



# Classification of Presbyopia by Severity

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## ABSTRACT

There are close to two billion individuals globally living with presbyopia. In spite of its ubiquitous and progressive nature, there is no widely accepted, formal guideline or consensus statement on the classification of presbyopia by degree of severity. A panel of leading eye care professionals representing both optometrists and ophthalmologists convened virtually to discuss and document their combined assessments from the body of literature and clinical practice expertise in this commentary. In light

of emerging therapies, classifying presbyopia by mild, moderate, or advanced severity may help provide consistency of diagnosis among eye care providers and may aid in managing patient expectations with different treatment options.

**Keywords:** Classification of presbyopia; Presbyopia; Severity

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## Key Summary Points

### *Why write this paper?*

There are close to two billion individuals globally living with presbyopia, a condition that results in significant reduction in quality of life and impairs activities essential for daily living.

In spite of its ubiquitous and progressive nature, there is no widely accepted, formal guideline or consensus statement on the classification or severity of presbyopia.

This paper seeks to develop a consensus understanding of mild, moderate, and advanced presbyopia according to three factors: clinical/behavioral symptoms, visual acuity, and near vision correction (diopters).

### *What was learned from this paper?*

While the most common means of diagnosing and classifying presbyopia appears to be age, it is not a true indicator of severity of condition and should be seen as a screening tool rather than as an indicator of severity of presbyopia.

The required add power for the distance-corrected eye to produce functional near vision is the best means of classifying presbyopia by severity.

The authors propose mild presbyopia as requiring  $< 1.25\text{D}$  of add power, a moderate presbyope as requiring between  $> +1.25\text{D}$  and  $+2.0\text{D}$  add power, and an advanced presbyope as requiring  $> +2.0\text{D}$  of add power.

## INTRODUCTION

A healthy, fully functional visual system is able to accommodate (pun intended) robust changes in focal length to project a clear, focused image

on the retina of objects from near to infinity. This dynamic characteristic of the visual system is regulated by the crystalline lens, capsule, zonules, and ciliary muscle. As the eye ages, changes in proteins and the formation of higher molecular weight entities lead to increasing lens thickness, lens sclerosis, and decreasing elasticity of the capsule [1]. In 2015, there were an estimated 1.8 billion people globally with presbyopia [2], and the prevalence is expected to increase with a growing aging population. Wolffsohn and Davies determined that “Presbyopia occurs when the physiologically normal age-related reduction in the eye’s focusing range reaches a point, when optimally corrected for distance vision, that the clarity of vision at near is insufficient to satisfy an individual’s requirements” [3].

Waring et al. proposed stratifying the stages of the aging lens in 2018 [1]. They determined that the onset of presbyopia is the first stage of age-related changes referred to as dysfunctional lens syndrome, which progresses towards lenticular opacity and eventually the need for cataract surgery. Despite the progressive nature of presbyopia, there is no widely accepted, formal guideline or consensus to further stratify presbyopia by severity.

While there are modern options currently available to treat presbyopia, the oldest and still most common solution is reading glasses. Though considered the standard, reading glasses have some associated risk: older adults with multifocal glasses are 2.3 times more likely to fall than those with single vision or no glasses [4]. Presbyopia contact lens solutions (multifocal or monovision) also have limitations. Less than half of presbyopic contact lens patients in the United States are even offered multifocal or monovision options [5], and of those who do get them, only 50% are still using them after 6 months [6]. Many of the more recent innovations are coupled with invasive or permanent procedures, leaving few nonsurgical choices for individuals with milder presbyopia [7]. Fortunately, new technologies are in late-stage development or clinical trials that could dramatically increase treatment options directed towards the cornea, the sclera, the lens, the pupil, or other structures of the eye [8]. As the

options expand, it will become important to correctly identify patients at specific stages of disease progression, allowing for a tailored approach to management of presbyopia [9, 10].

For the first time, pharmacological therapies may become available that will leverage mechanisms that either increase the depth of focus through pupil modulation or a proposed mechanism of lens softening [11, 12]. Pharmacologics that induce miosis employ the principles of small aperture optics to offer presbyopic patients a temporary increase in depth of focus for the duration of the miotic effect [13]. Theoretically, patients at any stage of presbyopia may benefit, although the degree of near vision improvement obtained will likely correlate with the patient's baseline visual acuity. Pharmacologics containing lipoic acid and choline ester chloride propose to reduce rigidity of the lens, thereby increasing the dynamic refractive power of the crystalline lens [14]. This therapy will likely be best applied to eyes in the early stages of presbyopia.

