

The RAAB survey is conducted as a door-to-door survey using basic ophthalmic equipment (at most a direct ophthalmoscope and a portable slit lamp). The sampling frame is limited to individuals 50 years and older because the prevalence of blindness in people 50 years of older is much higher than among younger individuals. The objective of this secondary analysis of 11 RAAB surveys conducted in Africa is to examine the overall prevalence of blindness and causes of blindness with a specific focus on the relationship between gender and visual impairment/blindness due to cataract. The article will also address the association between CSC and gender to examine if women (or men) are disproportionately receiving fewer services.

Methods

A retrospective secondary analysis of cross-sectional survey data was performed from previously published population based RAAB studies in The Gambia, Southern Malawi, Western Rwanda, Nakuru Kenya, Kilimanjaro Tanzania, Eritrea, and unpublished RAAB studies in South Africa, South Nyanza Kenya, Kericho Kenya, Mali, and Sudan (12-17). Data were obtained in Microsoft Office Excel (Microsoft, Redmund, Washington) files created from RAAB forms filed out by trained researchers who attended a standardized workshop and participated in published RAAB studies. Excel data files were imported into SAS 9.3 for Windows (SAS Institute, Inc., Cary, North Carolina) for analysis.

Details of the RAAB survey methodology has been described in previous literature (18, 19). Clusters containing about 50 (target of 40-60) people aged 50 years and older are selected through probability proportionate to size sampling. When there were more individuals 50 years and older than needed in the selected population unit, households within clusters were selected via compact segment sampling.

Examination and data collection

Each participant underwent a standard eye examination in each eye with VA graded into 6 categories (≥6/18, <6/18 but ≥6/60, <6/60 but ≥3/60, <3/60 but ≥1/60, light perception, or no light perception). VA was assessed using a Snellen tumbling 'E' chart with an optotype size 6/18 on one side and 6/30 on the other side at a 3 or 6 meter distance during daylight hours and with best correction available. When presenting visual acuity (PVA) was deemed less than 6/18 in either eye, a pinhole VA was obtained. In cases in which VA improved to at least 6/18 with a pin-hole, the primary cause of visual impairment was recorded as refractive error.

If VA did not improve to at least 6/18 with pin-hole, additional examination of the anterior segment was performed by an ophthalmologist. Lens opacity was measured in both eyes using direct ophthalmoscopy in a dark or shaded area without pharmacologic dilation and categorized as either 'normal lens', 'obvious lens opacity', 'lens absent (aphakia), or ‘IOL implantation’. Eyes in which significant corneal opacification impaired viewing of the lens were recorded as ‘no view of lens’.

Eyes which were classified as ‘normal lens’ or ‘minimal lens opacity’ and no other clear cause of reduced vision were then examined via fundoscopy with a mydriatic eye drop. Glaucoma was listed as the primary cause of impairment if the optic cup-to-disc ratio was greater than 0.6. Once the disorders and underlying causes of impairment were identified for each eye, the ophthalmologist determined the principal cause of low vision in the person. When multiple causes of visual impairment were observed, the most treatable or preventable condition was deemed to be the primary cause of vision loss. The recommended choice of principal disorder with respect to treatability/preventability for RAAB surveys follows WHO rankings of 1) Refractive error, 2) Cataract, 3) Uncorrected aphakia, 4) Surgery related complications, 5) Preventable corneal opacities and phthisis, 6) (Primary) glaucoma, 7) Other posterior segment disorders.

Individuals who had undergone cataract surgery were asked about the time and place of their surgery and their satisfaction with the surgery. Those who needed cataract surgery were asked about why they had not received surgery. When possible, if eligible individuals refused to be examined, were unable to communicate, or were unavailable upon return visits, a relative or neighbor was asked whether they believed the individual was not blind, had blindness due to cataract, blindness due to other causes, or had been operated for cataract. Use of replacement subjects was avoided due to the potential over-sampling of people with poor vision who are more likely to be at home compared to people with good vision.

Statistical Analyses

The primary analysis aimed to determine the overall and gender-specific prevalence of blindness, visual impairment, and untreated visually significant lens opacity. All statistical analyses were conducted using SAS 9.3 (SAS Institute Inc., Cary, NC, USA). Five-year age groups were created beginning at age 50 at the time of examination or prior operation with one group for patients aged 85 and older to determine the age group-specific prevalence of cataract and visual impairment. The distribution of age as a continuous variable was assessed for normality using a normal probability plot and Kolmogorov-Smirnov test. Student t-tests and chi-square tests were conducted to access age differences between groups. Unadjusted prevalence of presenting bilateral blindness (VA less than 3/60 in the better eye) was calculated for each region using the PROC SURVEYMEANS procedure in SAS along with the CLUSTER statement to account for the cluster sampling design. 95% confidence intervals were based off Taylor series (linearization) adjustments to variance estimates. Non-respondent individuals were excluded from visual impairment and cataract prevalence estimates due to the limited information available without an in-person examination.

