Title: A systematic review of the proportion of blindness in the population 50 years and older from total population-based surveys of blindness and visual impairment

Running Head: Total population surveys: blind proportion >50yrs

Authors (John Buchan is the corresponding author – details as below)

1. Edmund Mushumbusi: International Centre for Eye Health, Faculty of Infectious and Tropical Diseases, London School of Hygiene and Tropical Medicine, Keppel Street. London, UK, WC1E 7HT. Phone; +44 (0) 2076368636,Email;eddferd@gmail.com
2. John Buchan: Clinical Research Department, International Centre for Eye Health, London School of Hygiene and Tropical Medicine, Keppel Street, London, UK, WC1E 7HT. Phone; +44 (0) 2076368636, Email; John.Buchan@lshtm.ac.uk

   ORCiD 0000-0003-1005-7011
3. Islay Mactaggart: Clinical Research Department, International Centre for Eye Health, London School of Hygiene and Tropical Medicine, Keppel Street, London, UK, WC1E 7HT. Phone;+44 (0) 2076368636, Email; Islay.Mactaggart@lshtm.ac.uk
4. David Macleod: Clinical Research Department, International Centre for Eye Health, London School of Hygiene and Tropical Medicine, Keppel Street, London, UK, WC1E 7HT. Phone;+44 (0) 2076368636, Email; david.macleod@lshtm.ac.uk
5. Allen Foster: Clinical Research Department, International Centre for Eye Health, London School of Hygiene and Tropical Medicine, Keppel Street, London, UK, WC1E 7HT. Phone; +44 (0) 2076368636, Email; Allen.Foster@lshtm.ac.uk

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ABSTRACT (words 228)

Purpose: Epidemiological data is essential for planning; however, all-age population-based surveys are resource intensive. Rapid Assessment of Cataract Surgical Services methodology was developed in India in 1995, and subsequently promoted by the World Health Organisation for use worldwide. The commonly-used Rapid Assessment of Avoidable Blindness (RAAB) evolved from this in 2005, constraining surveys to populations aged 50 or more based on the report 'The Epidemiology of Blindness in Nepal', (SEVA, 1988), where 78.7% of blindness occurred in people aged 50+. The purpose of this study is to examine whether more recent total-population based surveys continue to find a similar proportion of blindness in the population aged 50+.

Methods: A systematic literature review identified all population-based surveys of blindness published 1996 - 2017. Data extraction was undertaken by two independent researchers and compared.

Results: The proportions of blindness (presenting visual acuity (PVA) <3/60) and moderate/severe visual impairment (MSVI) (PVA <6/18-3/60) from total population-based surveys in people aged 50+ ranged from 90% (Mali, 1996) to 45.8% (South Korea, 2015); the mean proportions across all surveys were 73.1% (95% CI, 60.4%- 85. 8%) for blindness, and 73.8% (95% CI, 54.8- 92.8) for MSVI. No trend over time or association with GDP was identified.

Conclusion: This systematic literature review supports the rationale for constraining surveys to the population aged 50+ as this will greatly reduce sample size but still include a high

proportion of total cases of blindness; paucity of total population-based surveys highlights the ongoing need for RAAB in service planning internationally.

INTRODUCTION

Under the “VISION 2020: The Right to Sight” initiative, WHO member states were encouraged to establish national eye care programmes. However, lack of data for planning was a major obstacle as national surveys are expensive and resource intensive. To address this challenge, the Rapid Assessment of Cataract Surgical Services (RACSS) methodology developed in India in 1995 (1), was adapted and published by the WHO for worldwide use in 2000 (https://apps.who.int/iris/handle/10665/67847). In 2005, the package was entirely recoded in Windows software and renamed the Rapid Assessment of Avoidable Blindness (RAAB). Both RACSS and RAAB surveyed the population 50+ only, based on data from India and Nepal that this would identify the majority of cases of blindness.(2) In 2006, an analysis of the data from a total population-based survey in Africa(3) was undertaken to see if surveys in the population aged 50 or above in low- and middle-income countries would provide data on the majority (80%+) of blind people in the population, as seen in India and Nepal.(1,2)

The RAAB methodology continues to sample the population 50+, and has become the main tool for obtaining epidemiological data for eye care service planning globally with data from 308 such surveys from around the world having been placed on the online RAAB repository since the year 2000 (http://raabdata.info/ accessed October 2018). The results are widely used for planning of eye care services, evidence-based advocacy and in generating global estimates of blindness and visual impairment.(4)

The RAAB methodology permits estimation of the magnitude and distribution of blindness in the population aged 50+, and is not dependent for its validity upon assumptions about the proportion of blindness in this demographic. However, population growth, an ageing global population with reducing birth rates and increasing life expectancy, along with changes in the major causes of blindness over the last 20 years may have caused a shift in the proportions of blindness in 50+ age group since this question was most recently explored by analysis of the Gambian dataset in 2006.(2) This could leave eye health service providers wishing to reconsider whether constraining surveys to this demographic still provides the best balance between efficient use of resources and provision of the epidemiological estimates necessary for planning.

