Global Vision Impairment Due to Uncorrected Presbyopia

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Objectives: To evaluate the personal and community burdens of uncorrected presbyopia.

Methods: We used multiple population-based surveys to estimate the global presbyopia prevalence, the spectacle coverage rate for presbyopia, and the community perception of vision impairment caused by uncorrected presbyopia. For planning purposes, the data were extrapolated for the future using population projections extracted from the International Data Base of the US Census Bureau.

Results: It is estimated that there were 1.04 billion people globally with presbyopia in 2005, 517 million of whom had no spectacles or inadequate spectacles. Of these, 410 million were prevented from performing near tasks in the way they required. Vision impairment from uncorrected presbyopia predominantly exists (94%) in the developing world.

Conclusions: Uncorrected presbyopia causes widespread, avoidable vision impairment throughout the world. Alleviation of this problem requires a substantial increase in the number of personnel trained to deliver appropriate eye care together with the establishment of sustainable, affordable spectacle delivery systems in developing countries. In addition, given that people with presbyopia are at higher risk for permanently sight-threatening conditions such as glaucoma and diabetic eye disease, primary eye care should include refraction services as well as detection and appropriate referral for these and other such conditions.

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Uncorrected distance refractive error is the most common cause of vision impairment and the second most common cause of blindness in the world.[1-4] Although presbyopia creates refractive error affecting the near vision of older people,[5] it is not included in the World Health Organization reported prevalence of uncorrected refractive error.[4,6] However, the combination of the high prevalence in older adults and the low rates of spectacle access in some communities means that presbyopia has the potential to cause a global burden of vision loss worthy of attention.

Presbyopia is caused by age-related elasticity changes in the crystalline lens and its capsule.[5] To understand the progression, consider that the average 12-year-old European child can accommodate by 12 diopters (D), allowing a nearest point of clear vision of about 8 cm.[7] The average 48-year-old European adult can accommodate by only 3 D, allowing a nearest point of clear vision of about 33 cm.[7] The average 60-year-old European adult has minimal accommodation and relies on depth of focus or artificial assistance such as spectacles to enable clear and comfortable near vision.[5,7] The exact age that near vision spectacles are required depends on a range of factors such as individual variation in accommodative ability,[8] distance refraction,[9,10] climate,[11-15] geographic location,[12,16,17] demands and expectations,[18] sex,[17-21] and ethnicity.[22-27] It has been argued that studies of factors affecting presbyopia are prone to the effects of confounding variables,[16,28] but there does seem to be general acceptance of earlier onset in people with higher melanin levels in equatorial regions.

Although known physiology and population demographics suggest that presbyopia is common or nearly universal in people older than 65 years,[5,7] direct estimates of prevalence are rare. This article provides an estimate of the global prevalence of presbyopia by applying the results of a systematic review of published population-based surveys to population projections.

The total number of people with presbyopia is primarily of interest as a precursor to the figures of greatest public health

interest: the number of people with impaired vision due to uncorrected or undercorrected presbyopia and the effect on their lives. In the developed world, distance refractive errors and presbyopia are corrected with readily available spectacles, leaving the perception that uncorrected refractive error does not create a significant sociomedical problem.[15,29] However, underserviced areas of the world have high levels of uncorrected and undercorrected distance refractive error,[3] and anecdotal observations suggest that it is likely to be as bad for near vision impairment. Access to spectacles in developing countries is limited by insufficient numbers of health care professionals able to perform relevant eye examinations, a lack of available, affordable spectacles, and a lack of adequate public health support structures to help people obtain spectacles.[17,18,30-32] The worldwide effect of uncorrected presbyopia is determined by combining prevalence figures with spectacle coverage rates.

METHODS

POPULATION PROJECTIONS AND CLASSIFICATIONS

The population projections used to estimate presbyopia prevalence and burden were extracted from the International Data Base, a computerized database containing statistical tables of demographic data for 228 countries and areas of the world published by the US Census Bureau.[33] The figures were obtained from the August 24, 2006, release notes, which were current at the time of writing. The International Data Base combines data from country sources (especially censuses and surveys) with the US Census Bureau's International Programs Center estimates and projections to provide information dating back as far as 1950 and projections as far forward as 2050.