Crude odds ratios (cOR) for the association between sex and both blindness and cataract unadjusted for age were estimated using the PROC FREQ procedure in SAS. Asymptotic confidence intervals for the cORs were obtained and the continuity adjusted chi-square was used to estimate p-values. Age-adjusted odds ratios (aOR) using the 8 predefined age-groups were obtained for the association between blindness and sex and cataract and sex using the PROC SURVEYLOGISTIC procedure in SAS. 95% Wald confidence intervals were used to estimate precision of the aOR estimates and Wald Chi-square values were used to estimate p-values.

Gender-specific cataract surgical coverage was calculated as the number of people with at least one operated eye divided by the number of people with at least one operated eye in addition to the number of people with PVA <6/60 in the better eye due to cataract. Patients that had received surgery were assumed to have visual acuity of less than 6/60 at the time of surgery for calculations of cataract surgical coverage, since the majority of cataract operations in Africa are believed to be performed below this VA level.

Ethical Approval

Consent was obtained from appropriate national, regional, and village administration before conduction of each RAAB survey included in this study. All Excel data files provided from the primary researchers were void of any possible personal identifiers. In each survey, individuals with treatable conditions were referred for treatment after examination.

Results

The total surveyed sample included 38639 examined individuals (96.1% of eligible participants). 17583 (43.75%) were male and 22607 (56.25%) were female. A total of 811 clusters were included, ranging in size from 6 to 58 examined individuals.

1018 (2.53%) of potential participants were unavailable for examination at the initial and any subsequent visits, 287 (0.71%) refused to participate, and 262 (0.65%) were unable to communicate. Ocular history information was obtained from a neighbor or relative for 1547 (99.7%) of those that were eligible but did not participate. The proxies were asked if they believed the unexamined individual had visual impairment that limits social interaction (blindness). 46 (2.96%) were believed (by the interviewee) to have blindness due to cataract, 40 (2.58%) were said to have bilateral blindness due to other causes, and 2 (0.12%) were said to have bilateral blindness due to cataract in one eye and blindness due to another cause in the other eye. In addition, 95 (6.12%) were reported to have had a cataract operation in at least one eye with 30 (31.5%) of those operated on having had surgery in both eyes.

Age and gender characteristics of all examined individuals across the 11 regions of Africa are shown in Table 1. Recorded ages of both sexes ranged from 50 to 99 (the upper limit on the RAAB form). The overall distribution of age approximated a normal distribution (Kolmogorov-Smirnov test, $D=0.125$, $p<0.01$) with an apparent overrepresentation at 5-year cut-offs (e.g. 50, 55, 60, etc.) likely due to participant or examiner preference for estimation at these values across all regions. The gender-specific age distribution also approximated a normal distribution for both males (Kolmogorov-Smirnov test, $D=0.118$, $p<0.01$) and females (Kolmogorov-Smirnov test, $D=0.130$, $p<0.01$). The overall mean age of examined subjects was 63.9 years (95% CI: 63.8-64.1) for males and 62.9 years (95% CI: 62.8-63.1) for females and this age difference was statistically significant (Pooled t-test, $t=8.70$, $p<0.001$). In addition, a higher proportion of women were in the younger 5-year age groupings compared to men ($\chi^2=102.2$, $df=7$, $p<0.001$).

Among unexamined males and females, the mean age was 64.9 (95% CI: 64.2-65.6) and 64.3 (95% CI: 63.5-65.2) respectively. The distribution of age among unexamined males (Kolmogorov-Smirnov test, D=0.133, p<0.01) and females (Kolmogorov-Smirnov test, D=0.147, p<0.01) both approximated a normal distribution. The age difference between examined and unexamined males (Pooled t-test, t=2.43, p=0.015) and slightly larger difference in mean age between examined and unexamined females (Pooled t-test, t=3.56, p<0.001) were both statistically significant.

Prevalence of Blindness and Visual Impairment

The overall crude prevalence of bilateral blindness (PVA<3/60 in the better eye) was 5.3% (95% CI: 5.0-5.7). The prevalence of blindness, severe visual impairment, and moderate visual impairment by region is summarized in Table 2. The highest prevalence of bilateral blindness was observed in Koulikor Mali (11.1%, 95% CI: 9.6-12.6) and the lowest was found in Western Rwanda (1.7%, 95% CI: 1.1-2.4). As shown in Table 3, crude prevalence of bilateral blindness increased with increasing age across all 8 age groups for both males and females.

