Review Article

Future trends in global blindness

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The objective of this review is to discuss the available data on the prevalence and causes of global blindness, and some of the associated trends and limitations seen. A literature search was conducted using the terms "global AND blindness" and "global AND vision AND impairment", resulting in seven appropriate articles for this review. Since 1990 the estimate of global prevalence of blindness has gradually decreased when considering the best corrected visual acuity definition: 0.71% in 1990, 0.59% in 2002, and 0.55% in 2010, corresponding to a 0.73% reduction per year over the 2002–2010 period. Significant limitations were found in the comparability between the global estimates in prevalence or causes of blindness or visual impairment. These limitations arise from various factors such as uncertainties about the true cause of the impairment, the use of different definitions and methods, and the absence of data from a number of geographical areas, leading to various extrapolation methods, which in turn seriously limit comparability. Seminal to this discussion on limitations in the comparability of studies and data, is that blindness has historically been defined using best corrected visual acuity.

Key words: Global blindness, prevalence, visual impairment, visual acuity

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Blindness and vision impairment affects not only the quality of life of an individual, but also has implications for their educational and employment opportunities.[1] Adequate redress of this issue requires global planning and advocacy with governments, professional bodies, and international nongovernment organizations. Studies on the prevalence and causes of vision impairment should be carried out in key locations to inform situational analysis and identification of the need at both a regional and global level.

The number of people blind globally has been previously estimated and published by the World Health Organization (WHO), with the most recent estimates being that over 285 million people are blind or vision impaired.[2] This review discusses the available data on the prevalence and causes of global blindness, and some of the associated trends and limitations seen.

Materials and Methods

Literature search

A search of the National Library of Medicine's PubMed literature database, Medline, was conducted in January 2012 to identify previously reported estimations of the prevalence of global blindness and vision impairment. The terms "global AND blindness" and "global AND vision AND impairment" were used to locate papers in any language. This search yielded 62 publications between 1989 and the present. The abstract of each was reviewed, and articles excluded which were clearly not relevant to the review. Complete references found to be relevant to this study were obtained, as were copies of relevant papers referenced in the papers located through the Medline search. This resulted in the subsequent review of 7 articles listed in Table 1.

Demographic data

In order to assess the global trends of blindness and vision impairment, while taking into consideration the constant growth of the world population, not only should the absolute numbers be compared but also the prevalence, as the global population and its demography is changing and aging.[3] For the purpose of this review, the population was sourced from

Table 1: Successful papers from literature review

Author	Year of publication	Title
Pascolini D *etal.*[2]	2011	Global estimates of visual impairment: 2010
Holden BA *etal.*[6]	2008	Global vision impairment due to uncorrected presbyopia
Resnikoff S *etal.*[9]	2008	Global magnitude of visual impairment caused by uncorrected refractive errors in 2004
Dandona L *etal.*[8]	2006	What is the global burden of visual impairment?
Resnikoff S *etal.*[30]	2004	Global data on visual impairment in the year 2002
Pascolini D *etal.*[29]	2004	2002 global update of available data on visual impairment: A compilation of population-based prevalence studies
Thylefors B *etal.*[7]	1995	Global data on blindness

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the World Population Prospects: The 2010 Revision,[4] an internationally accepted source of global population.

Results

The estimated number of blind and visually impaired over the period 1972–2010 is presented in Table 2. Overall, over the past 40 years, when using the best corrected visual acuity definition, the estimated prevalence has steadily increased from around 0.3% in 1972[5] to 0.72% in 1990, then decreased to 0.55% in 2010[2] [Table 2]. Data on the global prevalence of low vision are only available from 1990. Over the past 20 years, the estimated prevalence of low vision has apparently decreased from 2.07% in 1990 to 1.79% in 2010 when using the best corrected visual acuity definition. The magnitude of uncorrected refractive errors was first estimated in 2002 and the presenting visual acuity definition was introduced in 2004. In 2005, it was the first time data indicating global prevalence of presbyopia and the subsequent burden of uncorrected presbyopia were reported.[6] If these estimates were combined with estimates at the time of global vision impairment, then the prevalence would increase to 11.13%, whereas without presbyopia, 2004 prevalence approximated 4.89%.

