Journal of Optometry 18 (2025) 100571

Journal of Optometry

www.journalofoptometry.org

ORIGINAL ARTICLE

Impact of high myopia on visual disability and its causes in a Spanish cohort

Pablo Arlanzon-Lope[a,*], Daniel Fernandez-Pedruelo[a], Belén Alvarez-Arauzo[a], Ruben Cuadrado-Asensio[a], Maria Teresa del Alamo-Martin[b], Rosa Maria Coco-Martin[a,c,d]

[a] *Grupo de Investigación de Retina, Instituto de OftalmoBiología Aplicada (IOBA), Departamento de Cirugía, Oftalmología, Otorrinolaringología y Fisioterapia, (Facultad de Medicina), Universidad de Valladolid, Valladolid, Spain*
[b] *Unidad de investigación social en salud y enfermedades raras, Departamento de Sociología y Trabajo Social, Facultad de Educación y Trabajo Social, Universidad de Valladolid, Valladolid, Spain*
[c] *Centro en Red de Medicina Regenerativa, y Terapia Celular de Castilla y León, Valladolid, Spain*
[d] *Unidad de Excelencia, Instituto de OftalmoBiología Aplicada (IOBA), Universidad de Valladolid, Valladolid, Spain*

Received 20 April 2025; accepted 14 June 2025
Available online xxx

KEYWORDS
Pathologic myopia;
Visual disability;
Blindness;
Functional limitations;
Myopic macular atrophy

Abstract
Purpose: To evaluate visual disability (VD) and associated functional limitations in a Spanish High Myopia (HM) cohort using various disability scales and to identify the main causes of this disability and its impact on daily life.
Methods: This observational study reviewed HM (spherical equivalent (SE)$\leq$-6 D) adults clinical records at IOBA from January 2023 to June 2024. Exclusion criteria included incomplete data and having different pathologies other than pathologic myopia. VD was classified using ICD-10, ICD-11, and Wecker scales. R was used for statistical analysis.
Results: We analysed 600 eyes from 300 patients (73.7 % women, mean age 57.6 $\pm$ 15.3 years, mean SE -13.04 $\pm$ 6.03 D, mean LogMAR visual acuity 0.52 $\pm$ 0.72). According to ICD-11, 7.6 % had mild VD, 12.3 % moderate, 4.7 % severe, and 2.7 % were blind. Wecker scale showed 46.7 % had VD. VD patients were older (p-value= 5.81 $\times$ 10^{-17}) and had more negative SE (p-value=7.96 $\times$ 10^{-13}). No sex differences in VD or pathology frequency were found. Myopic macular atrophy (MMA) (OR=7.816), retinal detachment (OR=3.956), amblyopia (OR=3.455), neovascularization (OR=2.668), SE (OR=1.115), and age (OR=1.040) were statistically significant key factors (p-value$<$0.05) for greater VD.

* Corresponding author at: Instituto de Oftalmobiologia Aplicada, University of Valladolid, Campus Miguel Delibes, P ° de Belén n° 17, Valladolid 47011, Spain.
E-mail address: pablo.arlanzon@uva.es (P. Arlanzon-Lope).

https://doi.org/10.1016/j.optom.2025.100571

Conclusion: This study highlights a significant VD in a Spanish HM cohort being MMA the main cause. Age and SE were found to be relevant factors, as well.This helps to indentify patients more in need of visual rehabilitation.

Introduction

High myopia (HM) is an ocular condition characterized by an ametropia with a spherical equivalent (SE) $\leq$-6 diopters (D) or an axial length (AL) exceeding 26 mm. Pathologic myopia (PM) refers to myopia accompanied by specific ocular changes, such as staphyloma or myopic macular degeneration (MMD).[1,2] It is estimated that 1.4 million people worldwide are affected by myopia, 11.6 % of whom have HM,[3] and 3 % of the global population may experience PM, which can lead to irreversible vision loss.[4] Projections indicate that by 2050, the prevalence of myopia will double, while HM will increase fivefold compared to 2000.[3] In Europe, approximately 22.9 % of the population is estimated to be myopic,[5] while in some Asian subpopulations, myopia affects around 95.5 %, with 19.5 % having HM.[6] Notably, the prevalence of HM in Spain is among the highest in Europe, highlighting the relevance of studying the impact of PM in this population.[7]

Visual disability (VD) due to PM is an escalating concern, as it is the leading cause of low vision and blindness in approximately 7 % of the European population[8,9] and 12−27 % of the Asian population.[10,11] In 2015, it was estimated that 10 million people worldwide had VD due to myopic maculopathy, with 3.3 million affected by blindness. Projections suggest that by 2050, without interventions, VD due to myopic maculopathy will affect 55.7 million people, with 18.5 million cases of blindness.[12] Therefore, PM is the second leading cause of VD or blindness globally, particularly among younger individuals, as it encompasses a range of pathologies that can significantly impair visual acuity (VA).

In Spain a study identified PM as the leading cause of visual disability and blindness among institutionalized patients[13] and data from the Spanish National Blind Association (ONCE) show that HM accounted for 21.1 % of all affiliates and 17.6 % of new cases in 2023. However, this data has some biases as institutionalized patients do not represent the entire population and ONCE applies specific criteria for patient admission. Underlying pathologies have been previously described.[2] Several studies have identified MMD, optic nerve neuropathies (ON), particularly glaucoma, and retinal detachment, as the primary contributors to visual disability in patients with HM.[14]

The significance of this disease lies not only in its detrimental effects on visual function but also in its impact on psychosocial well-being, as well as its considerable economic burden due to the associated loss of productivity.[15] VD can limit independence, participation in work and social activities, and overall quality of life. Therefore, it is crucial to evaluate not only VA but also the functional limitations and the impact of disability on the daily lives of people with HM.

