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Demographics

Vision Impairment Due to Uncorrected Presbyopia

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The need to wear spectacles or contact lenses or undergo some form of refractive surgery to see near objects clearly as a result of presbyopia causes measurable decreases in quality of life.[1] The effects will vary depending on several factors, such as the near task expectations, distance refraction, ethnicity, and gender,[2] and significant quality of life differences have been measured across modalities.[1] Furthermore, uncorrected refractive error has been identified as a major global public health problem in countries where inadequate refractive services exist.[2,3] This chapter will explore how many presbyopes there are, how they are distributed around the world, who they are likely to be within a community, and how their lives are affected by the vision impairment presbyopia causes.

The Prevalence of Presbyopia

Measures of the prevalence of presbyopia are dependent on the definition used.

The curves reported by Hofstetter[4] suggest that most Europeans will start to experience presbyopia beginning in their fortieth year of life and will be left with nothing much more than depth of focus (DOF) ability to change distance by 60 years of age. Clinicians argue that some people in their late 30s already experience presbyopic symptoms and seek appropriate treatments, but, in their experience, virtually everyone older than 50 years has some symptom(s) related to presbyopia that requires treatment.

Overall, because the development of presbyopia varies, it seems reasonable to conclude that, worldwide, a number of people (approximately 20%) start to experience presbyopia to a level requiring clinical management between 35 and 39 years of age. This increases to 50% for 40 to 44 year olds, to 80% for 45 to 49 year olds, and greater than 95% for those older than 50 years. If these percentages are applied to the population of each country in the world using the mid-2010* census, the estimated total number of presbyopes is approximately 2 billion people (29% of the world's population). (*Prevalence figures should be applied to individual country populations rather than globally because every country has specific age demographics [eg, the median age in Japan is 44.6 years, whereas it is 16.5 years in the Democratic Republic of the Congo]). Table 1-1 shows the population distribution around the world.

An accurate population-based survey would require the following:

- Clearly described tests and conditions, near vision threshold, and a method of differentiating optical defocus as a cause of reduced near vision from cataract or ocular pathology.
- Differentiation between presenting unaided and aided vision.

Pallikaris IG, Plainis S, Charman WN.
Presbyopia: Origins, Effects, and Treatment (pp. 3-10).

TABLE 1-1. *ESTIMATED NUMBER OF INDIVIDUALS WITH PRESBYOPIA FROM VISION SCIENCE AND CLINICAL ASSUMPTIONS*

WORLD HEALTH ORGANIZATION REGION	MID-2010 POPULATION (MILLIONS[5])	PREVALENCE OF PRESBYOPIA (%)	NUMBER OF PEOPLE WITH PRESBYOPIA (MILLION)
Africa	830	15	128
Americas	936	32	302
Eastern Mediterranean	600	19	115
Europe	901	42	376
Southeast Asia	1767	25	442
Western Pacific	1819	35	645
Total	*6853*	*29*	*2008*

Note: Although the same prevalence numbers for the specified age groups were applied to every country of each region, the total population prevalence is different in each region due to the variation in age demographics–regions with older populations will have a higher prevalence percentage of presbyopia.

- A sample size of 1000 individuals or more, with randomized participant selection, participation and eligibility rates provided, and clearly described inclusion criteria.

The above conditions were met and were summarized and extrapolated into a global representation by Holden et al.[2] The prevalence and number of presbyopes yielded by that study were dramatically different than those arising from the assumptions used for Table 1-1. The published figure of 1.044 billion people with presbyopia by Holden et al[2] was based on mid-2005 populations. Bringing their methods and prevalence forward to mid-2010 for comparison, epidemiological techniques suggest there were 1.22 billion people with presbyopia in mid-2010, but still significantly lower than the estimate of 2 billion.

The definition of presbyopia is one factor responsible for the difference between the two estimates. Epidemiologic studies are more likely to use the definition "functional presbyopia," in which an individual is considered presbyopic if he or she requires a significant optical correction (eg, ≥+1.00 D) added to his or her preferred distance refractive correction to achieve a near visual acuity criterion (eg, one or more lines of acuity improvement). In contrast, clinicians are more likely to use "objective presbyopia," in which an individual is considered presbyopic if he or she requires a significant optical correction added to his or her best distance optical correction to improve near vision. A key consequence of the difference between functional and objective presbyopia is that individuals with low to moderate myopia may never develop functional presbyopia, but they will develop objective presbyopia.