Laser scleral microperforation (LSM) is another new approach that decreases scleral cross-linked tissue overlying the ciliary muscles, thereby hopefully increasing accommodative ability. An early study [15] shows improvement in distance-corrected near vision from 20/60 preoperatively to 20/34 at 6 months, perhaps indicating that this procedure will be best used in moderate presbyopes rather than advanced presbyopes.

These emerging treatments may potentially supplement traditional treatments, as they will move a patient along the severity spectrum, i.e. from moderate to mild presbyopia, rather than correcting them for reading at a single distance as with a pair of glasses. Clinicians may be able to personalize a patient's treatment to fit their lifestyle needs by correctly utilizing the upcoming therapies to reach a desired goal. With so many tools in the toolkit, clearly diagnosing baseline visual acuity becomes much more important.

The objective of the authors of this paper is to develop a consensus understanding of mild, moderate, or advanced presbyopia according to three factors: clinical/behavioral symptoms, visual acuity, and near vision correction/

required add power (diopters). The terms "mild," "moderate," and "advanced" to classify presbyopia are directly related to the accommodative reserve of the lens and thus refer to lenticular dysfunction. In other words, the baseline severity of presbyopia determines how much improvement is needed for an individual to obtain functional vision. Such an understanding of presbyopia by baseline severity would facilitate consistency between health care practitioners and their ability to best match patients to the optimal treatment.

## METHODS

A literature search was conducted that included peer-reviewed papers in English in optometry and ophthalmology, academic textbooks, and published recommended practice patterns by the preeminent professional organizations, to find any existing classification of presbyopia by severity. This article does not contain original research data.

The authors of this paper are experts across private practice and academia in optometry and ophthalmology, with well-established interests in refraction and methods to address refractive error. This article does not contain any new studies with human participants or animals performed by any of the authors.

## RESULTS

### Behavioral/Clinical Findings

Symptoms of presbyopia are noticeable to individuals long before they seek out an eye care professional. One survey of 1739 individuals with self-diagnosed presbyopia found that only two-thirds had spoken to an eye care provider regarding their condition [16]. Whether due to lack of seeking treatment or ability to pay for it, it is estimated that approximately 45% of presbyopes are living with near vision impairment due to no or inadequate vision correction [3]. For untreated presbyopes, the burden of the condition is even greater, as it impairs activities essential for daily living, from reading to

growing food, cooking, and caring for children [17]. The resulting productivity loss is estimated to be over USD \$25 billion for individuals under age 65 [18].

As the loss of near visual acuity directly impacts many activities of daily living [17], uncorrected presbyopes often develop numerous coping systems prior to purchasing reading glasses. Common knowledge tells us that mild presbyopes may need to hold objects farther away in order to see them clearly and can have difficulty focusing in very dim lighting. Mild presbyopes may tire from reading or develop headaches or other asthenopias. Moderate presbyopes often need brighter lighting conditions, as well as some sort of reading aid in most settings. They may take a picture with their phone so they can then magnify it to see the object clearly; they reach a point where they can no longer cope with their condition and must seek treatment. Advanced presbyopes are not able to read at near or intermediate distances without some kind of aid. They may be able to read street signs but struggle to read the speedometer, or they may not be able to clearly identify food on their plate.