Severe visual impairment in the better eye (PVA<6/60 but ≥3/60) was observed in 2.5% (95% CI: 2.31-2.7) of individuals with the highest non-gender specific prevalence in Koulikor Mali (4.5%, 95% CI: 3.4-5.5) and the lowest in Kericho Kenya (1.6%, 95% CI: 1.0-2.3). Crude non-gender specific prevalence of moderate visual impairment in the better eye (PVA<6/18 but ≥6/60) was also highest in Koulikor Mali (12.7%, 95% CI: 11.3-14.3) and was lowest in Western Rwanda (4.9%, 95% CI: 4.0-5.9).

Gender and Visual Impairment

A summary of the gender-specific crude prevalence of blindness, severe visual impairment, and moderate visual impairment by region is shown in Table 4. The crude (not controlling for age group) odds ratio of bilateral blindness among men to blindness among women was 1.14 (95% CI: 1.05-1.25, p=0.0033), however after controlling for age the odds ratio of bilateral blindness among men to blindness among women was lowered to 1.07 (95% CI: 0.97-1.17, p=0.1830) reflecting the older age distribution of male participants.

Causes of Visual Impairment

Gender-specific primary causes of bilateral blindness, bilateral severe visual impairment, and bilateral moderate visual impairment are summarized in Table 5. The predominant cause of visual impairment at all three levels was untreated cataract for both males and females. However, a higher proportion of females had visual impairment (at all three levels) that was due to untreated cataract, while males were likely to have glaucoma as their primary cause of visual impairment compared to females.

Gender and Visual Impairment due to Cataract

The crude prevalence of cataract (obvious lens opacity, obscuring a clear red reflex) as the principal cause of PVA<6/18 was 9.4% (95% CI: 8.8-9.9) for all examined participants. Among men the crude prevalence was 9.4% (95% CI: 8.7-10.0) and among women the crude prevalence was also 9.4% (95% CI: 8.8-10.0) as is shown in Table 6. The unadjusted odds ratio of male untreated cataract to female untreated cataract was 1.00 (95% CI: 0.93-1.07, p=0.9846). The adjusted odds ratio of male to female cataract controlling for age group was 0.91 (95% CI: 0.85-0.98, p=0.0129) once again reflecting the older distribution of males in the sample.

Cataract Surgical Coverage

Gender-specific cataract surgical coverage (CSC) at PVA<6/60 and age-adjusted odds ratios comparing male CSC to female CSC for each of the 11 regions are shown in Table 7. Overall across all 11 regions, CSC at PVA<6/60 was higher among males (60.5%, 95% CI: 57.8%-63.3%) than females (54.5%, 95% CI: 51.8%-57.2%). The lowest CSC for males (27.4%) was seen in South Africa and the lowest CSC for females (26.1%) was in Southern Malawi. The highest CSC for males (82.9%) and females (75.0%) was exhibited in Kericho, Kenya.

Discussion

The prevalence of blindness and visual impairment observed in this study was lower than what has been reported in some prior population-based surveys in Africa. Likewise, previously published RAAB surveys, including those in this analysis, have reported a prevalence of blindness among individuals 50 years and older that was lower than the 2002 WHO estimates of 9% for the Afr-D and Afr-E subregions (10, 12, 13, 15).

One possible explanation for the lower prevalence of blindness reported in RAAB surveys is their use of compact segment sampling rather than the random walk method of household selection which is commonly used in population-based sampling and may result in an oversampling of blind individuals. Since village leaders and guides may be aware of the residences containing members of their community that are blind, they may preferentially lead survey teams employing the random walk method towards these households.

Crude prevalence of bilateral blindness varied significantly by region for both males and females. Among males 50 years and older examined, bilateral blindness was as high as 10.4% (95% CI: 8.0-12.8) in Koulikor Mali and as low as 1.5% (95% CI: 0.8-2.1) in Kericho Kenya. The highest prevalence among females was also observed in Koulikor Mali (11.6%, 95% CI: 9.7-13.4) while the lowest (1.6, 95% CI: 0.9-2.4) was found in Western Province, Rwanda, although it is worth noting this population had a low sample size and only 17 female cases and 17 male cases.

Untreated cataract was the predominant cause of PVA loss across all three levels of visual impairment for both genders, a finding that is consistent with previous reports (10). Although the crude prevalence of untreated cataract was nearly identical for males and females (cOR=1.00, 95% CI: 0.93-1.07, reference group=females), the age-adjusted odds ratio of untreated cataract among males to untreated cataract among females of 0.91 (95% CI: 0.85-0.98, p=0.0129) however was statistically significant. This difference in the age-adjusted OR of untreated cataract may reflect the lower cataract surgical coverage among women in Africa which has been reported previously and was also seen in this study (20).