Economic development classifications used in the estimation of burden were taken from the Population Database (2006 revision) published by the Population Division of the United Nations Department of Economics and Social Affairs.[34] The United Nations has updated the Population Database since we calculated burden; however, the changes, including the graduation of Cape Verde (population, 570 000) from least developed to less developed, were too minor to alter the calculation.

LITERATURE SEARCH STRATEGY

The prevalence of presbyopia, the prevalence of uncorrected or undercorrected presbyopia, and the effect of uncorrected or undercorrected presbyopia on quality of life were assessed by searching published population-based surveys using the guidelines for reporting meta-analyses suggested by the Meta-analysis of Observational Studies in Epidemiology Group.[35]

STUDIES AND DATABASES SEARCHED

The PubMed literature database (National Library of Medicine, initially accessed on July 9, 2007, and repeated on October 3, 2007) was searched for publications from January 1987 to September 2007 using the following medical subject heading terms defined by the National Library of Medicine to ensure repeatability of the search: "presbyopia AND epidemiology," "QALY AND vision," and "cost-utility AND vision." The search was performed on all available articles regardless of the original language of publication. The aim of the literature search was to locate relevant articles including the prevalence of presbyopia, the rate of correction or noncorrection of presbyopia, methods of measuring near vision, the type of presbyopia measured, the effect of presbyopic vision impairment on the quality of life, and the net benefit of correcting presbyopia. The search yielded 95 articles. The abstract of each publication was reviewed, and articles that were population-based surveys and included 1 or more measurements of near vision, the prevalence of presbyopia, the prevalence of spectacle wear for presbyopia, the relevant quality-of-life findings, or a cost-utility analysis were obtained from the journals. Two articles from the PubMed search that were in a language other than English were assessed on the basis of their English abstracts. One article was not assessed as there was no English abstract available.[36] No additional articles on population-based surveys of presbyopia published from 1987 onward were found in the reference lists of the articles located through the PubMed search.

The following exclusion criteria were applied to the population-based surveys on presbyopia: (1) participating sample size of less than 1000; (2) unspecified number of eligible participants or participation rate (as this limits generalization of the data); (3) inclusion of only very specific age groups (eg, if a study was restricted to ages 70-75 years, which excludes most people with presbyopia because the age at onset is generally much younger); (4) data from a specific population that could not be generalized to the population as a whole (eg, institutionalized nursing home population or only women who have given birth); and (5) an unspecified method for determining that reduced near vision was due to optical defocus rather than cataract or ocular pathological abnormalities.

PRESBYOPIA DEFINITIONS

Two different presbyopia definitions were used in the articles we found using these search methods. Functional presbyopia is defined as needing a significant optical correction added to the presenting distance refractive correction to achieve a near visual acuity criterion (≥1 line of acuity improvement in one case, J1 print in another, and N8 print in the other).[18,21,37] Objective presbyopia is defined as needing a significant optical correction (≥+1.00 D) added to the best distance optical correction to improve near vision to a near visual acuity criterion of N8.[17] Perhaps the key epidemiological consequence of the difference between functional and objective presbyopia is that people with low to moderate uncorrected myopia never develop functional presbyopia but are likely to develop objective presbyopia. Both definitions were accepted, but the definition used was noted because it is expected to have an epidemiological effect.

RESULTS

PREVALENCE OF PRESBYOPIA

Four population-based surveys met the inclusion criteria for assessing the prevalence of presbyopia (**Table 1**). Three studies were cross-sectional surveys,[17,18,21] and the fourth was a rapid assessment survey.[37,38] The prevalence estimates vary owing to differing definitions, measurement methods, measurement conditions, population age groups studied and other population demographics such as ethnicity and urbanization, and climate and geographic locations.[17,18,21,37,38] Each of these sources of variation will be discussed at relevant points in our analysis and discussion. It is worth noting at this

Table 1. Summary Table of Findings From Presbyopia Population Studies in Tanzania, Brazil, India, and Timor-Leste

