

ORIGINAL ARTICLE

# New Systematic Review Methodology for Visual Impairment and Blindness for the 2010 Global Burden of Disease Study

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## ABSTRACT

**Purpose:** To describe a systematic review of population-based prevalence studies of visual impairment (VI) and blindness worldwide over the past 32 years that informs the Global Burden of Diseases, Injuries and Risk Factors Study.

**Methods:** A systematic review (Stage 1) of medical literature from 1 January 1980 to 31 January 2012 identified indexed articles containing data on incidence, prevalence and causes of blindness and VI. Only cross-sectional population-based representative studies were selected from which to extract data for a database of age- and sex-specific data of prevalence of four distance and one near vision loss categories (presenting and best-corrected). Unpublished data and data from studies using rapid assessment methodology were later added (Stage 2).

**Results:** Stage 1 identified 14,908 references, of which 204 articles met the inclusion criteria. Stage 2 added unpublished data from 44 rapid assessment studies and four other surveys. This resulted in a final dataset of 252 articles of 243 studies, of which 238 (98%) reported distance vision loss categories. A total of 37 studies of the final dataset reported prevalence of mild VI and four reported near VI.

**Conclusion:** We report a comprehensive systematic review of over 30 years of VI/blindness studies. While there has been an increase in population-based studies conducted in the 2000s compared to previous decades, there is limited information from certain regions (eg, Central Africa and Central and Eastern Europe, and the Caribbean and Latin America), and younger age groups, and minimal data regarding prevalence of near vision and mild distance VI.

\*The GBD Vision Loss Study Group includes >50 ophthalmic epidemiologists as listed in the acknowledgements section.

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## INTRODUCTION

Vision loss and age-related eye diseases are major global public health problems. The World Health Organization (WHO) estimated that 1% of the total global burden of disease measured as disability-adjusted life years in 2002 was attributable to vision loss.<sup>1</sup> In the 2004 World Health Report, 42.7 million people were estimated to be blind and 272.4 million people to have low vision.<sup>2</sup>

The Global Burden of Disease (GBD), Risk Factors and Injury Study 2010 commenced in 2007 in order to obtain comparable estimates on the financial burden of disease, injuries and risk factors for 1990 and 2005, following the original GBD study in 1990<sup>3</sup> and the subsequent GBD updates published by the WHO.<sup>1,2,4</sup> The project is a large collaboration led by the Institute for Health Metrics and Evaluation at the University of Washington, and includes Harvard University, Johns Hopkins University, the University of Queensland, and the WHO. The GBD study focuses on more than 200 diseases and injuries and more than 43 risk factors for 21 regions of the world. Epidemiological reviews of all diseases, injuries, and risk factors allow cause-specific prevalence, mortality rates and disability weights for disabling outcomes to be calculated.<sup>5-7</sup>

For the first time, the GBD 2010 study is calculating "impairment envelopes"<sup>8</sup> of which vision is one. These envelopes consist of numbers of all-cause visually impaired (visual acuity in the better seeing eye <6/18 to 3/60) or blind (<3/60 in the better eye) and are constructed from information that allows the estimation of prevalence of visual impairment/blindness (VI/B) by age and sex independent of cause. Competing claims for the magnitude of people affected by VI/B from various causes must be reconciled within this envelope: ie, the sum of those with VI/B from all specific causes for any sex-age group must sum to the total number with VI/B for that age-sex group. In November 2007, the GBD study core group selected an expert group in vision loss (28 active members, 50 corresponding members) from interested individual ophthalmologists, optometrists and epidemiologists with expertise in regional individual diseases or impairments who responded via an announcement in *The Lancet* journal and on the GBD study website (<http://www.globalburden.org/>). The new study design allows for expert debate and collaboration among the expert groups regarding critiques of previous GBD study methodologies. The new GBD study methodology allows for retrospective and prospective consistent and comparative systematic review and objective consideration of all causes of

disability which separates epidemiology from advocacy. The information gathered under this review will provide information to aid planning and decision making by policy makers.

