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Ophthalmic Epidemiol. Author manuscript; available in PMC 2014 March 21.

Published in final edited form as:
Ophthalmic Epidemiol. 2013 ; 20(1): 33–39. doi:10.3109/09286586.2012.741279.

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

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Conflicts

None of the authors have any proprietary interests or conflicts of interest related to this submission. This submission has not been published anywhere previously and that is not simultaneously being considered for any other publication.

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On behalf of the Global Burden of Disease Vision Loss Expert Group*

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 4 distance and one near visual 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 Unpublished data and data from studies using ‘rapid assessment’ methodology were later added (Stage 2).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 Stage 2 added unpublished data from 44 ‘rapid assessment studies’ and 4 other surveys. This resulted in a final dataset of 252 articles of 243 studies, of which 238 (98%) reported distance vision loss categories. Thirty-seven studies of the final dataset reported prevalence of mild VI and 4 reported near vision impairment.

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 2000’s 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), younger age groups and minimal data regarding prevalence of near vision and mild distance visual impairment.

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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 (DALY) in 2002 was attributable to vision loss [1]. In the 2004 World Health Report, 42.7 million people were estimated to be blind and 272.4 million people to have low vision [2].

The Global Burden of Disease, Risk Factors and Injury Study 2010 (GBD) 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 [3] and the subsequent GBD updates published by the WHO [1, 24]. The project is a large collaboration led by the Institute for Health Metrics and Evaluation at the University of Washington, and including Harvard University, Johns Hopkins University, the University of Queensland, and the World Health Organization (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 [5–7].

For the first time, the GBD 2010 Study is calculating 'impairment envelopes' [8] of which vision is one. These envelopes consist of numbers of all-cause visually impaired (a visual acuity in the better seeing eye of <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: i.e., the sum of those VI/B from all specific causes for any sex-age group must sum to the total number of 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 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

A. 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.

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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 visual impairment (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 (e.g. 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 strategy was also combined with search terms to retrieve country-specific records. Once agreed, the MEDLINE strategy was translated appropriately for EMBASE and WHOLIS.

iii. Inclusion criteria for GBD Vision Loss database: The studies that were included in the GBD Vision Loss database met the following requirement criteria:

- The 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/clinic case series, blindness registries and interview studies self-reported vision status were not included.
- The definitions of VI or blindness must be clearly stated, using thresholds of visual acuity, in the better eye that matched or could be later modelled to match the definitions given in Table 1.
- Best corrected and/or presenting visual acuity must be stated.
- The 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 categorisation 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) [9] augmented the population-based data.

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B. 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 5 vision loss categories, which ranged from mild visual impairment 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 visual impairment and one that pertains to near vision. In those publications where more than one visual sequela were presented, the extracted data were coded to reflect this combination. For example, a study which reported prevalence of individuals with visual acuity less than 6/12 but 6/60 or better would be coded as mild and moderate visual impairment 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 best-corrected and presenting visual acuity, then data of both methods were extracted.

Some studies measured vision impairment in multiple countries; others in multiple years. On the other hand, data from one site-year may be published in several journal articles. We treated each study site-year combination independently and called them ‘country-years’; a publication that has several sites contributes several country-years and several publications that describe only one study together contribute 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 visual impairment 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, 4 from government reports and 44 from Rapid Assessment of Cataract Surgical Services and Rapid Assessment of Avoidable Blindness surveys [9]. We carefully screened data sources for duplicated data, i.e., 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 Tables 2 to 16 (accessible with references via the webappendix- see references section).

The final dataset for analysis included 5 studies which reported incidence data, 4 studies with near-vision data and 238 which reported the prevalence of distance vision impairment. Of the studies reporting distance vision impairment, 192 reported the prevalence of blindness, 145 reported the prevalence of severe visual impairment or a similar definition (e.g. <= 6/60), and 183 reported the prevalence of moderate visual impairment or a similar definition (e.g., <6/18 and >= 6/60). The prevalence of mild distance vision impairment was

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reported for 36 studies. Few studies reported all four definitions of visual impairment targeted by this systematic review (8 studies).