Characteristic	Tanzania[18]	Brazil[21]	India[17]	Timor-Leste[37,38]
Participants, No.	1562	3007	5587	1414
Region	Africa	South America	Asia	Asia
Ethnicity	African	81% White, 19% other	Indian	Austronesian
Participation rate, %	83	93.2	>90	96
End-point N print size	N8	N4	N8	N8
Method of measuring near vision	Modified near low vision screening E chart at 40 cm	Letter chart at 37 cm	Unspecified near VA chart at 40 cm	Modified near VA chart at unspecified distance
Prevalence of presbyopia, %				
Age, y				
30-39	NA	10.7	22.9	NA
40-49	50.4	47.8	92.6	43.5
50-64	68.7	86.3	NA	NA
50-69	NA	NA	94.6	48.1
≥65	72.4	92.9	NA	NA
≥70	NA	NA	88.4	32.6
Overall	61.7	54.7	69.9	43.8
Presbyopia type	Objective and functional	Functional	Objective	Functional
Assumed age at onset, y[a]	40	45	40	40
Prevalence of presbyopia from assumed age at onset and older, %	Objective, 61.7; functional, 58.9	83.0[b]	93.4	43.8

Abbreviations: NA, not applicable; VA, visual acuity.
[a] Assumptions are based on varying reports of the effect of climate, ethnicity, geographic location, and other variables on presbyopia.[8-28]
[b] The prevalence of presbyopia in subjects aged 40 years and older is 72.3%.

Table 2. Summary Table of Findings From Presbyopia Population Studies That Did Not Meet the Inclusion Criteria

Characteristic	Nigeria[39]	Southwest Uganda[39,40]	Ghana[27]	Pakistan[41]
Participants, No.	510	182	1884	511
Age, y	18-49	≥13	≥5	0 to ≥70
Type of study	Random survey	Referred patients to eye clinic	Retrospective study of clinical records	Cross-sectional study of non-vision-impairing conditions
Assumed age at onset, y[a]	40	40	40	40
Reason for exclusion from global calculations	Too small, lack of definitions	Too small, lack of definitions, clinical population	Lack of definitions, clinical population	Too small, lack of definitions
Prevalence of presbyopia, %	83[b]	80[b]	82[b]	71.5[c]

[a] Assumptions are based on varying reports of the effect of climate, ethnicity, geographic location, and other variables on presbyopia.[8-28]
[b] For ages 40 years and older.
[c] For ages 30 years and older.

point that all of the articles taken into account in our analysis had a method for differentiating presbyopia (reduced near vision due to optical defocus) from reduced near vision due to other causes such as cataract or ocular pathological abnormalities.

Table 1 shows that the best epidemiological studies of presbyopia provide a wide range of prevalence estimates. Prevalence from the age at onset ranged from 43.8% (Timor-Leste) to 93.4% (India). The low prevalence of functional presbyopia was not addressed in the Timorese articles, which focused on the correction of refractive error and presbyopia.[37,38] It should be noted, however, that vision measurements in the Brazilian and Indian studies were conducted under standard indoor illumination, whereas the Tanzanian and Timorese studies were conducted in prevailing outdoor illumination. As illumination affects contrast, pupil size, and, consequently, depth of focus, it could contribute much of the variation between results. Additionally, the higher prevalence in the Indian study can be partly attributed to the use of an objective presbyopia definition (as compared with the functional definition used by the other 3 studies).[17,18,21,37,38] The authors of the Indian study recognized that the objective definition of presbyopia may overstate the number of services and spectacles required.[17]

Another 4 studies contained data on the prevalence of presbyopia but did not meet the inclusion criteria. The results from these studies and the reasons for exclusion are summarized in **Table 2**. These extra studies increase confidence that the larger population-based data are reasonable, but they were not used in our prevalence estimations because of their scientific limitations.

CALCULATION OF GLOBAL PREVALENCE

The outcome of the Brazilian study (conducted in the country's far southern temperate region with 81% of the par-