The purpose of this paper is to present the methodology of a major systematic review of blindness and visual impairment (VI) studies that forms the basis for forthcoming estimates of the prevalence of global prevalence of vision loss. The inclusion criteria for this GBD database are described. In addition, recommendations are suggested for the methodology of future studies to better strengthen future global estimates.

## MATERIALS AND METHODS

### Data collection and methods of data selection

The data collection process involved two approaches (Figure 1), which are described as follows:

- Stage 1. Systematic review of published literature
- Stage 2. Identification of additional data sources through personal communications with researchers, including inquiries about additional data from authors of published studies.

#### Stage 1. Systematic review of published literature

- (i) *Purpose:* To identify all indexed articles containing data on the prevalence and/or incidence of blindness and VI.
- (ii) *Search methods:* A systematic review of medical literature from 1 January 1980 to 31 January 2012 was carried out using the following sources: United States National Library of Medicine (MEDLINE), Excerpta Medica Database (Embase) and the World Health Organization Library Information System (WHOLIS). Search terms included concepts to describe "blindness," "VI," "population," "eye," "survey" and a list of conditions affecting the eye. Several approaches to capturing the search concepts using keywords or medical subject headings (MeSH terms) were developed and tested in Ovid MEDLINE. The objective was to achieve a focused strategy that would identify epidemiological studies of blindness. A strategy of using both keywords and MeSH terms targeted both indexed and non-indexed records (eg, MEDLINE In-Process records). To improve the precision of the search a range of limits and their effects on the numbers of records retrieved were explored. The search

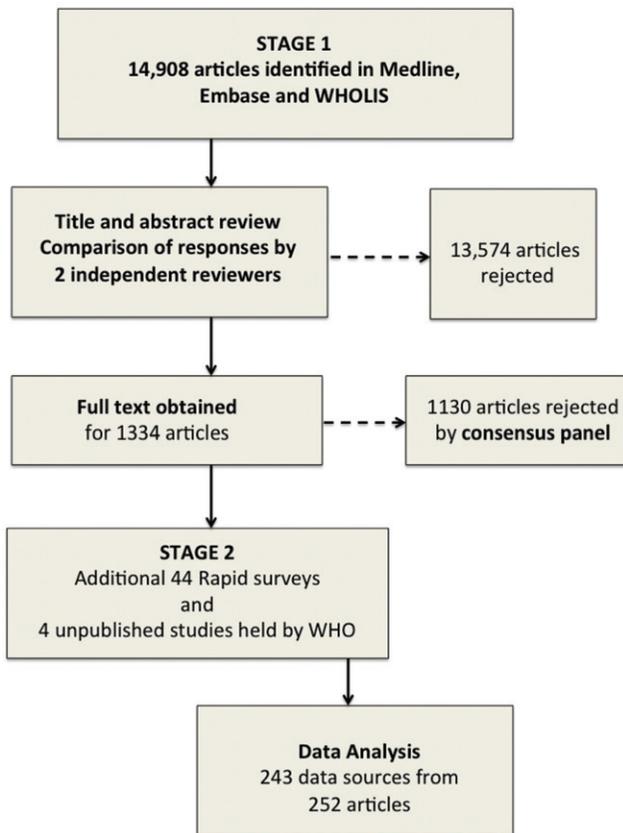


FIGURE 1. Stages of the systematic review.

strategy was also combined with search terms to retrieve country-specific records. Once agreed, the MEDLINE strategy was translated appropriately for Embase and WHOLIS.

- *Inclusion criteria for GBD Vision Loss database:* Studies that were included in the GBD Vision Loss database met the following requirement criteria:
- Reported prevalence of blindness and/or VI must be measured from random sample cross-sectional surveys of representative populations of any age of a country or area of a country. Studies using hospital or clinic case series, blindness registries and interview studies with self-reported vision status were not included.
- Definitions of VI or blindness must be clearly stated, using thresholds of visual acuity, in the better eye that matched or could be later modeled to match the definitions given in Table 1.
- Best-corrected and/or presenting visual acuity must be stated.
- Procedures used for measurement of visual acuity must be clearly stated.