Among the 238 studies reporting distance vision impairment prevalence data which were 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 [9] as 79 studies in the 2000s were rapid assessments, as compared to 4 prior to 2000.

Data on child visual impairment 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 [10], Ethiopia [11], United Kingdom [12], Lebanon [13], Malaysia [14], Nepal [15], Oman[16], Thailand (unpublished data, Prompubesara and Wongwetsawat: Third National Survey on blindness and low vision in Thailand, 1994), Tunisia [17], and Fiji [18].

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

DISCUSSION

The GBD Vision Loss database (Tables 2–16) compiled by this systematic review includes 189 country-years of distance vision prevalence data representing 2.9 million vision examinations. This extensive review of published and unpublished information from studies covering a period of over 30 years has yielded several important observations. Many studies were excluded on the basis of the definitions used for vision loss categories, where the published data presented cut-offs of visual acuity that did not match those used by the WHO and the GBD Study. In some instances we were able to access unpublished data from these studies in order to extract data that had been recategorised to those of the GBD Study, but most such studies had to be excluded. This is unfortunate given the effort involved in conducting these studies and their potential to enhance the information provided in this review, and could be considered a limitation of this study. Additional limitations include the inability to access all unpublished data and the omission of some publications that may have only be listed in other medical literature sources. Future surveys should include careful reporting of VA data in accordance with the WHO guidelines of the time. A distinction between ‘presenting’ and ‘best corrected’ visual acuity has been made in this review, allowing both to be analysed simultaneously on a global scale.

Representativeness of the population examined was an important inclusion criterion. A strength of this study was the involvement of many ophthalmic epidemiologists around the world with knowledge of specific regions and studies conducted in these regions. The dearth of data relating to vision impairment and blindness in children was unsurprising given that the majority of such studies are performed in blind schools [19] or obtained from registers [20],

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with the result that the number of population-based studies involving these younger age groups was small.

The number of studies reporting mild visual impairment was also small as was the case with near vision impairment. With a rapidly ageing world population, further studies in this area would be of benefit in determining the prevalence of these vision loss categories, as would efforts to measure their incidence, of which studies were also sparse. This review has also highlighted the lack of data on mild distance vision impairment and near vision impairment.

The increased number and broader distribution of recent data sources underscores an increase in population-based studies conducted in the 2000's compared to the previous decades; however there remains a dearth of such information from certain world regions such as Central Africa and Central and Eastern Europe, the Caribbean and Latin America. There was also a dearth of national studies which will increase the uncertainty around prevalence estimates in these countries and regions. Subnational studies may not reflect the prevalence of VI/B that exists due to the unequal distribution of eye care resources in some developing countries. Rapid Assessment surveys [10] were particularly useful in that they had often been performed in regions where published data were sparse [2122]. Additionally the results of these surveys 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 [2324] 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 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 visual impairment 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 2000's compared to previous decades, there remains a dearth of information from certain regions (e.g., 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 visual impairment and blindness. Additionally a project is underway to retain the database as a regularly updated central resource from which summary data can be readily accessed via a web-based portal. Unlike former publications that have not disaggregated prevalence data by gender and have chosen only 6/18 and 3/60 cut-offs by which to report global estimates [25], 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 the Vision 2020: The Right for Sight initiative, which aims to eliminate 80% of avoidable blindness by the year 2020 [26].

Acknowledgments

Benita J O'Colmain assisted with the incorporation of microdata from several large population-based studies. The principal investigators of these studies are thanked for authorizing unpublished study data to be used in this project. Catherine Michaud and Colin Mathers greatly assisted in the communications between the GBD Core Group and the GBD Vision Loss Expert Group. Donatella Pascolini kindly assisted in retrieval of some unpublished data sources.