Table 3. Estimate of Global Prevalence of Presbyopia

Region	Age at Onset[a]	Prevalence of Presbyopia, %	Population From Age at Onset and Older in Specified Year, No. in Millions				Population With Presbyopia in Specified Year, No. in Millions			
			2005	2010	2020	2050	2005	2010	2020	2050
More-developed countries within regions[b]										
Australia and New Zealand	45	83.0	9.0	10.1	11.9	15.8	7.5	8.4	9.9	13.1
North America	45	83.0	74.8	85.2	108.4	145.1	62.1	70.7	89.9	120.5
Europe	45	83.0	299.5	315.7	338.3	341.6	248.6	262.0	280.8	283.5
Japan	40	43.8	68.7	72.0	75.9	78.0	30.1	31.5	34.2	31.1
Total			452.0	482.9	534.5	580.5	348.2	372.6	414.8	448.2
Less-developed countries within regions[b]										
Pacific Islands	40	58.9	1.6	1.9	2.5	5.1	0.9	1.1	1.5	3.0
Latin America and Caribbean	40	58.9	156.1	180.9	236.1	383.3	91.9	106.6	139.0	225.7
Africa	40	58.9	86.9	97.9	125.2	269.8	59.0	66.8	86.3	183.3
Eastern Asia, excluding Japan	40	43.8	505.6	593.3	669.2	714.9	221.5	259.9	293.1	313.1
South-central Asia	40	43.8	364.2	418.4	478.3	542.0	159.5	183.3	209.5	237.4
Southeastern Asia	40	43.8	133.7	156.3	179.8	205.0	58.6	68.5	78.8	89.8
Western Asia	45	83.0	35.5	42.8	51.0	60.6	29.5	35.5	42.3	50.3
Total			1283.7	1491.5	1742.1	2180.6	620.9	721.6	850.5	1102.7
Least-developed countries within regions[b]										
Pacific Islands	40	58.9	0.2	0.2	0.3	0.6	0.1	0.1	0.2	0.3
Latin America and Caribbean	40	58.9	1.6	1.8	2.3	5.1	1.0	1.1	1.4	3.0
Africa	40	58.9	74.5	84.3	112.1	299.9	45.6	51.7	68.8	182.6
South-central Asia	40	43.8	42.2	50.0	58.7	68.5	18.5	21.9	25.7	30.0
Southeastern Asia	40	43.8	17.6	20.4	23.6	26.8	7.7	8.9	10.3	11.7
Western Asia	45	83.0	2.4	2.9	3.4	4.0	2.0	2.4	2.8	3.3
Total			138.5	159.5	200.3	404.8	74.9	86.0	109.1	231.0
Global total			1874.2	2133.9	2476.9	3165.9	1043.9	1180.2	1374.4	1781.8

[a] Assumptions are based on varying reports of the effect of climate, ethnicity, geographic location, and other variables on presbyopia.[8-28]
[b] The United Nations Department of Economics and Social Affairs classifies all countries in Europe and North America plus Australia, New Zealand, and Japan as more developed, and all other countries are either less or least developed.[34]

ticipants being white) was chosen as representative of cooler climates and a white population. Consequently, a presbyopia prevalence of 83.0% and an age at onset of 45 years were used to calculate the number of people with presbyopia in Australia, New Zealand, North America, Europe, and western Asia.[21] An age at onset of 40 years and a functional presbyopia prevalence of 58.9% from the Tanzanian study were used for Africa, Latin America, the Caribbean, and the Pacific Islands.[18,42] An age at onset of 40 years and a prevalence of 43.8% from the Timorese study were used for Asia (except western Asia).[37,38]

These choices of representative data lead to the interesting situation of using Timorese data rather than data from Andhra Pradesh, India, for estimating the Indian presbyopia prevalence. The result has been a far more conservative estimate of global prevalence, but one that we anticipate will prove more practical in reality. The conventional understanding of physiology is that everyone eventually develops objective presbyopia, and all of those without low to moderate myopia develop functional presbyopia.[5,7] In reality, individual variations in pupil size and, consequently, depth of focus and accommodation ability create a difference between physiology-based expectations and epidemiological findings. The low prevalence used for Asia provides an allowance for the high rate of myopia in the region, which enables many of those affected by objective presbyopia to be able to function at near without optical correction. One study found that 32% of Chinese adults in Singapore older than 40 years have low myopia,[43] although other studies show substantial variation in myopia. A review of 6 large population studies covering the United States, western Europe, and Australia found that 25.4%, 26.6%, and 16.4% of the respective populations aged 40 years or older have at least 1.00 D of myopia.[44] An Indian population study showed that around 5% of its population aged 40 to 49 years had low myopia.[45] By using the functional presbyopia prevalence from Timor-Leste (43.8%) rather than the objective presbyopia prevalence from Andhra Pradesh (93.4%), we believe that we have provided a more practical estimation of the number of people with vision impairment from presbyopia.

Combining the prevalence data with the population projections of the International Data Base gave an estimate of 1.04 billion cases of functional presbyopia in 2005. It is estimated that 67% of people (or 696 million people) with presbyopia live in the less- and least-developed regions of the world. This global prevalence of presbyopia is predicted to increase to 1.4 billion by 2020 and to 1.8 billion by 2050. These estimates are summarized in **Table 3** and shown in the **Figure**.