Limitations

There are a number of limitations to the results of this analysis. RAAB methodology includes an examination of the lens using the red reflex and does not follow any accepted cataract grading schemes. It is also possible that the lens examination relying on an ‘obvious lens opacity’ for designation of cataract as the main cause of PVA<6/18 may have led to an underestimation of cataract prevalence. Furthermore, eyes with lens opacity not considered to be the primary cause of visual impairment, such as cases of uncorrected refractive error, which is recommended to be ranked higher among principal causes following the RAAB methodology, were not included as cataracts leading to a possible underestimation of cataract prevalence (21). Nevertheless, recent published studies within African populations, including those in this analysis, have reported a very low prevalence of blindness due to uncorrected refractive error (22). Thus, the underestimation of blindness due to cataract because of comorbid untreated refractive error could be fairly small.

The presence of trachoma, other corneal opacities, and phthisis may also have either increased or decreased the estimated prevalence of untreated cataract as the principal cause of blindness both via their obstruction of a view of the lens and their classification as less treatable/preventable conditions. Likewise, the presence of comorbid posterior segment disease and lens opacity may have increased prevalence of estimates of blindness due to cataract by exacerbating visual impairment or decreased prevalence estimates when marked as the principal cause in possible cases of cataract noted as ‘minimal lens opacity’ which did not obscure a clear red reflex. Differences in such determinations of the principal cause of blindness between regions and examiners may affect comparisons between surveys.

Variations in age structure between regions of Africa may also strongly influence estimates of blindness and cataract prevalence as could the slightly higher reported age of unexamined compared to examined individuals in this study. Furthermore, because of the

RAAB is not a detailed large-scale blindness survey, these results do not provide reliable estimates of specific, less common, causes of blindness and visual impairment other than cataract.

Cataract surgical coverage was calculated only for people with blindness or severe visual impairment, as has been done in previous publications of the authors (20). Without any information on post-operative visual acuity, this assumes that only a small fraction of cataracts in Africa are operated at a visual acuity above 6/60. However, this may result in an overestimation of CSC for individuals with PVA less than 6/60 due to an unknown proportion of cases that were operated on above this level.

Conclusion

The lower cataract surgical coverage among African women evident from this analysis and previous studies suggests that the prevalence of untreated cataract among women can be significantly reduced through increased access to surgical services (20).

The Rapid Assessment of Avoidable Blindness provides a relatively quick, cost-effective method for estimating the prevalence of blindness, visual impairment, and cataract within a district population. However, further validation of the RAAB survey methodology is needed to determine the extent to which previous estimates of blindness and visual impairment may or may not have been overestimated in WHO estimates and other large population-based surveys.

References

1. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. The British journal of ophthalmology 2012;96(5):614-8.

2. Garms RC. The global initiative: launch of Vision 2020. Community eye health / International Centre for Eye Health 1998;11(28):56-7.

3. Resnikoff S, Kocur I, Etya'Ale DE, Ukety TO. Vision 2020 - the Right to Sight. Annals of Tropical Medicine and Parasitology 2008;102:3-5.

4. Abou-Gareeb I, Lewallen S, Bassett K, Courtright P. Gender and blindness: a meta-analysis of population-based prevalence surveys. Ophthalmic Epidemiol 2001;8(1):39-56.

5. Murthy GV, Vashist P, John N, Pokharel G, Ellwein LB. Prevelence and causes of visual impairment and blindness in older adults in an area of India with a high cataract surgical rate. Ophthalmic Epidemiology 2010;17(4):185-95.

6. Kandel RP, Sapkota YD, Sherchan A, Sharma MK, Aghajanian J, Bassett KL. Cataract surgical outcome and predictors of outcome in Lumbini Zone and Chitwan District of Nepal. Ophthalmic Epidemiology 2010;17(5):276-81.

7. Salomao SR, Cinoto RW, Berezovsky A, Araujo-Filho A, Mitsuhiro MR, Mendieta L, et al. Prevalence and causes of vision impairment and blindness in older adults in Brazil: the Sao Paulo Eye Study. Ophthalmic Epidemiology 2008;15(3):167-75.

8. Huang S, Zheng Y, Foster PJ, Huang W, He M. Prevalence and causes of visual impairment in Chinese adults in urban southern China. Archives of Ophthalmology 2009;127(10):1362-7.

9. Wu M, Yip JL, Kuper H. Rapid assessment of avoidable blindness in Kunming, china. Ophthalmology 2008;115(6):969-74.

10. Resnikoff S, Pascolini D, Etya'ale D, Kocur I, Pararajasegaram R, Pokharel GP, et al. Global data on visual impairment in the year 2002. Bulletin of the World Health Organization 2004;82(11):844-851.

