



# Journal of Optometry

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## SCIENTIFIC LETTERS

### Definition of refractive errors for research studies: Spherical equivalent could not be enough

Currently many areas of the world are facing an epidemic of myopia.<sup>1,2</sup> The standardization of terminology, recently undertaken by the International Myopia Institute (IMI) members on defining and classifying myopia experts is not only positive, but necessary.<sup>2</sup> In addition, a simple but fundamental principle is that it should be clear not only what is defined as myopia, but the different refractive states of the eye, including emmetropia, hyperopia and astigmatism.

However, the proposal made by IMI experts might not be the most suitable option, simply because it was based on a measurement that does not adequately describe the refractive error of a given eye: the spherical equivalent.<sup>3</sup> It is known that the presentation of the refractive state data of a group of eyes based solely on the spherical equivalent loses specificity and sensitivity of the refractive error calculation, because it lacks all the information on the astigmatic component of the optical system.<sup>3</sup> Two eyes with very different refractive errors may have the same spherical equivalent, and also eyes with negative spherical equivalent may have a hyperopic principal meridian (as in the case of many mixed astigmatism), which makes it wrong to classify them as myopic eyes.

Some multicomponent definitions to classify the refractive state of a given eye (analyzed using the negative cylinder notation) were coined by us.<sup>4,5</sup> The specific components of these definitions and the rationale for using them are explained below:

**Emmetropia:** An eye is emmetropic if it has a spherical equivalent of less than 0.50 Diopters in absolute value (that is, regardless of whether the blur is myopic or hyperopic). Additionally, it must have a maximum magnitude of astigmatism of 0.75 D. In this way, clinically significant mixed astigmatism are excluded, which could have a spherical equivalent within the range  $\pm 0.50$  D (for example  $+2.00 -4.00 \times 180$ ).

**Myopia:** Both spherical myopic errors, and simple or compound myopic astigmatism (except the very low ones included in the emmetropia group) are encompassed here. The value of the spherical equivalent must be  $-0.50$  D or more negative, but additionally the value of the sphere (using the negative cylinder notation, as previously indicated) must be zero or less. In this way, high mixed

astigmatism that may have a negative spherical equivalent (for example  $+1.00 -5.00 \times 180$ ) are excluded. It seems appropriate that because the eyes with mixed astigmatism have a hyperopic principal meridian, they are not considered within the myopia group.

**Hyperopia:** Both spherical hyperopic refractive errors, and simple or compound hyperopic astigmatism are encompassed here (except the very low ones included in the emmetropia group). The value of the spherical equivalent must be  $+0.50$  D or more positive, but additionally the absolute value of the cylinder must be less than or equal to the absolute value of the sphere. In this way, mixed astigmatism that have a spherical equivalent of  $+0.50$  D or more positive are excluded (for example  $+4.00 -5.00 \times 180$ ). It seems appropriate that because the eyes with mixed astigmatism have a myopic principal meridian, they are not considered within the hyperopia group.

**Mixed Astigmatism:** All those eyes presenting the steepest principal meridian with myopic defocus and the orthogonal (flattest) principal meridian with hyperopic defocus, are encompassed here (except those with very low astigmatism that are included in the emmetropia group). Using the negative cylinder notation, the value of the sphere must be greater than zero (in order to exclude myopic astigmatism) and the absolute value of the cylinder must be greater than the absolute value of the sphere (to thus exclude hyperopic astigmatism), and, as indicated, the value of the negative cylinder must be  $-1.00$  D or more negative.

On another note, there is the issue of defining the refractive error of an individual, whose two eyes can have any combination of refractive states. In our epidemiological studies to consider an individual as emmetropic, he/she should have emmetropia, according to the previous definition, in both eyes. If he/she presented ametropia in one eye, and emmetropia in the fellow eye, the individual was classified according to that refractive error. If a different type of refractive error was present in each eye, the individual was classified in the anisometropia group.<sup>4,5</sup>

An Excel spreadsheet that can be downloaded is attached as supplementary material, in which by entering the sphere and the cylinder, the classification of the ametropias according to what has been explained above is obtained both for eyes and for individuals. This calculator, designed by two of us (VG and AT), is for free use by researchers, providing that the user(s) cite this publication. These concepts are

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proposed to be applied in epidemiological studies, and not for the analysis of refractive surgery results.

These proposals undoubtedly lend themselves to academic discussion, but could offer important advantages in the characterization of refractive errors in epidemiological studies.

## Conflicts of interest

The authors have no conflicts of interest to declare.

## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.optom.2020.10.003>.

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- Virgilio Galvis<sup>a,b,c</sup>, Alejandro Tello<sup>a,b,c,\*</sup>, Paul A. Camacho<sup>a,b,c</sup>, Luz María Gómez<sup>b</sup>, Juan José Rey<sup>b</sup>, Andrés A. Serrano<sup>a</sup>
- <sup>a</sup> Centro Oftalmológico Virgilio Galvis, Floridablanca, Colombia  
<sup>b</sup> Universidad Autónoma de Bucaramanga (UNAB), Bucaramanga, Colombia  
<sup>c</sup> Fundación Oftalmológica de Santander (FOSCAL), Floridablanca, Colombia
- \* Corresponding author at: Centro Oftalmológico Virgilio Galvis, Centro Médico Ardila Lulle, Floor 3rd, Floridablanca, Colombia.  
E-mail address: [atello579@unab.edu.co](mailto:atello579@unab.edu.co) (A. Tello).  
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