BURDEN OF UNCORRECTED AND UNDERCORRECTED PRESBYOPIA

Six population-based surveys met the criteria for assessing the rate of correction of presbyopic vision impairment. As expected, the percentage of people with pres-

byopia who have adequate spectacles varies between countries. In Tanzania, only 6% of people with presbyopia had corrective near vision spectacles.[42] In Brazil, 55% of people with presbyopia had spectacles, but only 71% of these corrections were adequate (ie, 39% of presbyopic Brazilian individuals had adequate near optical correction).[21] Only 30% of people with presbyopia in India and 26% in Timor-Leste had appropriate corrective near vision spectacles.[17,37,38]

In the Australian population-based study, 85% of men and 87% of women older than 40 years wore spectacles at their near vision assessment, and 98% were able to read N8 print with those spectacles[46]—ie, 84% had appropriate corrections. The Finnish study found that 96% of individuals in a sample population older than 30 years were able to read newsprint with their current spectacles.[47]

This published evidence was used to calculate global uncorrected or undercorrected presbyopia, matching populations as closely as possible for geographic region and level of development. **Table 4** shows the calculation of the global percentage of people who do not have adequate near vision spectacles. In a United Nations Department of Economics and Social Affairs–defined least-developed country, the likelihood of possessing appropriate near vision spectacles is only 6% to 26%. The likelihood rises to 30% to 39% for less-developed countries and 84% to 96% for more-developed countries.

An important part of the question related to the burden of uncorrected presbyopia is the significance of the level of impairment caused by presbyopia, taking into account socioeconomic, geographic, and cultural issues.

Measures of the impairment caused by presbyopia show that 70% of rural Tanzanian individuals, 58% of Brazilian individuals, and 53% of Indian individuals with functional presbyopia experience difficulty with relevant near tasks when using their habitual spectacles.[17,21,42] In more-developed countries, the only near vision disability measure investigated by any study was whether people can see to read. The assumption is that everyone is literate and no other activities of daily living are generally investigated. For example, a Finnish study found that 93% of its sample population felt capable of seeing for reading, and 96% of the same sample were able to read newsprint with their current spectacles.[47] This evidence was used to estimate the global number of individuals feeling disabled by uncorrected presbyopia, using local definitions of feeling disabled. Estimates are shown in **Table 5**.

COMMENT

MAGNITUDE AND IMPORTANCE OF THE PROBLEM

We estimate that there were 517 million people without adequate correction for functional presbyopia in 2005 (Table 4). However, not every one of these people with uncorrected or undercorrected functional presbyopia would require a pair of spectacles for near tasks. Some people have minimal or no near-point vision requirements. Using local definitions of disability, the best estimate of the number of individuals experiencing disability caused by uncorrected presbyopia was 410 million people in 2005, of whom 386 million (94%) live in less- and least-developed countries (Table 5).

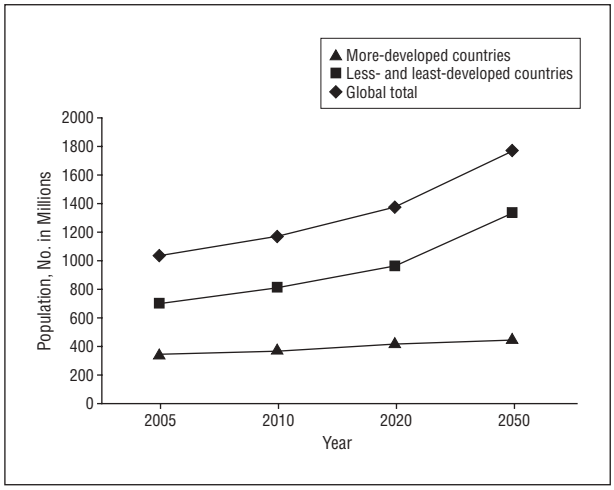

Figure. The predicted number of people with presbyopia from 2005 to 2050.

Without intervention to make spectacles more accessible, the global number of individuals who will have a disability associated with uncorrected presbyopia is predicted to grow to 563 million people by 2020 (Table 5).