Other factors responsible for the difference between the 2 estimates of the presbyopic population include the following:

- Higher and more stringently applied thresholds in epidemiology (working to vision impairment levels) compared with clinical (correcting noticeable differences).
- Ethnicity, climate, geographic location, and urbanization differences not taken into account in clinical estimates.
- Differences in test conditions (eg, studies from Tanzania and Timor Leste,[6-8] both sources of primary epidemiology evidence cited by Holden et al,[2] used "prevailing outdoor illumination," which is likely to be brighter than clinical test conditions, thereby causing smaller pupil sizes, larger DOFs, and lower estimates of presbyopia).

The total number of individuals with presbyopia (somewhere between about 1.2 and 2 billion, depending on estimation method) is of interest from the perspective of planning a workforce able to provide care to these individuals, infrastructure able to supply currently available treatment and correction modalities, and facilitating the judgment of the viability of bringing new technologies to market.

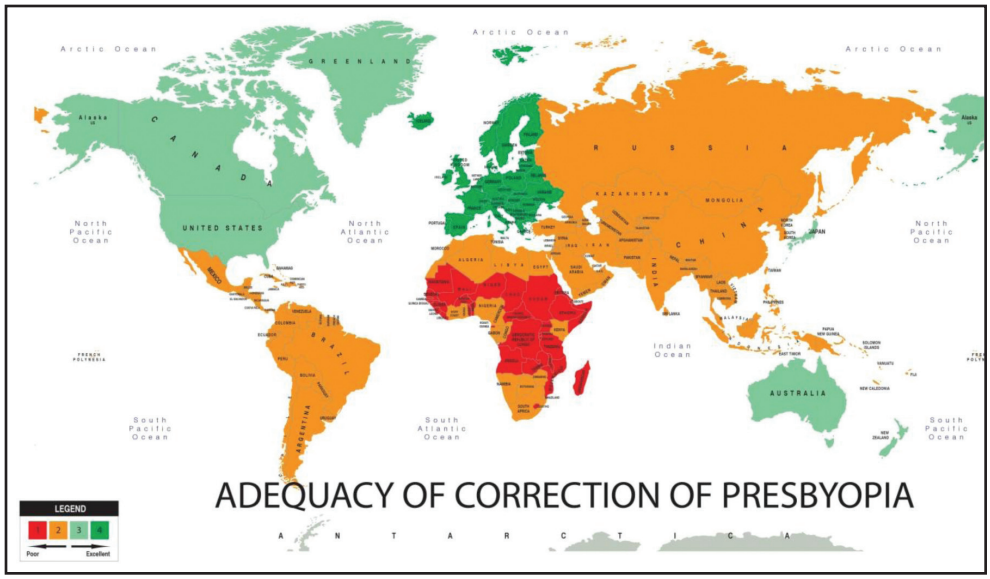

Figure 1-1. Estimate of the adequacy of access to correction of presbyopia in individual countries in 2010. Spectacle coverage rates for presbyopia are estimated at less than 10% in countries shaded red, 10% to 50% in countries shaded orange, 50% to 90% in countries shaded light green, and over 90% in countries shaded dark green. (Reprinted with permission of Professor Brien A. Holden.)

THE LEVEL OF VISION IMPAIRMENT FROM UNCORRECTED PRESBYOPIA

The total number of individuals with presbyopia is also of interest as a precursor to the figures of greatest public health interest—the number of individuals with impaired vision due to uncorrected or undercorrected presbyopia and how it impacts 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.[9,10] However, underserviced areas of the world (including subpopulations within wealthy countries) have high levels of uncorrected and undercorrected distance refractive errors,[11,12] and anecdotal observations suggest that the incidence of near-vision impairment is likely to be as high. 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 attain spectacles.[6,13-15]

The global prevalence of uncorrected presbyopia can be determined by combining prevalence figures with spectacle coverage rates. Spectacle coverage rates vary widely across countries and regions. In Tanzania, only 6% of the population with presbyopia had corrective near-vision spectacles.[3] In Brazil, 55% of individuals with presbyopia had spectacles, but only 71% of these corrections were adequate (ie, 39% of presbyopic Brazilians have adequate near optical correction).[16] Only 30% of individuals with presbyopia in India and 26% in Timor Leste had appropriate corrective near-vision spectacles.[7,8,13] In an Australian population-based study, 85% of men and 87% of women over age 40 years wore spectacles at their near-vision assessment, and 98% were able to read N8 print with those spectacles[17] (ie, 84% had appropriate corrections). A Finnish study found that 96% of a sample population aged over 30 years were able to read newsprint with their current spectacles.[18]

Holden et al[2] used this kind of published evidence to calculate the global prevalence of vision impairment from uncorrected or undercorrected presbyopia, matching populations as closely as possible for geographic region and level of development. In summary, 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%.[19] The likelihood rises to 30% to 39% for "less-developed" countries and is 84% to 96% for "more-developed" countries. Globally, bringing the data forward to mid-2010 populations and assuming no dramatic changes in spectacle coverage rates over the past 5 years, there are approximately 600 million people with vision impairment from uncorrected or undercorrected presbyopia.