The reported causes of blindness and vision impairment have also changed over the years [Table 3 and Fig. 1]. Pre-1990, data detailing the different causes of blindness and vision impairment were not available and 2010 was the first time data were published estimating the global causes of visual impairment, in addition to blindness. In the earlier reports, the causes were only classified into four main causes: cataract, glaucoma, trachoma, and onchocerciasis, with a large proportion (28.3%) due to other causes.[7] More recent papers incorporate around eight or nine causes of blindness, leading to a much lower proportion of cases being classified as other (around 13% in 2002[7]). In 2010, the category of undetermined was used instead of other and increased to 21%.[2] Uncorrected refractive error was included as a cause of global blindness for the first time in 2002, causing the overall reported prevalence of global vision impairment to increase from 2.59% to 4.13%.[8] At the time, it was estimated that uncorrected refractive error was the cause of 12.00% of global blindness, second in prevalence only to cataract. While the reported pattern and prevalence remained similar in 2004,[9] the 2010[2] estimates showed a marked decrease in the number and associated prevalence of people blind or vision impaired due to uncorrected refractive error.

A comparison of the methodology used to estimate the global prevalence of blindness and the associated causes is depicted in Table 4. Criteria and definitions presented vary, as does the time frame and number of papers and studies included in each study. The papers also indicate much data were lacking and thus were extrapolated to derive the absolute numbers and prevalence information presented. Multiple sources of epidemiological data were used, and the inclusion criteria varied between studies. Such limitations were acknowledged and discussed within the studies.[7,10] Thylefors[7] exemplifies these shortcomings, indicating the necessity of standardized protocols, as the estimates for the total blind in 1978, 1984, and 1990 could not be compared due to employment of three incompatible methodologies. Prior to 1990, the data are not widely available on the individual causes of blindness or vision

Table 2: Summary table of estimated number of blind and vision impaired and corresponding prevalence (1972–2010)

Year*		1972[7]	1972[7]	1978[7]	1984[7]	1990[7]	2002[30]	2002[8]	2004[9]	2005[6]	2010[2]
Global population (No. in millions)		3,848.32	3,848.32	4,300.40	4,760.00	5,306.43	6,276.72	6,276.72	6,429.76	6,506.65	6,895.89
Blind	Best corrected VA† (No. in millions)	10.00	15.00	28.00	31.20	38.00	36.86	N/A	N/A	N/A	38.18‡
	Prevalence %	0.26	0.39	0.65	0.66	0.72	0.59				0.55
	Presenting VA (No. in millions)	N/A	N/A	N/A	N/A	N/A	N/A	42.01	45.08	N/A	39.37
	Prevalence %							0.67	0.70		0.57
Low vision	Best corrected VA (No. in millions)	N/A	N/A	N/A	N/A	110.00	124.26	N/A	N/A	N/A	142.69§
	Prevalence %					2.07	1.98				2.07
	Presenting VA (No. in millions)	N/A	N/A	N/A	N/A	N/A	N/A	217.19	269.24	N/A	246.02
	Prevalence %							3.46	4.19		3.57
Vision impaired	Best corrected VA (No. in millions)	N/A	N/A	N/A	N/A	148.00	161.12	N/A	N/A	N/A	180.88
	Prevalence %					2.79	2.57				2.62
	Presenting VA (No. in millions)	N/A	N/A	N/A	N/A	N/A	N/A	259.20	314.32	N/A	285.39
	Prevalence %							4.13	4.89		4.14
Uncorrected presbyopia	Presenting VA (No. in millions)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	410.00	N/A
	Prevalence %									6.30	

*Refers to the year at which the estimation was calculated, which in all cases is different to the year in which article was published, †Whereby 'VA' refers to visual acuity, ‡Calculated as presenting VA minus 3% of uncorrected refractive error, §Calculated as presenting VA minus 42% of uncorrected refractive error

Table 3: Summary table of the estimated causes and prevalence of global blindness