CAVEAT ON FUTURE PREDICTIONS

Many developments are likely to affect future predictions of the burden of uncorrected presbyopia. Fixed demand for and availability of spectacles have been assumed, neither of which are likely to be true. Economic development generally brings a greater reliance on literacy and other acuity-related near activities, which are likely to increase the demand for near vision spectacles. Economic development is also likely to increase the supply of and access to spectacles. We have made no attempt to predict the influence of these factors in our estimates.

MORE STUDIES NEEDED

The studies on which we have based our global estimates had the strengths of large participating sample sizes, clearly stated participation rates, appropriate age ranges with good spread between ages, population-based recruitment, and clear methods for excluding near vision impairment due to presbyopia from other causes such as cataract or ocular pathological abnormalities. A more precise estimate of the global prevalence of presbyopia would require this quality of data from as many individual countries as possible. This would decrease the influence of confounding factors such as ethnicity, geographic location, climate, distance refraction, visual demand, and personal expectation. However, only a limited number of high-quality population-based studies have been completed at this time.

The available studies were generalized as carefully as possible based on ethnicity, location, and climate. For example, the functional presbyopia prevalence figure of

Table 4. Estimate of Global Uncorrected and Undercorrected Presbyopia

Region	Population Without Adequate Optical Correction, %	Population Without Adequate Optical Correction in Specified Year, No. in Millions			
		2005	2010	2020	2050
More-developed countries within regions[a]					
Australia and New Zealand	16	1.2	1.3	1.6	2.1
North America	16	9.9	11.3	14.4	19.3
Europe	4	9.9	10.5	11.2	11.3
Japan	16	4.8	5.0	5.5	5.0
Total		25.9	28.2	32.7	37.7
Less-developed countries within regions[a]					
Melanesia	61	0.5	0.6	0.8	1.7
Micronesia	61	0.0	0.0	0.0	0.1
Polynesia	61	0.0	0.0	0.1	0.1
Caribbean	61	3.7	4.2	5.0	6.2
Central America	61	12.8	15.4	21.6	37.8
South America	61	39.5	45.4	58.3	93.7
Eastern Africa	70	3.4	3.7	4.9	12.9
Middle Africa	70	1.6	1.8	2.2	5.3
Northern Africa	70	18.7	22.1	30.2	58.9
Southern Africa	70	5.3	5.5	5.6	7.7
Western Africa	70	12.4	13.7	17.5	43.7
Eastern Asia, excluding Japan	70	155.0	181.9	205.2	219.2
South-central Asia	70	111.7	128.3	146.6	166.2
Southeastern Asia	70	41.0	47.9	55.1	62.9
Western Asia	70	20.6	24.8	29.6	35.2
Total		426.2	495.4	582.7	751.3
Least-developed countries within regions[a]					
Melanesia	74	0.1	0.1	0.1	0.2
Caribbean	74	0.7	0.8	1.0	2.2
Eastern Africa	94	21.4	24.0	31.6	84.5
Middle Africa	94	7.5	8.4	11.1	30.6
Northern Africa	94	5.6	6.6	8.9	19.3
Southern Africa	94	0.2	0.2	0.2	0.2
Western Africa	94	8.2	9.4	12.9	37.0
South-central Asia	74	13.7	16.2	19.0	22.2
Southeastern Asia	74	5.7	6.6	7.6	8.7
Western Asia	74	1.5	1.8	2.1	2.5
Total		64.5	74.0	94.5	207.4
Global total		516.6	597.6	709.9	996.4

[a] The United Nations Department of Economics and Social Affairs classifies all countries in Europe and North America plus Australia, New Zealand, and Japan as more developed, and all other countries are either less or least developed.[34]

43.8% used for Asia was generalized from the Timor-Leste study.[37,38] Even though the Timorese prevalence figure seems low, it was felt that this conservative estimate should be used to avoid overstating the need. The alternative for Asia would be to use the objective presbyopia prevalence figure of 93.4% from the Andhra Pradesh Eye Disease Study in India.[17] Although the Andhra Pradesh study had a more thorough and robust method, use of the objective presbyopia definition will include people with myopia who do not have near vision impairment and do not require spectacles for near tasks. Given the prevalence of myopia in many countries in Asia, we elected to use the most appropriate functional presbyopia prevalence figure, thus excluding people with low to moderate myopia from the estimate.