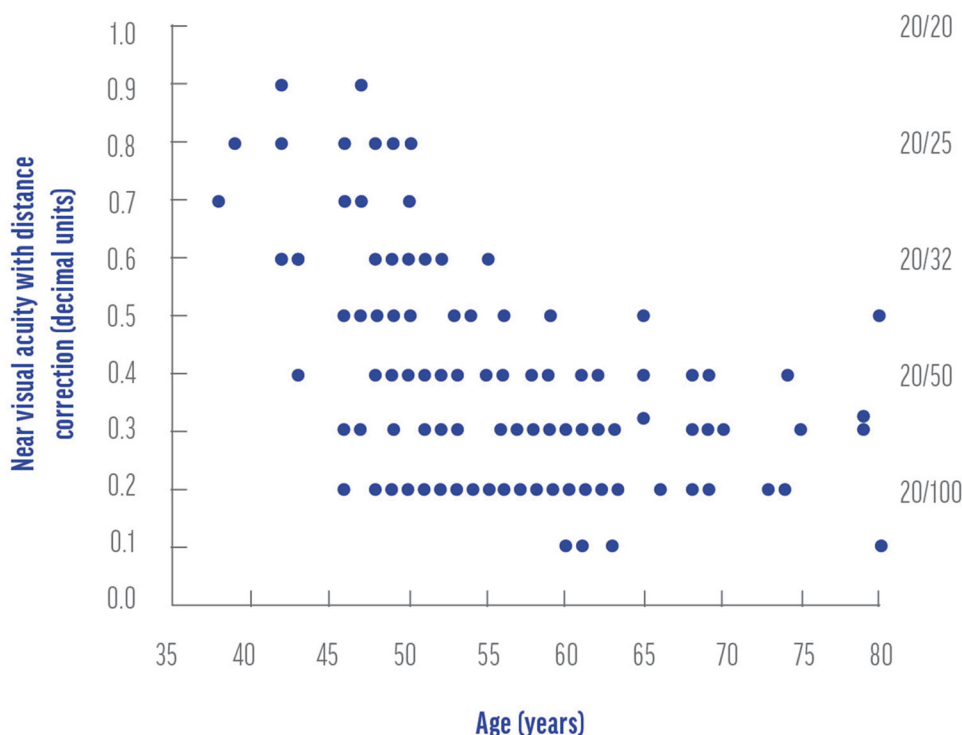
While patient behavior is more difficult to quantify than near visual acuity, it can be of equal value when evaluating new treatments. Patient-reported outcome (PRO) instruments are more commonly being developed in studies today to consistently quantify subjective outcome measures, allowing for systematic evaluation of functional improvements and quality of life. The US Food and Drug Administration (FDA) is beginning to appreciate the value of the patient perspective and seeking to incorporate it into their assessments of new ophthalmic drugs and devices [19]. More specifically, a task-based PRO instrument has been developed in accordance with the FDA's PRO guidance. The Near Vision Presbyopia Task-based Questionnaire (NVPTQ) allows participants to assess their own ability to perform near vision tasks in both mesopic and photopic lighting. The Presbyopia Impact and Coping Questionnaire (PICQ) evaluates the participant's self-reported use of a coping behavior to perform the task (increase font size, squint, adjust brightness), and their

satisfaction with their ability to perform the task [20].

## Age

Since presbyopia is a progressive condition that results from the natural aging of the lens, it follows that the severity of presbyopia is highly correlated with age. Donders first published the outcomes of his early version of a push-up test on 130 individuals from 10 to 80 years of age in 1864 [21]. Duane used a similar testing technique with a much larger sample of eyes, and published his own data on the relationship between age and accommodative amplitude [22]. Hofstetter continued this work, attempting to reconcile the differences between Donders' and Duane's work, and concluded that the data did not "justify the use of any specific curve to represent the trend of the amplitude with the age" [23].

It is clear that the loss of flexibility of the lens starts at birth and progresses throughout life, but even at age 70, there is some residual accommodation [3]. While studies correlating required add power and age do create a sigmoidal curve, it should be noted that the standard deviation of each point is generally quite large [24–26] (Fig. 1). For example, individuals 45 years of age were found with near visual acuity ranging from 20/25 to 20/100, and individuals at the other extreme, aged 65, also had a near visual acuity ranging similarly from 20/40 to 20/100. Not only do individuals age differently, but refractive error also impacts how each person will experience presbyopia. Myopes naturally compensate and tend to notice the lack of accommodation later than hyperopes. Panke and colleagues evaluated 216 adults aged 35–80 and concluded that the usability of age to anticipate expected near add requirements was limited due to large individual differences [27]. Although its value as a screening factor is unquestionable, age in diagnostic terms is actually more of an indirect indicator of severity, with high individual-level variability.



Adapted from: Panke K, Ikaunieks G, Svede A, et al. Limitation of tables indicating the relation between age and reading addition for presbyopia correction. Conference Paper. June 2019 DOI: 10.1117/12.2527291

[https://www.researchgate.net/publication/333816776\\_Limitation\\_of\\_tables\\_indicating\\_the\\_relationship\\_between\\_age\\_and\\_reading\\_addition\\_for\\_presbyopia\\_correction/link/5da0227045851553ff06a4c5/download](https://www.researchgate.net/publication/333816776_Limitation_of_tables_indicating_the_relationship_between_age_and_reading_addition_for_presbyopia_correction/link/5da0227045851553ff06a4c5/download)

**Fig. 1** Relationship between age and near vision correction required demonstrates that while there is a correlation, the standard deviation of each point is quite large, making age more useful as a screening tool for presbyopia rather than a true indicator of near add requirement