11. Dean WH, Patel D, Sherwin JC, Metcalfe NH. Follow-Up Survey of Cataract Surgical Coverage and Barriers to Cataract Surgery at Nkhoma, Malawi. Ophthalmic Epidemiology 2011;18(4):171-178.

12. Faal H, Minassian DC, Dolin PJ, Mohamed AA, Ajewole J, Johnson GJ. Evaluation of a national eye care programme: re-survey after 10 years. The British journal of ophthalmology 2000;84(9):948-51.

13. Kalua K, Lindfield R, Mtupanyama M, Mtumodzi D, Msiska V. Findings from a Rapid Assessment of Avoidable Blindness (RAAB) in Southern Malawi. Plos One 2011;6(4).

14. Mathenge W, Nkurikiye J, Limburg H, Kuper H. Rapid assessment of avoidable blindness in western Rwanda: Blindness in a postconflict setting. Plos Medicine 2007;4(7):1187-1194.

15. Mathenge W, Kuper H, Limburg H, Polack S, Onyango O, Nyaga G, et al. Rapid assessment of avoidable blindness in Nakuru District, Kenya. Ophthalmology 2007;114(3):599-605.

16. Habiyakire C, Kabona G, Courtright P, Lewallen S. Rapid Assessment of Avoidable Blindness and Cataract Surgical Services in Kilimanjaro Region, Tanzania. Ophthalmic Epidemiology 2010;17(2):90-94.

17. Muller A, Zerom M, Limburg H, Ghebrat Y, Meresie G, Fessahazion K, et al. Results of a Rapid Assessment of Avoidable Blindness (RAAB) in Eritrea. Ophthalmic Epidemiology 2011;18(3):103-108.

18. Dineen B, Foster A, Faal H. A proposed rapid methodology to assess the prevalence and causes of blindness and visual impairment. Ophthalmic Epidemiology 2006;13(1):31-34.

19. Kuper H, Polack S, Limburg H. Rapid assessment of avoidable blindness. Community eye health / International Centre for Eye Health 2006;19(60):68-9.

20. Lewallen S, Mousa A, Bassett K, Courtright P. Cataract surgical coverage remains lower in women. British Journal of Ophthalmology 2009;93(3):295-298.

21. Limburg H, Meester W. RAAB Instruction Manual. London: International Centre for Eye Health; 2007. http://www.cehjournal.org/files/raab/RAABManualVFPV4.02.pdf

22. Sherwin JC, Lewallen S, Courtright P. Blindness and visual impairment due to uncorrected refractive error in sub-Saharan Africa: review of recent population-based studies. The British journal of ophthalmology 2012.

Tables

Table 1. Age and gender composition of examined participants across all 11 RAAB surveys

	Males		Females		Total	
Age Group	n	%	n	%	n	%
50 to 54	3641	21.6%	5422	24.9%	9063	23.5%
55 to 59	2767	16.4%	3759	17.2%	6526	16.9%
60 to 64	2962	17.6%	3885	17.8%	6847	17.7%
65 to 69	2179	12.9%	2606	12.0%	4785	12.4%
70 to 74	2203	13.1%	2571	11.8%	4774	12.4%
75 to 79	1311	7.8%	1406	6.4%	2717	7.0%
80 to 84	967	5.7%	1274	5.8%	2241	5.8%
85 and older	802	4.8%	884	4.1%	1686	4.4%
Total	16832	100.0%	21807	100.0%	38639	100.0%

Table 2. Gender-specific crude prevalence of different levels of visual impairment with available correction in the better eye in persons aged 50 years and older by region