THE DISTRIBUTION OF UNCORRECTED PRESBYOPIA

Figure 1-1 maps the likelihood of an individual with presbyopia possessing spectacles that correct his

TABLE 1-2. *ESTIMATE OF NUMBER OF PEOPLE WITH VISION IMPAIRMENT (VI) FROM UNCORRECTED OR UNDERCORRECTED PRESBYOPIA FROM EPIDEMIOLOGICAL EVIDENCE*

WORLD HEALTH ORGANIZATION REGION	PREVALENCE OF PRESBYOPIA (%)	NUMBER OF INDIVIDUALS WITH PRESBYOPIA (MILLION)	NUMBER OF INDIVIDUALS WITH VI FROM UNCORRECTED OR UNDER-CORRECTED PRESBYOPIA (MILLION)
Africa	10	86	71
Americas	24	221	84
Eastern Mediterranean	12	69	49
Europe	33	294	32
Southeast Asia	13	222	156
Western Pacific	18	328	208
Total	*18*	*1220*	*600*

or her near vision to a reasonable level, whereas Table 1-2 shows how individuals with vision impairment from uncorrected or undercorrected presbyopia are distributed around the world.

HOW DOES VISION IMPAIRMENT FROM UNCORRECTED PRESBYOPIA AFFECT PEOPLE'S LIVES?

The societal burden of vision impairment from uncorrected or undercorrected presbyopia depends not only on how many people it affects, but also on the impact the impairment causes to individuals. Uncorrected presbyopia is likely to affect individuals differently, depending on socioeconomic, geographic, cultural, and individual variables. The disability experienced by someone who depends on clear near vision for work is likely to be greater than someone who can function without clear near vision.

A long-standing assumption is that people who read are affected by presbyopia, whereas those who do not read are not affected. An extension of this has been an assumption that presbyopia is less important in developing countries than developed countries. These assumptions were conclusively disproved by Patel et al[3] who showed that uncorrected presbyopia had substantial impact on activities of daily living in rural Tanzania. People with uncorrected presbyopia in rural Tanzania found it more difficult to read, write, cook, winnow grain, sort grain, thread needles, weed, harvest sorghum, and attend to personal grooming.[3] Overall, people with uncorrected presbyopia were more than 8 times more likely to report "high difficulty" with near tasks than those without uncorrected presbyopia. The strength of the effect was related to the amount of presbyopia (measured by the size of the near addition required for best near vision).

Published measures of the impairment caused by uncorrected presbyopia show that 70% of rural Tanzanians, 58% of Brazilians, and 53% of Indians with functional presbyopia experience difficulty with relevant near tasks when using their habitual spectacles.[3,13,16]

In developed countries, the only near vision disability measure investigated by any study is 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 their sample population felt capable of seeing for reading, and 96% of the same sample were able to read newsprint with their current spectacles.[18]

Holden et al[2] combined this evidence to estimate the global number of individuals feeling disabled by uncorrected presbyopia. As much as possible, the study used local definitions of feeling disabled. Their methods, brought forward to mid-2010 population figures, estimate that about 460 million individuals feel disabled from uncorrected presbyopia. The regional distribution of this problem is shown in Table 1-3.

TABLE 1-3. *ESTIMATED NUMBER OF INDIVIDUALS DISABLED BY UNCORRECTED OR UNDERCORRECTED PRESBYOPIA FROM EPIDEMIOLOGICAL AND IMPACT EVIDENCE*

WORLD HEALTH ORGANIZATION REGION	NUMBER OF INDIVIDUALS WITH DISABILITY FROM UNCORRECTED OR UNDERCORRECTED PRESBYOPIA (MILLION)	PREVALENCE OF DISABILITY FROM UNCORRECTED OR UNDERCORRECTED PRESBYOPIA (%)
Africa	53	6
Americas	71	8
Eastern Mediterranean	38	6
Europe	22	2
Southeast Asia	122	7
Western Pacific	156	9
Total	*462*	*7*

GROUPS MOST AFFECTED BY UNCORRECTED PRESBYOPIA

Age is the obvious and most significant determinant of presbyopia. Ethnicity with more skin and ocular pigment, living in a climate of higher average ambient temperature, geographic location closer to the equator and/or higher altitude, and increased urbanization are all probably associated with earlier onset of presbyopia.[2] The studies noting these associations are almost certainly confounded, but the general trends are worth noting.