### Near Visual Acuity

Presbyopia presents clinically as the loss of near visual acuity; therefore, determining the severity of presbyopia is most directly measured by assessing a patient’s near vision. There are multiple options for assessing near vision, so any number of methods may be appropriate. While distance vision is generally measured at 20 feet or 6 m, near vision is commonly assessed at 14 inches or 35 cm from the phoropter. The most common near visual acuity test is the Jaeger Schrift–Scalen Test, or Jaeger for short. However, near vision can also be assessed with Snellen, logMAR (logarithm of the minimum angle of resolution), or M tests [28]. As reading tests can be influenced by differing native

languages or low literacy, an optotype test rather than a reading test may be considered.

At an exam, understanding the patient’s near visual acuity gives the clinician an idea of the baseline severity of the patient’s presbyopia, but additional considerations may be made as to the required level of correction for the patient to attain functional near vision. Although approval by the US FDA may require a presbyopia treatment to provide three lines of improvement without loss of distance vision, a mild presbyope may start with near vision of 20/40, making three lines of improvement difficult to achieve. Or a severe presbyope may start with 20/100 near vision and might easily achieve three lines of improvement, but still have difficulty with near vision. It is

**Table 1** Comparison of various near visual metrics

| Snellen DCNVA | Jaeger equivalent | M   | Print size | Example                                 |
|---------------|-------------------|-----|------------|---|
| 20/20         | J1                | 0.4 | 3 pt font  | Medicine bottle labels                  |
| 20/25         | J2                | 0.5 | 4 pt font  | Legal disclaimers on bank statement     |
| 20/30         | J3                | 0.6 | 5 pt font  | Footnotes, bible                        |
| 20/40         | J5                | 0.8 | 7 pt font  | Splenda packet, driver's license        |
| 20/50         | J6                | 1.0 | 8 pt font  | Want ads                                |
| 20/80         | J9                | 1.6 | 11 pt font | Standard text font                      |
| 20/100        | J10               | 2.0 | 12 pt font | Business card                           |
| 20/200        | J14               | 4.0 | 23 pt font | Children's book, newspaper sub-headline |

Information adapted from [30, 31]

DCNVA distance-corrected near visual acuity



**Image 1** Exam room at 33 lux. Image courtesy of Melissa Barnett, OD



**Image 2** Exam room at 180 lux. Image courtesy of Melissa Barnett, OD

noteworthy that a published review of everyday social reading activities found common print size to be approximately J5 or 20/40 [29], demonstrating that functional vision may be attained without reaching 20/20 near vision (Table 1).

Changing luminance can also significantly impact visual acuity, where a doubling of luminance levels improves acuity by one letter on a five-letter row [32, 33]. While clinical practice may lean towards measuring visual function in photopic conditions, interestingly, US FDA assessments of presbyopia treatments

may include evaluation under more challenging mesopic conditions. Thus, visual function in low luminance (mesopic—10–11 lux) (Image 1) conditions should be examined along with visual function in high luminance (photopic—> 255 lux [34]) (Image 2) conditions. Standardizing the illumination level in the exam room is possible using basic smartphone applications such as the Lux Light Meter Pro, which measure the lumens in the room. Intermediate vision evaluation should also be considered, as mild presbyopes will still retain their intermediate vision but advanced presbyopes likely will not.

**Table 2** Expert panel's suggested guidelines for average characteristics related to mild, moderate, and advanced presbyopia\*

|                                 | Mild presbyopia   | Moderate presbyopia  | Advanced presbyopia   |
|---------------------------------|---|--|---|
| Near add required               | < +1.25 D   | > 1.25 to +2.00D   | > +2.00D  |
| DCNVA<br>(photopic)             | 20/25–20/40   | > 20/40–20/80  | > 20/80   |
| Jaeger equivalent<br>(photopic) | < J3  | J4–J9  | > J9  |
| DCNVA<br>(mesopic)              | 20/25–20/50   | > 20/50–20/100   | > 20/100  |
| Jaeger equivalent<br>(mesopic)  | ≤ J5  | J6–J10   | > J10   |
| Behavioral/clinical<br>findings | Holding objects further away,<br>difficulty in very dim<br>lighting | Turning up lights in most settings,<br>require aids in almost all<br>circumstances | Inability to read at near and<br>intermediate distance<br>without aid |
| Typical age                     | 40–47 years   | > 47–55 years  | > 55 years  |
| Refractive error                | Hyperopes earlier and more<br>impacted                              | Hyperopes earlier and more<br>impacted   | No difference between<br>hyperopes and myopes                         |