Cause of blindness	1990[7]		2002[30]		2002[8]		2004[9]		2010[2]	
	Estimate and prevalence (%)	Proportion of blindness (%)	Estimate and prevalence (%)	Proportion of blindness (%)	Estimate and prevalence (%)	Proportion of blindness (%)	Estimate and prevalence (%)	Proportion of blindness (%)	Estimate and prevalence (%)	Proportion of blindness (%)
Uncorrected refractive errors		N/A	N/A	N/A	5.041 (0.08)	12	8.23 (0.13)	18.24	1.18 (0.02)	3.00
Cataract	15.83 (030)	41.8	17.62 (0.28)	47.8	17.617 (0.28)	41.94	17.63 (0.07)	39.1	20.08 (0.29)	51.00
Glaucoma	5.12 (0.10)	13.5	4.53 (0.07)	12.3	4.533 (0.07)	10.79	4.55 (0.07)	10.1	3.15 (0.05)	8.00
ARMD	Other	N/A	3.21 (0.05)	8.70	3.206 (0.05)	7.63	3.20 (0.05)	7.1	1.97 (0.03)	5.00
Diabeticretinopathy	Other	N/A	1.77 (0.03)	4.80	1.769 (0.03)	4.21	1.76 (0.04)	3.9	0.39 (0.01)	1.00
Trachoma	5.87(0.11)	15.5	1.33 (0.02)	3.60	1.322 (0.02)	3.15	1.31 (0.02)	2.9	1.18 (0.02)	3.00
Cornealopacities	Other	N/A	1.88 (0.03)	5.10	1.88 (0.03)	4.47	1.89 (0.03)	4.2	1.57 (0.02)	4.00
Childhood	Other	N/A	1.44 (0.02)	3.90	1.44 (0.02)	3.42	1.44 (0.02)	3.2	1.57 (0.02)	4.00
Onchocerciasis	0.36 (0.01)	0.09	0.29 (<0.01)	0.8	0.29 (<0.01)	0.7	0.32 (<0.01)	0.7	Other	N/A
Other	10.72 (0.20)	28.3	4.79 (0.08)	13.00	4.79 (0.08)	11.41	4.78 (0.07)	10.6	8.27 (0.12)	21.00

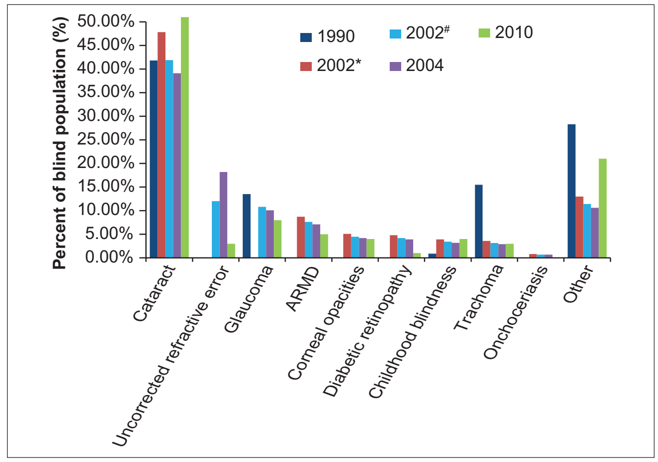

Figure 1: Global causes of blindness as a percentage of total blindness: 1990–2010* (*Excluding refractive error, #Including refractive error)

impairment.

Global magnitude of visual impairment due to uncorrected presbyopia was first discussed in detail in 2008,[6] whereby a dearth of appropriate published data led Holden *et. al.* to base their estimated prevalence of presbyopia using only four reported studies. This scarcity of data further resulted in conservative estimates.