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Funding Organizations

Bill and Melinda Gates Foundation

Fight for Sight (Dr. Hans and Mrs. Gertrude Hirsch award)

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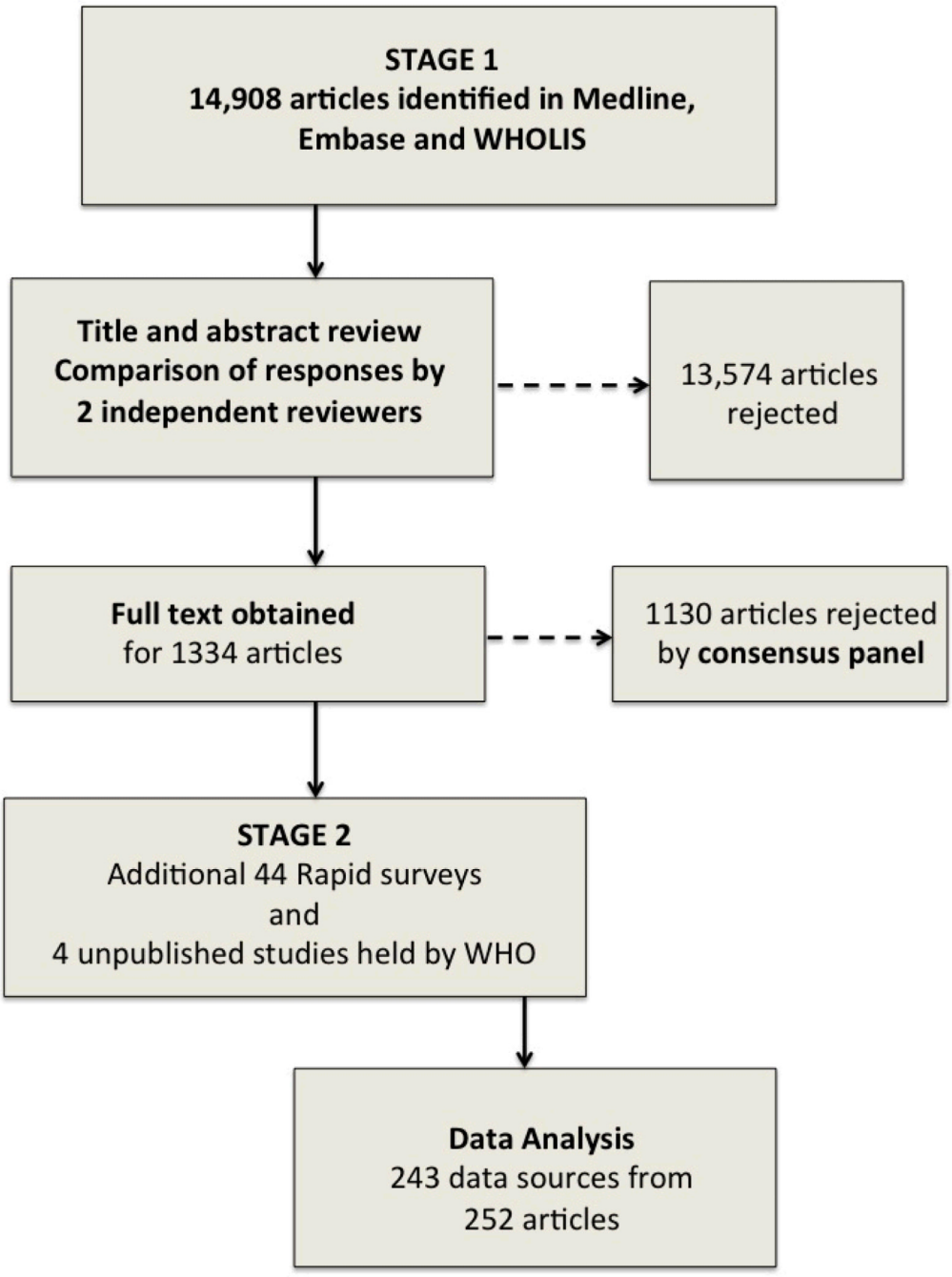