		Bilateral Blindness (<3/60)		Bilateral Severe Visual Impairment (<6/60 - ≥3/60)		Bilateral Moderate Visual Impairment (<6/18 - ≥6/60)	
Study Site		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Eritrea	Males	133	10.0 (8.4-11.6)	54	4.1 (2.8-5.4)	181	13.7 (11.6-15.7)
	Females	150	8.2 (6.7-9.7)	49	2.7 (2.0-3.4)	198	10.8 (9.2-12.4)
The Gambia	Males	11	3.8 (2.0-5.5)	7	2.4 (0.3-4.5)	31	10.7 (6.3-15.0)
	Females	20	5.3 (3.6-7.1)	14	3.7 (2.2-5.3)	40	10.7 (7.0-14.4)
Kericho, Kenya	Males	18	1.5 (0.8-2.1)	19	1.6 (0.7-2.4)	70	5.8 (4.2-7.4)
	Females	31	2.6 (1.5-3.6)	21	1.7 (0.9-2.6)	61	5.0 (3.7-6.4)
Kilimanjaro, Tanzania	Males	40	2.7 (1.8-3.7)	16	1.1 (0.6-1.6)	79	5.4 (4.2-6.6)
	Females	44	2.2 (1.5-3.0)	18	0.9 (0.5-1.3)	107	5.4 (4.4-6.4)
Southern Malawi	Males	47	3.6 (2.5-4.8)	41	3.2 (2.1-4.2)	126	9.7 (7.9-11.6)
	Females	67	3.1 (2.2-4.1)	53	2.5 (1.7-3.2)	200	9.4 (7.9-10.9)
Koulikor, Mali	Males	111	10.4 (8.0-12.8)	41	3.9 (2.4-5.3)	129	12.1 (10.0-14.3)
	Females	159	11.6 (9.7-13.4)	68	4.9 (3.7-6.2)	182	13.2 (11.2-15.3)
Nakuru, Kenya	Males	32	1.9 (1.2-2.6)	32	1.9 (1.2-2.6)	94	5.7 (4.4-6.9)
	Females	37	2.0 (1.4-2.6)	21	1.1 (0.7-1.6)	109	5.9 (4.8-7.1)
Western Province, Rwanda	Males	17	1.9 (0.9-2.8)	13	1.4 (0.6-2.2)	37	4.1 (2.6-5.5)
	Females	17	1.6 (0.9-2.4)	11	1.1 (0.5-1.7)	59	5.7 (4.5-6.9)
South Africa	Males	71	4.7 (3.6-5.8)	33	2.2 (1.3-3.0)	102	6.7 (5.4-8.0)
	Females	93	2.7 (2.1-3.3)	68	2.0 (1.5-2.4)	185	5.4 (4.5-6.2)
South Nyanza, Kenya	Males	37	3.4 (2.0-4.8)	14	1.3 (0.6-2.0)	62	5.7 (4.1-7.3)
	Females	68	4.5 (3.3-5.6)	26	1.7 (1.1-2.4)	71	4.7 (3.8-5.6)
Sudan	Males	447	8.9 (7.8-10.0)	186	3.7 (3.1-4.3)	565	11.3 (10.2-12.3)
	Females	414	8.2 (7.1-9.3)	168	3.3 (2.7-3.9)	519	10.3 (9.3-11.2)

Table 3. Prevalence of bilateral blindness (PVA<3/60) by age and gender across all 11 regions

	Males		Females		Total	
Age Group	n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
50 to 54	39	1.1 (0.7-1.4)	57	1.1 (0.8-1.3)	96	1.1 (0.8-1.3)
55 to 59	43	1.6 (1.1-2.1)	48	1.3 (0.9-1.7)	91	1.4 (1.1-1.7)
60 to 64	95	3.2 (2.5-3.9)	104	2.7 (2.1-3.2)	199	2.9 (2.4-3.4)
65 to 69	98	4.5 (3.5-5.5)	103	4.0 (3.1-4.8)	201	4.2 (3.5-4.9)
70 to 74	170	7.7 (6.5-9.0)	194	7.5 (6.4-8.7)	364	7.6 (6.7-8.6)
75 to 79	131	10.0 (8.3-11.7)	148	10.5 (8.6-12.5)	279	10.3 (8.9-11.6)
80 to 84	188	19.4 (16.4-22.5)	226	17.7 (15.3-20.1)	414	18.5 (16.4-20.5)
85 and older	200	24.9 (21.7-28.2)	220	24.9 (21.7-28.0)	420	24.9 (22.4-27.4)

Table 4. Associations between blindness (PVA<3/60 in the better eye) and sex unadjusted for age (cOR) and adjusted for age (aOR).

	Bilaterally Blindness (PVA<3/60)		No Bilateral Blindness (PVA>3/60)		cOR (95% CI)	p-value	aOR (95% CI)	p-value
	n	% (95% CI)	n	%				
Male	964	5.7 (5.2-6.2)	15868	94.3%	1.14 (1.05-1.25)	0.0033	1.07 (0.97-1.17)	0.1830
Female	1100	5.0 (4.6-5.5)	20707	95.0%				
Total	2064	5.3 (5.0-5.7)	36575	94.7%				

Table 5. Primary cause of blindness and visual impairment by gender across all 11 RAAB surveys