Fig. 1 depicts the changes in the global causes of blindness over the last 20 years, which also portray the difficulties in trying to identify trends, as data are not comparable because of differences in the definitions. Even when using the best corrected visual acuity definition [Fig. 2] diabetic retinopathy estimates gradually declined between 1990 and 2004, and then dramatically declined in 2010. Similarly, both glaucoma and age-related macular degeneration (ARMD) estimates dramatically declined over the same period. These changes in the estimates are in contradiction with the existing epidemiological transition and global population aging.[11] In contrast, the estimated global prevalence of blinding cataract has remained at a similar level over the past 20 years while the global surgical output has significantly increased over the same period.[12]

The estimated prevalence of trachoma-related blindness dropped between 1990 and 2002. This has been attributed to the combination of a better data collection and socioeconomic development in endemic countries rather to the impact of the recently implemented interventions.[13]

Discussion

Definitions

The current WHO definitions of blindness and visual impairment in the International Statistical Classification of Diseases (ICD-10), as shown in Table 5, were updated in 2010,[14] since prior versions were based on best corrected visual acuity [Table 6]. While there have been revisions over the years, the previous definitions were established in 1975 and, at the time, the four major causes of vision loss were considered to be trachoma, onchocerciasis, xerophthlamia, and cataract.[15] Further investigations into the global causes

Table 4: Comparison of study methodologies

Year	Range of years	Number of surveys	Number of countries	Population covered (calculated from paper by thousand)	Proportion of global population %	Definitions	Population and socioeconomic data sources	Inclusion criteria	Missing data
1990[7]	1978–1990	Unavailable	17 countries	Unavailable	Unavailable	Low Vision: Best Corrected VA <20/60≥20/400 Blindness: Best Corrected VA <20/400	World Population Projections 2000, published by John Hopkins University Press; Regions based on World Development Report, 1993.	WHO Global Data Bank on Blindness, including published and unpublished reportsClear definitions relevant to ICD-10; cross-sectional design with clear and appropriate sampling	WHO consultations to extrapolate data to countries with similar sociocultural, economic,and epidemiological environment. Algorithms developed to estimate major causes and prevalence
2002[30]	1993–2003	208	55	4465988.362	71.15	Low Vision: Best CorrectedVA <20/60≥20/400 Blindness: Best Corrected VA <20/400	United Nations estimates for; 17Subregions according to GBD 2000 project	Published and unpublished papers; Population-based studies– representative of typical area andpopulation; sound and explicit cross-section design and sampling design; specified response rate;clear, unequivocal definitions of visual impairment; both WHO and nonWHO definitions acceptable if classifiable within the ICD-10 ranges of visual loss; eye exam methodology is reported	Prevalence extrapolation based on data collected within the same subregion or from neighboring subregions that share similar socioeconomic, epidemiological, ecological, and eye care service characteristics
2002[8]	1996–2005	9 (additional studies which focus on refractive error)	8	2707509.823	43.14	Low Vision: Presenting VA<20/60≥20/400 Blindness: Presenting VA<20/400	United Nations estimates for 2002; 17Subregions according to GBD 2000 project	Published papers; Population-based studies– representative of typical area and population; not exclusive to children or adults >60 years; sample size>1000; specified response rate; same definitions used (or could be derived); specified number or prevalence of persons with VI due to URE; data post 1996	Data was applied to countries within the same GBD sub-region and/or applied to most closely matching subregion based on GBD mortality strata;adjustments were introduced when population characteristics were different

Contd...

Table 4: Contd...