There have been conflicting reports of gender associations of presbyopia, but the confounding factors of arm length, expectation, access to refractive care, and presence of reduced vision from other causes appear too strong to judge any real association either way.[20]

The groups most affected by presbyopia will be determined by 2 factors: (1) differential access to eye care and (2) differential value placed on correction of presbyopia.

Barriers to eye care are individual- and community-dependent, but the following are noted by the International Agency for the Prevention of Blindness (IAPB) as globally significant barriers preventing individuals from accessing refractive care[14]:

- Lack of awareness (of services or the benefit of care).
- Difficulty accessing services (too far, too expensive, etc).
- Acceptability of services provided (culturally relevant, in appropriate language, etc).
- Lack of perceived need (unaware of the potential benefits of care).
- Fear (that treatment could worsen or weaken eyes, or fear of the process).
- Gender and social issues (eg, willingness of a primary care provider within a family to access care).
- Cosmesis of treatments.
- Direct treatment costs.
- Transportation costs and/or availability of transport.
- Inability to take time off from family or work responsibilities, lack of somebody to accompany them.
- Social acceptance of treatment (eg, wearing glasses seen as something for wealthy, city people, but inappropriate for poor, illiterate rural people).
- Fatalism (accepting vision loss as an unavoidable consequence of age, "karma," or "God's will").

The value placed on correction of presbyopia is the other factor that determines who will have vision

impairment from uncorrected presbyopia. A widely held presumption is that educational level and literacy are the only determinants of the value placed on correction for presbyopia. Several studies provided evidence that higher education level and literacy do increase the value placed on correction of presbyopia.[21,22] However, the work by Patel et al,[3] reviewed in the previous section, established that there are many other reasons to value presbyopia correction; in rural Tanzania, correction of presbyopia facilitates not only reading, but also cooking, winnowing grain, sorting grain, threading needles, weeding, harvesting sorghum, and attending to personal grooming.

A few pieces of published evidence explore the relative importance of barriers versus value of vision correction on care-seeking behavior. In Andhra Pradesh, India, 47% of participants with vision impairment from uncorrected presbyopia reported they had not sought care either because they did not have a serious problem or they felt their vision was adequate.[13] The other 53% of participants in Andhra Pradesh were restricted from obtaining correction by a variety of barriers such as cost, distance to care, lack of awareness of services, discomfort with care available, and fear.[13] The Los Angeles Latino Eye Study[21] found that uncorrected refractive error (all types, rather than specifically uncorrected presbyopia) related to ethnicity, low income, lack of health insurance, and low level of education, which are factors considered mostly as barriers to care rather than reducing the value placed on correction. Laviers et al[23] reported that providing spectacle corrections for individuals whose presbyopia had previously been uncorrected due to cost and other barriers improved their visual function scores, quality of life, and the value they placed on correction. The evidence, particularly from Laviers et al,[23] points to the circularity of arguments distinguishing between access to eye care and the value placed on correction of presbyopia. Barriers to eye care can cause a lack of awareness of treatment effect and therefore a lack of value placed on treatment. Lower education level and literacy not only produce a lower value on correction of presbyopia but also increase the barriers to eye care (eg, awareness of services). Laviers et al[23] demonstrate the value to the individual, the community, and the ophthalmic industry of working to break out of the cycle of barriers to care and lack of value placed on optical correction.

SUMMARY

Uncorrected refractive error is the largest global cause of distance vision impairment (150 million individuals based on 2004 figures).[14] Uncorrected and undercorrected presbyopia also cause vision impairment to 600 million people based on 2010 figures. The presbyopia numbers are based on functional presbyopia (rather than objective presbyopia), and thus exclude the majority of older people with myopia. There will be some (unknown) overlap of the presbyopia cases with cases of vision impairment from uncorrected hyperopia and uncorrected astigmatism, but there are still approximately 700 million people in the world who would have vision impairment "cured" if they could have access to eye examinations and spectacles.

Ophthalmic professionals and the ophthalmic industry have a key role to play in overcoming this burden on society. The following strategies are important to effective solutions:

- Effective case identification (vision screening, community informants, public health education, outreach, etc) and refraction examinations are both important.
- Availability of affordable and acceptable spectacle correction for individuals who have refractive error blindness or vision impairment is just as important.
- Ocular health examination concurrent with refractive care, particularly for those aged 45 years or over, is also equally important as it provides an opportunity to identify other potentially blinding conditions (such as glaucoma and diabetic retinopathy) before they cause permanent vision loss, and adequate care or referral pathways are needed after identification.
- Eye health promotion that achieves community education (aimed at engaging individuals, families, and communities who have uncorrected refractive error), service improvements (aimed at practitioners to enable increased quality and quantity of services), and advocacy (aimed at funders and legislators who can facilitate growth of services) are also required.

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