Cause		Bilaterally Blindness (PVA<3/60)		Bilateral Severe Visual Impairment (<6/60 - ≥3/60)		Bilateral Moderate Visual Impairment (<6/18 - ≥6/60)	
		n	% (95% CI)	n	% (95% CI)	n	% (95% CI)
Refractive Error	Males	14	1.5 (0.7-2.2)	37	8.1 (5.6-10.7)	524	35.5 (32.9-38.1)
	Females	11	1.0 (0.4-1.6)	46	8.9 (6.3-11.5)	560	32.4 (29.9-34.8)
Cataract, Untreated	Males	464	48.1 (44.8-51.5)	293	64.3 (59.8-68.8)	698	47.3 (44.4-50.2)
	Females	664	60.4 (57.4-63.3)	340	65.8 (61.3-70.2)	883	51.0 (48.3-53.7)
Aphakia, Uncorrected	Males	23	2.4 (1.3-3.4)	11	2.4 (1.0-3.8)	24	1.6 (0.9-2.3)
	Females	17	1.5 (0.8-2.3)	18	3.5 (1.9-5.1)	16	0.9 (0.5-1.4)
Surgical Complications	Males	38	3.9 (2.7-5.2)	11	2.4 (1.0-3.8)	37	2.5 (1.7-3.3)
	Females	33	3.0 (2.0-4.0)	18	3.5 (1.8-5.1)	27	1.6 (1.0-2.1)
Trachoma	Males	10	1.0 (0.4-1.7)	3	0.7 (0.0-1.4)	1	0.1 (0.0-0.2)
	Females	26	2.4 (1.5-3.2)	8	1.5 (0.4-2.7)	14	0.8 (0.4-1.2)
Phthisis	Males	39	4.0 (2.7-5.4)	2	0.4 (0.0-1.0)	1	0.1 (0.0-0.2)
	Females	27	2.5 (1.5-3.4)	2	0.4 (0.0-0.9)	4	0.2 (0.0-0.5)
Other Corneal Scar	Males	92	9.5 (7.7-11.4)	17	3.7 (1.9-5.5)	32	2.2 (1.4-2.9)
	Females	80	7.3 (5.8-8.8)	13	2.5 (1.2-3.9)	33	1.9 (1.3-2.6)
Globe Abnormality	Males	11	1.1 (0.4-1.9)	0	0.0	7	0.5 (0.1-0.8)
	Females	9	0.8 (0.3-1.3)	4	0.8 (0.0-1.5)	8	0.5 (0.1-0.8)
Glaucoma	Males	185	19.2 (16.4-21.9)	40	8.8 (6.2-11.4)	56	3.8 (2.8-4.8)
	Females	137	12.5 (10.4-14.5)	25	4.8 (3.0-6.6)	60	3.5 (2.6-4.3)
Diabetic Retinopathy	Males	9	0.9 (0.3-1.6)	4	0.9 (0.0-1.7)	13	0.9 (0.4-1.4)
	Females	3	0.3 (0.0-0.6)	2	0.4 (0.0-0.9)	8	0.5 (0.1-0.8)
Age-related Macular Degeneration	Males	17	1.8 (0.9-2.6)	6	1.3 (0.3-2.4)	18	1.2 (0.6-1.8)
	Females	38	3.5 (2.3-4.6)	17	3.3 (1.8-4.8)	35	2.0 (1.3-2.7)
Onchocerciasis	Males	6	0.6 (0.0-1.3)	1	0.2 (0.0-0.7)	3	0.2 (0.0-0.4)
	Females	1	0.1 (0.0-0.3)	0	0.0	5	0.3 (0.0-0.5)
Other Posterior Segment/CNS	Males	56	5.8 (4.3-7.4)	31	6.8 (4.5-9.1)	51	3.5 (2.5-4.5)
	Females	53	4.8 (3.5-6.1)	24	4.6 (2.7-6.6)	71	4.1 (3.1-5.1)

Table 6. Associations between untreated cataract with PVA<3/18 in the better eye and sex unadjusted for age (cOR) and adjusted for age (aOR).

	Untreated Cataract (PVA<3/18)		No Untreated Cataract		cOR (95% CI)	p-value	aOR (95% CI)	p-value
Male	1578	9.38%	15254	90.63%	1.00 (0.93-1.07)	0.9846	0.91 (0.85-0.98)	0.0129
Female	2042	9.36%	19765	90.64%				
Total	3620	9.37%	35019	90.63%				

Table 7. Gender-specific cataract surgical coverage (CSC) at PVA <6/60 in the better eye, 95% confidence intervals, and age adjusted odds ratios (aOR)