Year	Range of years	Number of surveys	Number of countries	Population covered (calculated from paper by thousand)	Proportion of global population %	Definitions	Population and socioeconomic data sources	Inclusion criteria	Missing data
2004[9]	1995–2006	68 (Study focuses on uncorrected refractive error only)	31	3833173.263	59.62	Low Vision: Presenting VA<20/60≥20/400 Blindness: Presenting VA<20/400	United Nations World Populations prospects 2004 and world urbanization prospects 2003; 17 sub-regions according to WHO	Published and unpublished papers; Population-based studies–representative of typical area and population; sound and explicit cross-section design and sampling design; specified response rate; clear definitions used including both 'presenting' and 'best-corrected' vision (relevant to ICD-10); eye exam methodology is reported: Cycloplegic refraction on children;	Country prevalence determined by weighting rural-urban data; country prevalence was used to establish average for a subregion; prevalence then applied to subregions with similar epidemiological classification
2005[6]	1986–2006	4 (Study focuses on presbyopia only)	4	1345625.539	20.93	Objective presbyopia: Needing an optical correction ≥+1.00D added to best distance correction to improve near VA to N8Functional presbyopia: Needing an optical correction >+1.00D added to presenting distance correction to improve near VA to N8	US Census Bureau 2006; and UN Department of Economics and Social Affairs population database 2006	Published papers; Population-based studies–representative of typical area and population; not exclusive to a very specific age group; sample size>1000; specified response rate; specified method for determining uncorrected presbyopia as cause of VI	Prevalence extrapolation based on climate, ethnicity and geographic factors; Burden of URE based on geographic regions and level of development
2010[2]	2001–2008	53	39	4540879.078	65.85	Low Vision: Presenting VA<20/60≥20/400 Blindness: Presenting VA<20/400	United Nations estimates for 2008; 6 regions according to WHO. Socioeconomic data from UNDP, World Bank and OECD.	Published papers and WHO database; Population-based studies–representative of area and country; sample size adequate and relevant to population; 80% or higher response; same definitions used (or could be derived)	Regional estimates from available data; missing data imputed by applying model based on 3 factors (GDP, world bank class of economies, prevalence of blindness in 50+ age group), countries were clustered within regions according to purchasing power parity and world bank economies;weighted prevalence was then applied to countries within the same cluster

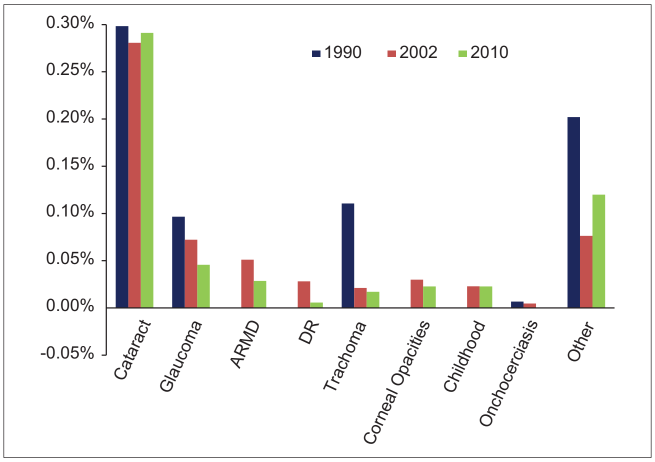

Figure 2: Causes of blindness 1990–2010 (BCVA)

Table 5: Blindness and visual impairment definitions in the ICD-10 (2010)

Category of visual impairment		Presenting distance visual acuity in the better eye: Maximum less than	Presenting distance visual acuity in the better eye: Minimum equal to or better than
0	Mild or no visual impairment		20/70
1	Mild visual impairment	20/70	20/200
2	Severe visual impairment	20/200	20/400
3	Blindness*	20/400	5/300 (or finger counting at 1 meter)
4	Blindness†	5/300 (or finger counting at 1 meter)	Light perception
5	Blindness	No light perception	
9	Unqualified vision loss	Undetermined or unspecified	

*If the extent of the visual field is taken into account, patients with a field no greater than 10° but greater than 5° around central fixation should be placed in category 3, †Patients with a field no greater than 5° around central fixation should be placed in category 4, even if the central acuity is not impaired

Table 6: Blindness and visual impairment definitions in the ICD-9 and ICD-10 from 1995 to 2010

Category of visual impairment		Visual acuity with best possible correction in the better eye: Maximum less than:	Visual acuity with best possible correction in the better eye: Minimum equal to or better than:
1	Low Vision	20/70	20/200
2	Low Vision	20/200	20/400
3	Blindness	20/400	5/300 (finger counting at 1 meter)
4	Blindness	5/300 (finger counting at 1 meter)	Light perception
5	Blindness	No light perception	
9	Unqualified vision loss	Undetermined or unspecified	

of vision impairment led to the recommendations that the classification be updated, since the use of Visual Acuity with Best Possible Correction rather than Presenting Distance Visual Acuity resulted in gross underestimation of the prevalence of uncorrected refractive error and hence underestimation of the prevalence of visual impairment.[16,17] When VISION 2020 was launched in 1999, refractive errors were included in the disease control priority list of interventions, even though the magnitude of the problem was not yet known.