Variations in methods explain some of the prevalence differences across the studies reported here. Methodological variations included the type of near visual acuity chart, working distance (predetermined or patient preference), type of illumination or test conditions (indoors or outdoors), and the survey method used. Pupil miosis increases depth of focus, assisting near vision particularly in bright sunlight[5]; this effect partly accounts for the lower prevalence of functional presbyopia in the Tanzanian and Timorese studies that were performed outdoors[18,37,38] compared with the Brazilian and Indian studies that were performed indoors.[17,21]

More epidemiological research in presbyopia is needed to decrease the assumptions and generalizations required for a better global estimate. As more data become available, an increasingly accurate picture of the burden of presbyopia will emerge.

Future studies of presbyopia should follow standardized definitions, protocols, and measurement methods similar to those developed by the Refractive Error Study in Children protocol for the World Health Organization's Prevention of Blindness and Deafness Program.[48] We propose using functional presbyopia with a cutoff at 0.4 logMAR (N8 at 40 cm) as it is the most practical direct measure of habitual near vision impairment.

Table 5. Estimate of Global Disability Caused by Uncorrected Presbyopia

Region	Population Feeling Disabled by Reduced Near Vision, %	Population Feeling Disabled by Reduced Near Vision in Specified Year, No. in Millions			
		2005	2010	2020	2050
More-developed countries within regions[a]					
Australia and New Zealand	7	0.5	0.6	0.7	0.9
North America	7	4.3	4.9	6.3	8.4
Europe	7	17.4	18.3	19.7	19.8
Japan	7	2.1	2.2	2.4	2.2
Total		24.4	26.1	29.0	31.4
Less-developed countries within regions[a]					
Melanesia	58	0.5	0.6	0.8	1.6
Micronesia	58	0.0	0.0	0.0	0.1
Polynesia	58	0.0	0.0	0.0	0.1
Caribbean	58	3.5	4.0	4.7	5.9
Central America	58	12.2	14.6	20.5	36.0
South America	58	37.6	43.2	55.4	89.1
Eastern Africa	53	2.5	2.8	3.7	9.8
Middle Africa	53	1.2	1.3	1.7	4.0
Northern Africa	53	14.2	16.8	22.9	44.6
Southern Africa	53	4.0	4.2	4.3	5.8
Western Africa	53	9.4	10.4	13.2	33.1
Eastern Asia, excluding Japan	53	117.4	137.7	155.4	166.0
South-central Asia	53	84.5	97.1	111.0	125.8
Southeastern Asia	53	31.0	36.3	41.7	47.6
Western Asia	53	15.6	18.8	22.4	26.6
Total		333.7	387.8	457.8	595.8
Least-developed countries within regions[a]					
Melanesia	70	0.0	0.1	0.1	0.2
Caribbean	70	0.7	0.7	1.0	2.1
Eastern Africa	70	15.9	17.9	23.5	62.9
Middle Africa	70	5.6	6.3	8.3	22.8
Northern Africa	70	4.2	4.9	6.6	14.4
Southern Africa	70	0.1	0.1	0.1	0.2
Western Africa	70	6.1	7.0	9.6	27.5
South-central Asia	70	12.9	15.3	18.0	21.0
Southeastern Asia	70	5.4	6.3	7.2	8.2
Western Asia	70	1.4	1.7	2.0	2.3
Total		52.4	60.2	76.4	161.7
Global total		410.5	474.1	563.2	788.9

[a] The United Nations Department of Economics and Social Affairs classifies all countries in Europe and North America plus Australia, New Zealand, and Japan as more developed, and all other countries are either less or least developed.[34]

PRESBYOPIC CORRECTION IN AN EYE CARE SYSTEM

Presbyopic correction can play an important role in the development of an integrated eye care system. The need for spectacles for presbyopia is already a major driver encouraging people to seek eye care,[40,49-51] especially in developing countries.[51] Visiting an eye care practitioner enables the detection of potentially permanently blinding diseases such as cataract, diabetes, and glaucoma at the same time if the eye care personnel are suitably trained.[50] Having the capacity to provide a solution to presbyopic problems will encourage even more people to seek care, and it allows for a more integrated model of eye care than vertical approaches such as those using cataract case finders.

However, it is also important to recognize that while spectacles provide an easy answer to the need for presbyopic correction, the mere handing out of spectacles without an appropriate eye examination biases against quality eye care for everyone regardless of socioeconomic status, sex, or geographic circumstance. Coupling spectacle distribution to meaningful eye care is an important link in the blindness prevention chain from community to hospital.[2,37] Random spectacle distribution breaks the chain of patient care and is counterproductive.