This study aimed to conduct a systematic review of the peer-reviewed literature of all-age total population-based studies (TPBS) of blindness and visual impairment in low, middle and high-income settings from 1996 to 2017 in order to assess the proportion of blindness and moderate / severe visual impairment (MSVI) in those aged 50 years and above.

MATERIALS AND METHODS

Criteria for Inclusion

The systematic review included peer reviewed publications published in the English language between 1st January 1996 and 31st July 2017. All population-based surveys of blindness were included in which the sampling frame was the total all-age population of a given geographic area. Studies were also included if they covered the population aged 6 years and above (6+), rather than all ages (0+). Vision assessment in young children (0-5) is difficult, and due to the low prevalence of blindness in this age group, sample sizes including very young children are large. (5). We did not include studies that excluded any part of the population over the age of 6 years. Studies were only included that used the WHO revised ICD-10 definition of Visual Impairment (www.icd10data.com/ICD10CM/Codes/H00-H59/H53-H54/H54-). Studies that gave data only on blindness (<3/60) but did not give data on moderate / severe visual impairment (<6/18 - 3/60) were included, but their data was only used in the analysis for blindness. Studies were included whether they presented crude or adjusted estimates of prevalence.

Search methodology

An electronic data search was conducted in PubMed, EMBASE, Global Health, Web of Science and Cochrane library databases. Searches were undertaken between June and July 2017. Search terms and concepts were constructed using the Problem/Indicator/Comparison/Outcome (PICO) framework. Identified key words and phrases were then searched in MEDLINE to check for corresponding MeSH terms. Key words included; "population-based", Surveys, Blindness, "visual impairment" and low vision.

Corresponding MEDLINE MeSH terms were; Population, cross-sectional studies, blindness and "vision, low". The search protocol in PubMed was conducted as shown in Table 1.

The search was limited to English language; humans and publication date (1996 to 2017). This search protocol was repeated in all databases.

Study Selection

The process of selecting studies for inclusion in the review was carried out through the following steps;

- The search results were all merged into a single folder using Endnote 8 reference management software (Clarivate Analytics, Philadelphia, PA, USA)
- Duplicate records of the same studies were removed
- Titles and then abstracts of reports were examined by two independent reviewers to exclude the obviously irrelevant reports
- Full texts of potentially relevant reports were retrieved
- Full text reports were examined by two independent reviewers for eligibility criteria
- Investigators were contacted for missing or additional information in two instances
- Provision was made for a final decision on study inclusion to be arbitrated by a third independent reviewer

At each stage the two researchers compared their selections and disagreements were discussed and compared to the inclusion criteria. If there had been disagreement at any point, a third reviewer would have been consulted for final decision.

Data extraction

Data from the selected studies was extracted by two independent reviewers and double entered into piloted data extraction forms. Communication with primary investigators was undertaken via email or direct phone contact so as to obtain or confirm missing data.

The prevalence of blindness and MSVI was extracted as presented in the included publications (adjusted if presented as such, crude if not) and the proportions of total population blindness and MSVI found in those aged 50 and above compared to the all-age population was calculated. Other variables recorded included the three most common causes of blindness and MSVI, national GDP per capita for the year in which the study was conducted (obtained from World Bank open data https://data.worldbank.org/)), and sources of study funding to assess risk of bias and conflict of interest. The mean proportion of blindness in the population 50 years or older was calculated across the extracted study estimates, as a measure of the spread of the proportion of blindness in the sample aged 50+.

Risk of bias in each individual study

No appropriate risk of bias (RoB) tool was identified, but after consideration of the parameters in other RoB tools (such as Cochrane risk of bias tools (https://methods.cochrane.org/bias/resources)) the RoB in each included study was evaluated. No source of bias was identified that lead to exclusion, however it was noted that one study had a relatively low response rate of 69%, introducing risk of selection bias,(6) and that two study reports offered inadequate breakdown of data regarding the causes of blindness and MSVI but this was not felt to compromise the primary aim of the study.(7, 8)

RESULTS

The total number of studies identified through database searching was 2447, which reduced to 1797 with removal of duplicates. Title screening of these 1797 excluded 1647 studies leaving 150 studies for abstract review. A further 108 studies were excluded after review of the abstracts. Full-Text articles of 42 papers were retrieved and assessed according to the eligibility criteria from which 32 papers were excluded leaving 10 full-text articles qualifying and included for review (figure 1).