The Andhra Pradesh Eye Disease Study[18] in the late 1990s was significant in helping to draw attention to refractive error blindness as a major cause of vision impairment. By applying the definition of presenting vision, the burden of vision impairment was reported as 61% higher than previously estimated by the WHO.[18] Since refractive error manifests at a young age, the number of associated blind-person-years from uncorrected refractive error was twice than those blind from cataract.[19]

Such changes to the definitions have significant impact when comparing blindness figures across the years. In addition, beyond the inclusion or exclusion of uncorrected refractive error, varying definitions and visual acuity thresholds have also been used in different countries for a variety of social, historic, scientific, or legal reasons. For example, the threshold for blindness in India, North America, and most of Europe is 20/200 while the threshold for driving is usually 20/40 in the United States and Australia. These differences in the definitions used in some surveys require adjustments to fit into the internationally agreed categories.

Even though the ICD-10 has recently been updated, it still does not include a classification system for near vision,[14] despite the increasing awareness inrecent years of the impact of uncorrected presbyopia on vision impairment and blindness.[6,18,20] The current definition of blindness at near was agreed upon by the International Agency for Prevention of Blindness (IAPB) Refractive Error Program Committee in 2008,[20] whereby near blindness is vision worse than N64 in the better eye when tested at the individual's required working distance, and vision impairment at near is worse than N8 in the better eye.

Further, it was suggested by the WHO that the cut-off for vision impairment in children aged under 16 years be lowered to 20/40 rather than 20/60 to account for the significant impact vision impairment has on learning, education, and the subsequent quality of life.[1]

Accuracy of surveys and biases related to protocols

Accurate assessment of the prevalence and causes of blindness and vision impairment require well-designed, population-based epidemiological studies spanning age and gender spectra. For example, prior to the Andhra Pradesh Eye Disease Study,[18] eye care programs in India had been primarily based on a single large, cross-sectional national survey conducted by the Indian Government in the 1980s.[21] The national survey determined that 80% of blindness was due to cataract, yet the survey design did not include detailed eye examination, and hence there was likely to be an underestimation of other causes of blindness such as glaucoma, retinal disease, and optic atrophy. In contrast, in Andhra Pradesh 10 years later, the tests previously omitted were included, and updated findings included only 60.3% of blindness due to cataract and refractive error, even though the overall prevalence of blindness had increased from 1.50% to 1.84%.[19]

It is also worth noting that the prevalence of blindness due to uncorrected refractive error is also reported as markedly decreasing from 18.2% in 2004[9] to 3.0% in 2010.[2] One of the justifications for this could be the fact that previously a significant proportion of blindness due to uncorrected refractive error, was due to uncorrected aphakia after cataract surgery. Nowadays, this is reduced due to the widespread use of intra-ocular-lenses even in low-income countries and because those who are aphakic are part of an aging population who are gradually dying. There is also an assumption that a large proportion of significant uncorrected refractive error is not being detected in the 15–50 years group, since most population-based surveys target either children under 15 years or the adults over 50 years, thus the causes and prevalence in the 15–50 years group is often extrapolated from those younger and older. Hence, not a true representation of that group is included.

In global estimates, childhood blindness refers to a group of diseases and conditions occurring in childhood or early adolescence, which, if left untreated, result in blindness or visual impairment. There are, however, only very limited population-based data on specific prevalence of causes such as vitamin A deficiency, congenital cataract, retinopathy of prematurity, or congenital glaucoma. Estimates have been therefore extrapolated from a limited numbers of studies, and prevalence projected according to socioeconomic development and under-five mortality rates.[22]

To estimate the breadth of causes, studies in blind schools have often been used. This methodology has limitations as not all blind children attend these schools, especially in low-income countries. In these countries, a high proportion of children who become blind may never actually attend a blind school since they die within a few years of becoming blind, as their blindness is often associated with systemic health problems that arise due to socioeconomic-related conditions.[22,23] In addition, more and more blind and vision impaired children are now integrated into mainstream education, in low-income countries as well.