ECONOMICS

The economics of correcting presbyopia are also important to consider. Correction of refractive errors via an eye examination and provision of spectacles has been demonstrated to be one of the simplest and most cost-effective blindness prevention interventions.[49] While the monetary value of the burden related to presbyopia is unknown, presbyopia is particularly suited to correction with low-cost ready-made spectacles.[31,52,53]

Primary eye care consistently struggles for sustainability in countries without universal health care (indi-

cating a government's lack of willingness to pay) or a wealthy population base (where there is no community-based ability to pay). If linked in a constructive way with primary eye care, a global low-cost spectacle delivery system can contribute to the economic sustainability of primary eye care. A link between primary eye care, refraction, and dispensing will facilitate the development of a system to finance these services.

CONCLUSIONS

Functional presbyopia, experienced by people who cannot see clearly at near, affects more than 1 billion people, 517 million of whom do not have adequate near vision correction. Significant near vision disability is experienced by 410 million people. Access to spectacles for correction of presbyopia is not equal across the world—67% of people with presbyopia and 94% of people with significant near vision disability due to uncorrected presbyopia live in less- or least-developed countries. When the number of people with significant near vision impairment due to near uncorrected refractive error (410 million) is added to those with blindness or impaired vision due to distance uncorrected refractive error (153 million),[4] the number of people who would benefit from spectacles is an estimated 563 million. If the goal of Vision 2020 to eliminate unnecessary blindness and impaired vision, in this case due to uncorrected refractive error, is to be achieved, planning will have to include the provision of human resources, affordable spectacles, and systems of delivery for these half-billion people in need.

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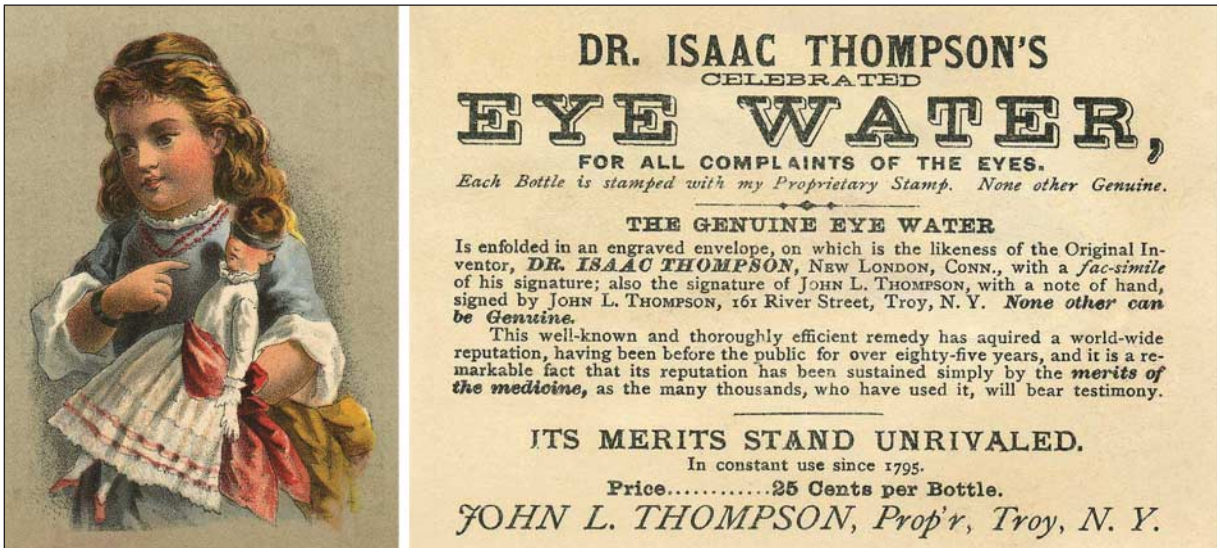
Ophthalmological Ephemera

In 1795, Dr Isaac Thompson concocted an eye water of zinc sulfate, saffron, camphor, and rose water. It was sold as late as 1939. This is 1 of a series of 32 medical trade cards advertising the product from 1875 through 1895.



Courtesy of: Daniel M. Albert, MD, MS