\*These are averages for the distance-corrected presbyope, and individuals will fall outside of these. Near add required is the most significant indicator of severity of presbyopia

The authors propose that individuals with distance-corrected near visual acuity (DCNVA) in photopic conditions from 20/25 to 20/40 (< J3) be considered a mild presbyope, from > 20/40 to 20/80 (J4–J9) be considered a moderate presbyope, and of 20/80 or worse (> J9) be considered an advanced presbyope. In mesopic conditions, individuals with DCNVA of 20/25 to 20/50 may be considered a mild presbyope, of > 20/50 to 20/100 may be considered a moderate presbyope, and of > 20/100 may be considered an advanced presbyope.

### Add Power

Presbyopia is clinically defined as the point at which near working distance dioptrically equals half of the accommodative amplitude. Thus, if an individual's working distance is 40 cm and his/her accommodative amplitude measures less than 5.0 D, he/she is considered presbyopic.

As the amplitude of accommodation diminishes, near add power is required to see clearly. Determining the near add power required by an individual is generally done by first establishing a tentative addition and then accounting for the individual's arm length, visual needs, and most common working distance to establish a final adjustment. Determining the tentative near add can be done a number of ways, including balance of negative relative accommodation (NRA)/positive relative accommodation (PRA), dynamic retinoscopy, fused cross-cylinder (FCC) test with and without myopization, near duochrome test, the half-the-amplitude method, plus build-up method, or by using an age chart. There are numerous published studies comparing the accuracy of the various methods of determining accommodative amplitude [35–37].

In this expert panel's opinion, the required add power for the distance-corrected eye to produce functional near vision is the best

means of classifying presbyopia by severity. Currently there are no published standard classification guidelines for severity of presbyopia by required diopters of add by the American Optometric Association (AOA) or the American Academy of Ophthalmology (AAO). The AOA classifies presbyopia as incipient, functional, absolute, and premature only in vague terms of symptoms [38], while the AAO does not further categorize. Contact lens manufacturers classify multifocal contact lenses with low or high add as appropriate for mild or moderate/severe presbyopia, respectively [22, 39], but this label refers to the lens optical design rather than specific patient parameters.

Taking into consideration contact lens labeling and the clinical experience of the authors, it is proposed that a mild presbyope be classified as an individual requiring  $\leq +1.25D$  of add power, a moderate presbyope as requiring between  $> +1.25D$  and  $+2.0D$  add power, and an advanced presbyope as requiring  $> +2.0D$  of add power.

## DISCUSSION

It is important to note that there are a number of causes of accommodative anomalies encompassing a wide range of ocular and systemic conditions including trauma, inflammatory diseases, toxicity, vascular diseases, medications, environmental factors, iatrogenic causes, and more [40–43]. It is not the aim of this paper to cover all of these, and a complete eye examination and thorough patient history is always recommended.

While we depend on regulatory agencies to thoroughly review the safety and efficacy of new therapeutics, approval does little to guide best practices in a new treatment paradigm. The FDA requires a presbyopia treatment to provide three lines of improvement from baseline to be considered effective. However, the amount of near vision improvement required by an individual to reach functional vision varies. An individual with early presbyopia may need very little correction to experience a meaningful improvement in visual ability, whereas an individual with advanced presbyopia may need

significantly more than three lines of improvement to accomplish their visual tasks.

Management of presbyopia allows patients to improve how they function in the daily tasks of living, as well as their quality of life. Understanding the severity of presbyopia that a patient is experiencing will also allow clinicians to manage the patient's expectations. An advanced presbyope most likely won't be able to read very small print in low light conditions even if they undergo treatment for presbyopia, but they will likely be able to read their speedometer and a book in good lighting.

With this upcoming revolution in treatment, there will be a concurrent need to more definitively stage each patient's condition. This group of authors suggests the following guidelines based on combined clinical practice experience and literature review for the classification of presbyopia by severity, and furthermore agrees that the most important indicator of severity is the required near add power (Table 2). Near add power is the most direct and accurate measure of accommodative loss, and the appropriate near vision correction ultimately depends on the functional demands of the patient. Furthermore, accurately characterizing and standardizing the language around the disease state in this new treatment paradigm would create consistency amongst clinicians and lay a single foundation for future conversations in the field.

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**Data Availability.** This article does not contain any new data nor are there any associated data sets.

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