The methodology used for collecting data and performing eye examinations can also create variability in reported estimates. For example, tests for determining best corrected visual acuity can vary from a subjective refraction, to an auto-refractor, to the pinhole method. Using the pinhole method can be problematic as cataracts and some other nonrefractive conditions may show a visual acuity improvement with pinhole and lead to an underestimation of ocular disease. Further to this, since illumination can affect depth of focus,[6] whether visual acuity is measured under associated lighting levels at the time, or whether it is measured outdoors or under standardized indoor illumination impacts the measurements.

Even with an increased use of standardized protocols, there are methodological limitations since such methodologies are based on the major causes of blindness as they were determined in 1988, suggesting a potential misclassification bias. The methodology calls for the collection of information on only the "most readily curable or, if not curable, that which is most easily preventable" in instances when there may be coexisting conditions.

While there has been an increased dissemination of the WHO standardized protocols to enhance comparability, many 'rapid' techniques are increasingly being implemented. A rapid style survey has been often encouraged to reduce the strain on resources.[10,19,21] Some rapid protocol tools, such as the rapid assessment of cataract surgical services (RACSS), only provide a basic eye examination. Hence they have a predilection for diagnosing anterior eye disease, such as cataracts, which can subsequently result in over-representations of such diseases as the primary cause of blindness.

The methodology of protocols is progressively improving and many, including the rapid assessment of avoidable blindness (RAAB), now include a more comprehensive eye examination, which however can be limited by equipment and clinical skills shortages. The RAAB is targeting the over 50 age group, as assessment had shown that this still provides comparable information to the total population.[24-26] Although the protocol aims to estimate the causes of avoidable blindness it is not always possible to accurately diagnose causes of posterior segment disease, especially when the diagnostic facilities are limited.

Underestimation of posterior segment disease and lack of accuracy in the diagnosis leading to misclassification under "undetermined cause" may account for this literature review showing a reduction in the prevalence of diabetic retinopathy while the global prevalence of diabetes mellitus is rising.[11,27]

Since the sample size in a RAAB is relatively small, it may give a reasonable estimate of the prevalence of avoidable blindness, but a larger sample size would be required to give an accurate estimate of the individual causes.

Changes over time

A significant achievement of the WHO Program Prevention of Blindness, established in 1979, is the associated Global Database on Blindness and Vision Impairment.[7,28,29] Analysis of this database is an integral part of the methodology employed historically to estimate the global burden of visual impairment and its causes.[2,7,9,16,29,30] Due to the lack of available data, there was often an overlap with the same studies used to estimate the causes and prevalence of global blindness. For example, as described in Table 4, surveys employed to estimate the vision impairment burden of 285 million for 2010 were spread between 2001 and 2008,[2]while surveys employed in the estimation of 259 million vision impaired in 2002 ranged from 1980 to 2003,[29,30] resulting in an overlap in the surveys employed and data generated. Furthermore, although data from high-income countries are available as far back as 15 years, they were still used in the most recent estimates under the assumption that there was no major changes in their results.[2] This assumption is arguable due to aging of the population.[3] Such an overlap is even more apparent in the study published by WHO in 1995 that determined an estimate of 148million, as the surveys employed ranged from 1974 to 1993.[7] While care was taken to exclude data and studies deemed unreliable, these overlaps prohibit accuracy of evidencing trends.

Drawing on a large number of surveys over a longer period of time, as in 2002 when 208 papers over 10 years were analyzed,[30] results in a larger pool of data and potentially more accurate extrapolations. Whereas including data acquired over a shorter time period result in less data, but allows for observation of greater changes in trends if the surveys and analysis are periodically repeated.