Proportion of all blindness occurring in the over 50-year age group

The proportion of all blindness from TPBS occurring in people aged 50 years and above varied across the studies. The mean proportion of estimates reported across studies was 73.1% (95% CI, 60.4%- 85.8%). The lowest proportion was 45.8% reported in the South Korean study published in 2015 while the highest proportion was 90.2% in the study conducted in Mali and published in 1996. (Table 2)

Proportion of MSVI (<6/18-3/60) (from TPBS) occurring in the over 50-year age group

Data on MSVI was available in 6 of the 10 studies included in the review. The proportion of MSVI from TPBS occurring in people aged 50 years and above was highest in China (89.5%) in 2012 and lowest in Southern Sudan (50.3%) in 2006 (table 2). The mean of proportions across all the studies was 73.8% (95% CI, 54.8- 92.8).

Proportion of blindness and MSVI in 50+ years by country's GDP.

No correlation was found between the national GDP and the proportion of blindness in the population aged 50+ tested with Spearman's rank order correlation (p=0.88). however, there did appear to be some evidence of an association between the prevalence of blindness and GDP, with countries with higher GDP having lower prevalence of blindness as might be expected (rho=-0.742; p=0.014).

Causes of Blindness

The causes of blindness were reported in 8 of 10 studies. Overall, cataract was the main cause of blindness in the population 50+, however there were variations in individual countries. In Central African Republic (CAR) onchocerciasis was reported as the main cause of blindness (73%); in Malaysia retinal diseases (25%); in Kenya refractive errors (25%); and in Southern Sudan trachoma (35%) (Table 2).

DISCUSSION

This study found the mean proportion of blindness in those aged 50 years and above across the studies was 73.1% (95% CI, 60.4%- 85.8%) and for MSVI 73.8%. This figure is lower than that found in the Gambian study from 2006 (2) and as suggested by a meta-analysis of global blindness (Global Burden of Disease (GBD)) which estimated for the year 2015 that 31 million (86%) of 36 million blind people were in the 50+ age group, compared with 80% (172 of 217 million people) for MSVI (<6/18-3/60).(9) The GBD findings are based on meta-analyses of a large number of studies (comprehensive and rapid, and with different sampling criteria), which may explain some of the difference in findings compared to this review containing just 10 total-population based surveys.

The wide range of values (45.8% - 90.2%) for the proportion of blindness found in those aged 50 or over in the 10 surveys found in this review underlines that one should be very careful making inferences from the results of RAAB to the total populations. However, the potential negatives of inappropriate inferences being drawn are arguably outweighed by the benefits of having an accessible, affordable, standard method of generating epidemiological data that facilitates planning of eye care services, and also evaluation of change over time. The need for RAAB is perhaps exemplified by the finding that there exist just 10 published total population-based surveys worldwide that met the inclusion criteria from the last 21 years.

MSVI and blindness distribution change over time

Given the global demographic changes, and the substantial efforts that have gone into prevention and cure of blindness internationally through VISION 2020 and more recently the WHO Universal Eye Health – Global Action Plan 2014-19, it would be expected that there have been changes in the magnitude, causes and distribution of blindness.

Between 1990 and 2020, GBD analysis estimated a 28.5% drop in prevalence of blindness in those aged 50 years or older, but the total number of blind people (all ages) increased by

50.6% because of population growth and an increase in the number and proportion of older adults.(10) Of the ten surveys included in the review for this study, the more recent surveys were not found to have lower or higher proportions of blindness in the 50+ age group than older studies, however the number of studies included is small.

Proportion of MSVI (<6/18-3/60) (from TPBS) occurring in the 50+ age group

There were missing data on MSVI in 4 out of 10 studies, all from low- and middle-income countries (Mali, Nigeria, Kenya, and Central African Republic). All four studies reported cataract as the main cause of MSVI: Mali (63%), Nigeria (46%); Kenya (58%), C.A.R. (54%). With cataract preferentially affecting the 50+ age group, the missing data from these 4 studies is likely to have caused some underestimation of the mean proportion of MSVI in those aged 50 years or above.

SUMMARY

The factors that led to the development of RAAB (the expense and resource intensive nature of total population-based surveys), make it perhaps unsurprising that we found just ten total population-based surveys eligible for this review. The data showed an estimate for the proportion of all blindness that is amongst those aged 50 or above that is similar to that found previously, but repeating this study and reviewing the proportion of blindness in the population 50+ in another 10 years would seem prudent as demographics and eye health programmes' effectiveness continue to change. If eye health planning is based on predominantly on survey data including only those aged over 50 years of age and there should be an increase in the proportion of blindness in younger age groups, then we risk paying insufficient attention to the needs of that younger population. If there were a shift to a greater proportion of blindness occurring in the older age groups then there could be an opportunity to gain further efficiency savings in terms of time and resource by constraining surveys to an even older age group.