Figure 1.
Flow Diagram detailing the stages of the systematic review

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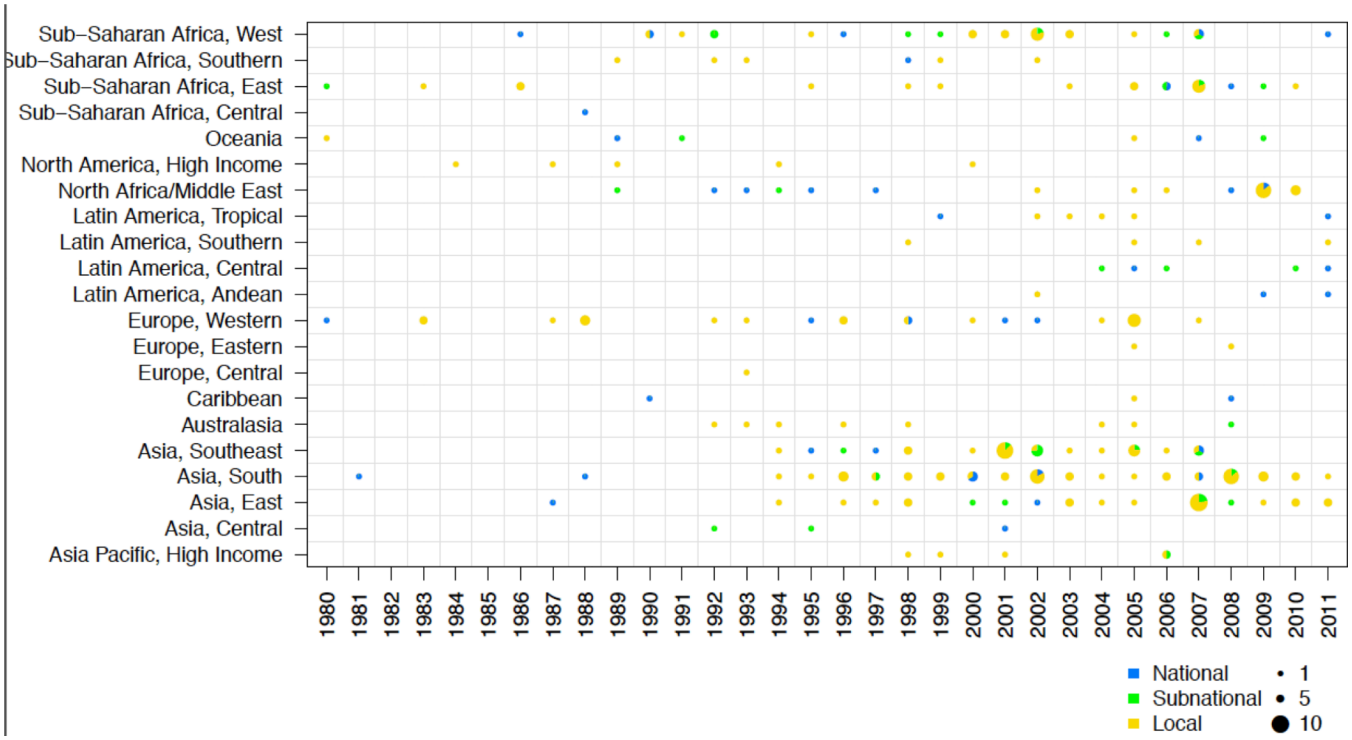

Figure 2.

Data availability plot for studies conducted between 1980 and 2012, identified by the GBD Study systematic review that reported distance visual acuity sequelae, organised by region, with survey year and population-representativeness highlighted. The population sampled by each study is represented as either national in scope, that of a first administrative unit or greater (includes state or regional) or a local/district level.

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Table 1

Vision loss categories chosen by the GBD Vision Loss Expert Group.

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

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