It has also been recommended that surveys are repeated approximately every 5 years[25,26] to estimate changes in cause and prevalence, and to measure program outcomes over that time period. Even when significant changes are observed, attribution to eye health interventions, as opposed to socioeconomic development is difficult.[12]

Representativeness

Few surveys were designed to be representative of a whole country. Most surveys were designed to be representative of a specific region or even district; some others were designed to compare specific populations such as urban and rural. This represents a serious limitation when these surveys are used in global estimates as surrogates of the country-level situation, especially for large countries. Yet a paucity of data often means that they are taken as the best estimate available. Such inaccuracies can be compounded if results are then extrapolated to neighboring countries.

Another major limitation is the fact that the vast majority of surveys used to estimate the 2002, 2004, and 2010 estimates were based on surveys of the >50 years population, rather than population of all ages.

Missing data

The paucity of data, and how different authors have addressed this limitation in their attempts to estimate the causes and prevalence of global blindness, continues to impose major limitations when trying to compare results and any associated trends. Published papers on the prevalence of global blindness state their inclusion criteria for studies to which they refer, and this has been summarized in Table 4.

In 1990,[5,7] a consensus among experts was developed to extrapolate data to neighboring countries based on similar sociocultural, economic, and epidemiological environments. Five algorithms were then applied to the population data and structure, for classification by cause. The extrapolations for missing data within regions were based on the economic division from the 1993 World Development Report.

In 2002,[8] for countries for which epidemiological data were not available, the prevalence of blindness was extrapolated from data collected in countries within the same epidemiological subregion used by the Global Burden of Disease (GBD) 2000 project[31] or from neighboring subregions that share similar epidemiological, socioeconomic, ecological, and eye care service characteristics. Age-group-specific prevalence was used to estimate the total number of blind people in each country of a subregion. This number was then used to calculate the subregional prevalence of blindness. Because most of the available data were for the age group 50 years and older, interpolations were made based on mortality stratum.

In 2010 the prevalence of blindness was estimated using economic status as a proxy.[2] The imputation process for missing data utilized a method developed by the International Labor Office, primarily based on gross domestic product per capita measured in Purchase Power Parity (PPP).[32] In each WHO region, the countries were clustered into ranges of PPP and World Bank classification of economies. A weighted prevalence of blindness was calculated for countries with data within a PPP cluster and imputed to other countries in the same cluster. According to the authors,limitations in the methodology could result in either an over or under estimation of visual impairment and blindness by 20%.[2]

Conclusion

There are obviously significant limitations in available data relating to the global prevalence of blindness. These limitations arise from various factors such as uncertainties about the true cause of the impairment, the use of different definitions, and the absence of data from a number of geographical areas, leading to various extrapolation methods, which in turn seriously limit comparability. Seminal to this discussion on limitations in the comparability of studies and data, is that blindness has historically been defined using best corrected visual acuity. Global prevalence estimates were based on that definition up until 2004; hence, data on both the prevalence and the global distribution of causes are not comparable, as uncorrected refractive errors were not measured in most former studies.

In conclusion, the very limited comparability between the repeated global estimates does not allow to measure reliable trends whether it is in prevalence or causes of blindness or visual impairment. However, since 1990 the estimate of global prevalence of blindness has gradually decreased when considering the best corrected visual acuity definition: 0.71% in 1990, 0.59% in 2002, and 0.55% in 2010, that is, a reduction by 18% and 5.7%, respectively, corresponding to a 0.73% reduction per year over the 2002–2010 period. The possibility of an actual decline is supported by the observation of an actual decline in some countries where repeated, comparable surveys were carried out, such as in Gambia,[33] Pakistan,[34] and India.[35]

In any case, to monitor trends and to enable the most efficient use of often limited resources, it is imperative to collect accurate and comparable data. This will only be possible if there is priority given to performing population-based surveys in subregions and countries where there are either no or limited data, or where the data are greater than 10 years old. Priority should be given to surveys that are effectively designed to be representative of large populations. All age groups should be investigated in appropriately selected places. Standardized protocols using internationally agreeddefinitions need to be adjusted in order to improve quality of data especially regarding posterior segment diseases. Similarly, the lack of available data on near vision impairment needs to be urgently addressed.

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