Members of the Vision Loss Expert Group with experience of blindness surveys in particular areas of the world were organized into regional consensus panels to judge each of the studies identified by the

search in their regions against the inclusion/exclusion criteria.

- (iv) Data extraction for the GBD Vision Loss database:

Extraction of data involved the preservation of the smallest bracket of age categorization as possible from the published material to provide a database of age- and sex-specific prevalence and/or incidence of the vision loss categories, overall and by underlying cause, if known. This database also specified the start and end dates of the study, geographical location and the methods used to assess visual acuity.

### Stage 2. Identification of additional data sources

Additional data sources were identified through personal communications with researchers, including enquiries about additional data from authors of published studies. These data were used only if information about the study population and measurement methods were available. We applied the same inclusion criteria to these data sources as were employed in the published articles identified in Stage 1. Additionally, published and unpublished results from rapid assessment survey methodologies which follow consistent protocols such as the Rapid Assessment of Avoidable Blindness (RAAB) and the Rapid Assessment of Cataract Surgical Services (RACSS)<sup>9</sup> augmented the population-based data.

### Notes on definitions

In order to streamline consistency of comparisons across the variation of definitions of blindness used during this time period throughout the world, consensus was obtained within the Vision Loss Expert Group for the coding selection of five vision loss categories, which ranged from mild VI to blindness in the better eye (Table 1).

These definitions more closely match those commonly described in the reviewed publications and those of the WHO. The chosen vision loss categories include three novel categories, one for distance mild VI and one that pertains to near vision. In those publications where more than one visual sequelae were presented, the extracted data were coded to reflect this combination. For example, a study which reported prevalence of individuals with visual acuity <6/12 but 6/60 or better would be coded as mild and moderate VI combined. With the advent of the new WHO definition of blindness which uses presenting visual acuity (International Classification of Disease Update and Revision Platform, ratified by WHO-FIC Network at the annual meeting in Tunis, October 2006), this became the preferred visual acuity measure; however, if data were available for

TABLE 1. Vision loss categories chosen by the Global Burden of Diseases (GBD) Vision Loss Expert Group.

Vision loss category	Definition by visual acuity* in the better eye
Distance mild visual impairment	<6/12 but $\geq$ 6/18
Distance moderate visual impairment	<6/18 but $\geq$ 6/60
Distance severe visual impairment	<6/60 but $\geq$ 3/60
Distance blindness	<3/60 and/or a visual field of no greater than 10° in radius around central fixation
Near visual impairment	<6/12 but $\geq$ 3/60 for near, but $\geq$ 6/12 for distance

\*Snellen visual acuity or the equivalent calculated from published LogMAR values.

best-corrected and presenting visual acuity, then data of both methods were extracted.

Some studies measured VI in multiple countries; others in multiple years. On the other hand, data from one site-year may have been published in several journal articles. We treated each study site-year combination independently and called them “country-years”; a publication that had several sites contributed several country-years and several publications that described only one study together contributed only one country-year.

## RESULTS

In the Stage 1 systematic review, a large proportion (98%) of the 14,908 articles identified in the original literature search (Stage 1) were not eligible for inclusion because they did not report the prevalence of VI or blindness in the better eye from random-sample, representative, population-based cross-sectional surveys (Figure 1). Stage 2 resulted in the acquisition of unpublished data from 48 population-based studies, four from government reports and 44 from RACSS and RAAB surveys.<sup>9</sup> We carefully screened data sources for duplicated data, ie, data from one study reported in more than one publication. We identified and eliminated all duplications, maintaining the most detailed data source in the database (which in some cases meant including data from more than one article for one study). Data from 243 data sources (studies) described in 252 articles and reports were included in the GBD Vision Loss database. A global map of data sources with national or subnational (defined in this study as a first administrative unit or greater, which includes a state or region) data is given in Figure 2.

More specific details of each of the studies in the GBD Vision Loss database and their bibliographic information are presented in Supplementary Tables 2 to 16 (accessible with references online via the Web Appendix).