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S/N	[MeSH]	S/N	Key word/Phrase	S/N	Boolean Operators	Advanced Search
1.	Population	5.	“Population based”	9.	1 OR 5	9 AND 10 AND 11
2.	Cross-sectional study	6.	“Survey”	10.	2 OR 6	
3.	Blindness	7.	“Vision impairment”	11.	3 OR 4 OR 7 OR 8	
4.	Vision, low	8.	“Low vision”			

Table 1: Literature search protocol

Location / Year	GDP PER CAPITA (US $)	STUDY TITLE	SAMPLE SIZE & SUBJECTS AGES	RESPONSE RATE	PREV. OF BL (PVA<3/60)	PREV. OF VI (PVA<6/18)	% OF BL IN 50+YRS	% OF VI IN 50+YRS	CAUSES OF BL BY %	CAUSES OF VI BY %
Segou, Mali, 1996(11)	282	"Prevalence of blindness and visual impairment in the region of Segou, Mali. A baseline survey for a primary eye care programme"	6,520 All ages	90.0%	1.7%	1.7%	90.2%	Not reported	1. Cataract 69% 2. Trachoma 12.1% 3. Glaucoma 8.1%	1. Cataract 63.3% 2. Trachoma 15.3% 3. Glaucoma 13.3%
Central African Republi, 1997(12)	267	"Blindness and visual impairment in a region endemic for onchocerciasis in the Central African Republic"	7,559 All ages	80.5%	2.2%	3.0%	56.7%	Not reported	1. Oncho 73.1% 2. Cataract 16.4% 3. Trachoma 4.5%	1. Oncho 40.0% 2. Cataract 53.9% 3. Trachoma 1.7%
Malaysi, 2002(6)	4,167	"Prevalence of blindness and low vision in Malaysian population: results from the National Eye Survey"	18,067 All ages	69.0%	0.3%	2.4%	87.5%	88.0%	1. Cataract 39.1%	1. RE 48.3% 2. Cataract 35.9% 3. Retinal D'ses 2.8%

									2. Retinal D'ses 24.5% 3. RE 4.1%	
Southern Tamil Nadu, India, 2003(13)	541	"Blindness and vision impairment in a rural south Indian population: the Aravind comprehensive eye survey"	17,200 ≥ 6years	98.4%	10.0%	13.9%	87.2%	81.6%	1. Cataract 77.5% 2. RE 38% 3.Glaucoma 4%	1. RE 18% 2. Not reported 3. Not reported
Nairobi, Kenya 2006(14)	697	"Prevalence of visual impairment and blindness in a Nairobi urban population"	1,588 All ages	93.0%	0.6%	6.2%	50.0%	Not reported	1. Cataract 37.5% 2. RE 25% 3. Not reported	1. RE 58.1% 2. Cataract 35.5% 3. Not reported
Mankien Payam, S. Sudan, 2006(15)	1,978	"Prevalence and causes of blindness and low vision in southern Sudan"	2,954 ≥ 5years	84.6%	4.1%	7.7%	60.8%	50.3%	1. Cataract 41.2% 2. Trachoma 35.3% 3. *CO 18.6%	1. Trachoma 58.1% 2. Cataract 29.3% 3. * CO 6.8%

Cape Verde, 2006(16)	2,304	"Blindness and low vision in Cape Verde Islands: Results of a national eye survey"	3,803 All ages	88.7%	0.8%	1.7%	84.6%	82.1%	1. Cataract 57.7% 2. Glaucoma 15.4% 3. CO 7.7%	1. Cataract 46.2% 2. RE 26.8% 3. *MD 8.9%
Kaduna State, Nigeria, 2008(17)	1,384	"Prevalence of blindness and low vision in North Central, Nigeria"	8,400 All ages	78.9%	0.6%	3.2%	78.4%	Not reported	1. Cataract 37.8% 2. Glaucoma 21.6% 3. RE 8.1%	1. Cataract 46.3% 2. *RE 14% 3. Corneal opacity 4.7%
Hebei, China, 2012(7)	6,338	"Prevalence of Blindness and Low Vision in a Rural Population in Northern China"	20,298 ≥ 7 years	82.7%	0.3%	2.4%	89.7%	89.5%	Not reported	Not reported
South Korea, 2014(8)	27,105	"A Nationwide Population-Based Study of Low Vision and Blindness in South Korea"	23,239 ≥ 5years	77.5%	0.3%	5.0%	45.8%	51.3%	Not reported	1. RE 89% 2. Cataract 35.9% 3. *AMD 5.4%

*Country GDP Per Capita in the year of study publication

*BL= Blindness

*VI= Visual Impairment

*RE= Refractive Errors

*CO= Other non Trachomatous Corneal Opacities

*AMD= Age-related Macular Degeneration

* MD= Macular Disorders

Table 2 Data Extracted from Total Population Based Surveys of blindness and visual impairment 1996- 2017

Figure 1: Flow diagram showing results of full-text articles included in the review