	CSC at PVA<6/60		
Region	Males (95% CI)	Females (95% CI)	aOR (95% CI)
Eritrea	61.7% (54.3%-69.1%)	60.1% (53.9%-66.4%)	1.23 (0.85-1.76
The Gambia	60.7% (37.4%-84.0%)	50.0% (30.0%-70.0%)	1.30 (0.41-4.1)
Kericho, Kenya	82.9% (74.6%-91.3%)	75.0% (65.8%-84.2%)	1.54 (0.69-3.45)
Kilimanjaro, Tanzania	69.7% (59.6%-79.7%)	68.6% (59.0%-78.3%)	1.02 (0.57-1.84)
Southern Malawi	42.6% (31.0%-54.3%)	26.1% (15.6%-36.6%)	2.01 (0.98-4.14)
Koulikor, Mali	49.7% (41.9%-57.4%)	36.6% (29.2%-44.1%)	1.77 (1.15-2.73)
Nakuru, Kenya	64.4% (53.9%-74.9%)	63.8% (53.8%-73.7%)	1.15 (0.57-2.31)
Western Province, Rwanda	33.3% (16.8%-49.8%)	30.8% (15.3%-46.3%)	0.80 (0.22-2.87)
South Africa	27.4% (16.8%-37.9%)	36.9% (29.3%-44.5%)	0.60 (0.34-1.07)
South Nyanza, Kenya	50.8% (36.2%-65.5%)	39.1% (28.4%-49.8%)	1.51 (0.67-3.38)
Sudan	65.4% (61.4%-69.4%)	62.6% (58.1%-67.1%)	1.12 (0.91-1.38)
Total	60.5% (57.8%-63.3%)	54.5% (51.8%-57.2%)	1.30 (1.14-1.48)

Chapter III

Public Health Implications

Access to Eye Care Services

Access to adequate eye care services is lacking throughout many regions of Africa. For example, in 2008, the country of Malawi had a population of 14.8 million (World Bank 2008) but only 7 trained ophthalmologists. Similarly, Rwanda, a country of 8.1 million, has only 10 ophthalmologists. It may be necessary for eye care service providers and policy makers (including the Vision 2020) to refocus their efforts on those areas with the highest prevalence of avoidable blindness and the lowest available resources, such as Malawi and other regions of sub-Saharan Africa.

Gender Barriers

The lack of eye care services in Africa may disproportionately affect women due to the societal barriers they face. A recent systematic review and meta-analysis found that cataract surgical coverage remains lower in women, especially in low- and middle-income countries.(1) Examining differences in sex-specific cataract surgical coverage, the authors estimated that around 11% of blindness and severe visual impairment would be eliminated in low and middle-income countries if women were to receive the same surgical coverage as men.

Although the results of this study did not find a large gender difference in the age-adjusted prevalence of untreated cataract, it is important for public health professionals to advocate increased cataract surgical coverage for women, especially those of lower socio-economic status or in developing countries. It is possible that men in our study are more likely to exhibit additional risk factors for untreated cataract at a higher rate than women, thus making up for their higher surgical rates.

Analysis of Cluster Sampling

Calculation of prevalence and 95% confidence intervals for prevalence in this study took into account possible excess error due to the stratified cluster random sampling study design by using the algorithms imbedded in the SAS 9.3 software. Almost all previously published RAAB surveys were analyzed using a different formula for the sampling error for the prevalence estimate in cluster sampling which is described elsewhere.(2) The Taylor series (linearization) method provided by the SAS software package and used in such complex survey designs such as NHANES may (or may not) offer a more accurate approximation of correction to the variance in cluster sampling methodology compared to the fixed design effect method used in the RAAB software.

SAS 9.3 Survey means only requires uses only the primary sampling units, in this case the clusters, for estimation of the standard error. SAS 9.1 Survey procedures calculate the degrees of freedom as the clusters in the non-empty strata minus the number of non-empty strata. Since there were no empty strata (all clusters contained individuals), SAS did not incorrectly increase the degrees of freedom.

Summary/Future Directions

Due to the limited financial decision making authority of African women, factors such as limited transportation services can disproportionately impact their access to care.(3) Outreach programs including transport to hospitals for surgical care for treatable conditions, although costly, have shown efficacy in approving services to women.(4)

Cataract surgeries are a relatively routine outpatient procedure and by removing barriers and improving access to care, policymakers and healthcare providers can drastically increase the quality of life among these East African populations.

References

1. Lewallen S. Poverty and Cataract-A Deeper Look at a Complex Issue. Plos Medicine 2008;5(12):1647-1648.

2. Bennett S, Woods T, Liyanage WM, Smith DL. A simplified general method for cluster-sample surveys of health in developing countries. World Health Stat Q 1991;44(3):98-106.

3. Mganga H, Lewallen S, Courtright P. Overcoming gender inequity in prevention of blindness and visual impairment in Africa. Middle East African journal of ophthalmology 2011;18(2):98-101.

4. Jefferis JM, Bowman RJ, Hassan HG, Hall AB, Lewallen S. Use of cataract services in eastern Africa--a study from Tanzania. Ophthalmic Epidemiology 2008;15(1):62-5.