The final dataset for analysis included five studies which reported incidence data, four studies with near-vision data and 238 which reported the prevalence of distance VI. Of the studies reporting distance VI, 192 reported the prevalence of blindness, 145 reported the prevalence of severe VI or a similar definition

(eg,  $\leq$ 6/60), and 183 reported the prevalence of moderate VI or a similar definition (eg, <6/18 and  $\geq$ 6/60). The prevalence of mild distance VI was reported for 36 studies. Few studies reported all four definitions of VI targeted by this systematic review (8 studies).

Among the 238 studies reporting distance VI prevalence data identified, 40 were nationally representative, 36 were subnational, and 162 were local (a community or several communities together). Of the subnational and local studies, 73 were carried out in a rural location, 58 in an urban location, and 67 sampled from both urban and rural populations. At least one study was identified for each GBD study region, but there were no national-level studies identified in six of the GBD study regions (Asia-Pacific high-income, Australasia, Central Europe, Eastern Europe, North America high-income, or southern Latin America). No study was identified for 103 countries, and no nationally representative study was identified for 155 of 190 countries.

We identified 23 distance vision studies from the 1980s, 63 from the 1990s, and 152 from the 2000s. Much of the recent increase in the number of epidemiological studies can be attributed to the rapid assessment programs<sup>9</sup> as 79 studies in the 2000s were rapid assessments, as compared to four prior to 2000.

Data on child VI were particularly sparse. We identified only 45 studies which reported prevalence data for children or youth under 18 years of age, of which 10 were nationally representative studies carried out in Benin,<sup>10</sup> Ethiopia,<sup>11</sup> United Kingdom,<sup>12</sup> Lebanon,<sup>13</sup> Malaysia,<sup>14</sup> Nepal,<sup>15</sup> Oman,<sup>16</sup> Thailand (unpublished data, Prompubesara and Wongwetsawat: Third National Survey on Blindness and Low Vision in Thailand, 1994), Tunisia,<sup>17</sup> and Fiji.<sup>18</sup>

Some data on cause of VI were reported in 132 studies. Of these, 64 studies reported the prevalence of VI caused by cataract, macular degeneration, glaucoma, and the total prevalence of VI. A total of 106 studies did not report any information on the causes of VI.

## DISCUSSION

The GBD Vision Loss database (Supplementary Tables 2–16) compiled by this systematic review includes 189



are centrally collated with the benefits of accessibility and a standardized use of vision loss category definitions and methodology. Interestingly, nationally representative studies were less common in high-income countries. Of the countries where representative population-based studies had been undertaken, most were single studies in a 28 year period.

The very small number of repeat studies,<sup>23,24</sup> means that temporal trends in these countries are difficult to forecast beyond predictions based on expected demographic changes. This would lead us to recommend that simple, standardized methods of monitoring the prevalence of categories of vision loss be instituted. The Global Indicators Reference Group, has recently considered the question of how often a national study should ideally be performed in order to establish the prevalence of VI and blindness by cause, and has recommended this be repeated every 5 years (personal communication, Professor Jill Keeffe).

In summary, while there has been an increase in population-based studies conducted in the 2000s compared to previous decades, there remains a dearth of information from certain regions (eg, Central Africa and Central and Eastern Europe, and the Caribbean and Latin America). The database created by this enterprise is being used to provide global all-cause and cause-specific estimates of the prevalence of VI and blindness. Additionally a project is underway to retain the database as a regularly updated central resource from which summary data can readily be accessed via a web-based portal. Unlike former publications that have not disaggregated prevalence data by sex and have chosen only 6/18 and 3/60 cut-offs by which to report global estimates,<sup>25</sup> this review provides a much more detailed and up-to-date assessment, which will allow more precise estimates and importantly, will allow us to better determine temporal trends in blindness. Such trends are of particular interest when considering initiatives such as Vision 2020: The Right to Sight initiative, which aims to eliminate 80% of avoidable blindness by the year 2020.<sup>26</sup>

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### DECLARATION OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

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### SUPPLEMENTARY MATERIAL AVAILABLE ONLINE

Web Appendix: Studies in the Global Burden of Disease (GBD) Vision Loss database