However, comparing rates of VD, its causes, and applicability across studies is often challenging due to varying definitions of VD and blindness. Some studies use the eye as the unit of analysis, while others assess the individual, to assess their health conditions, including the visual deficiency, and their interaction with the environment.[16] In 2005, the World Health Organization (WHO) classified VD into four categories based on the VA of the better eye, according to the International Classification of Diseases, 10th revision (ICD-10).[17] ICD-11 further refined these categories by splitting the "mild or no visual impairment" group into two subcategories.[18] It is important to note that criteria for defining legal blindness vary between countries. Furthermore, in Spain, the Wecker scale has been used as objective criteria and authoritative criterion to recognice the permanent incapacity for work (PI) for specific professions and determine elegibility for subsequent rights or welfare benefits by the Instituto Nacional de la Seguridad Social. In this context, the Wecker scale, which still considers the VA of both eyes, remains as a useful medical criterion to quantifying vision loss.

As previously mentioned, reported data suggest that PM is a leading cause of VD and blindness in Spain. This, coupled with the increasing prevalence of HM and its associated complications, has significant implications for planning social services.[3] Furthermore, as demonstrated by our group, the clinical behavior of Spanish patients with PM differs from that observed in other populations, particularly Asian populations. Specifically, we found variations in the proportion of staphyloma or peripapillary atrophy. More importantly, we observed a lower rate of progression to advanced categories within the Meta-PM classification of MMA in Caucasian Spanish patients.[19] Thus, it is crucial to collect data on the clinical presentation of Caucasian myopic patients to enable comparisons across diverse populations.

Therefore, the objective of this study was to assess the prevalence and severity of visual disability and associated functional limitations in a Spanish HM cohort, using various visual disability scales to categorize patients. This approach will facilitate comparisons of VD rates with those reported in other studies and aid in identifying and compare the primary contributing pathologies.

Materials and methods

Design

This was an retrospective, observational study conducted on a single-centre cohort, adhering to the principles of the Helsinki Declaration of 1964 (latest amendment, 2013). The study was approved by the Clinical Research Ethics Committee of the Valladolid East Health Area with code PI-21-2161.

Participants

Medical records of HM patients attending the Instituto de Oftalmobiología Aplicada (IOBA) were reviewed from 2023 to early 2024. An inclusion criterion of a SE of less than -6 D was used for diagnosing HM, as AL measurements were unavailable for every patient due to the retrospective nature of the study. For pseudophakic patients, the pre-surgical SE was used. Exclusion criteria were incomplete data and pathologies not related to HM apart from those stated therewith.

Variables

A database was created to collect study variables, including age, sex, SE, VA, ICD-10 scale, ICD-11 scale, Wecker scale and the presence of various pathologies in each eye. The collected pathologies included myopic maculopathy (categorized as 4 by META-PM scale[20]), retinoschisis outside the fovea, foveoschisis, epiretinal membrane, macular hole; active CNV, Fuchs spot, retinal detachment history, amblyopia, glaucoma or dome shaped macula (DSM) with fluid. All pathological features were reviewed by an expert ophthalmologist. Visual disability was assessed using the ICD-10, ICD-11, and Wecker scales.

The ICD-10[17] classifies patients into four categories:

- Mild or no VD: VA is $\geq$ 6/18 (0.3 decimal).
- Moderate VD: VA is $\geq$ 6/60 (0.1 decimal) and $\leq$ 6/18 (0.3 decimal).
- Severe VD: VA is $\geq$ 3/60 (0.05 decimal) and $\leq$ 6/60 (0.1 decimal).
- Blindness: VA is $<$ 3/60 (0.05 decimal).

The ICD-11[18] divides patients into five categories:

- No VD: VA is $\geq$ 6/12 (0.5 decimal).
- Mild VD: VA $\geq$ 6/18 (0.3 decimal) and $<$ 6/12 (0.5 decimal).
- Moderate VD: VA is $\geq$ 6/60 (0.1 decimal) and $\leq$ 6/18 (0.3 decimal).
- Severe VD: VA is $\geq$ 3/60 (0.05 decimal) and $\leq$ 6/60 (0.1 decimal).
- Blindness: VA is $<$ 3/60 (0.05 decimal).

Both scales refer to the VA of the better eye.

Wecker scale divides patients into three levels of VD according to Table 1.

Wecker scale uses the decimal VA of both eyes and assigns a percentage of VD, which falls within three categories of VD.

Statistical analysis

Data were collected in an Excel spreadsheet (Microsoft, Redmond, USA) and exported to the Statistical Programme for the Social Sciences (IBM, Armonk, USA, version 27). Quantitative variables are expressed as mean $\pm$ standard deviation, and qualitative variables as percentages. Numerical variables were described using means and standard deviations (SD). Differences in means were assessed using Welch's two sample t-test and one-way ANOVA, followed by Holm-Sidak post-hoc correction for multiple comparisons. Numerical variables with asymmetric distributions were described by their medians and interquartile ranges (IQR), and differences in population ranks were evaluated using the Wilcoxon test and Kruskal-Wallis test (followed by Dunn's post-hoc). Categorical variables were described using frequencies, and associations were tested using Pearson's Chi-squared test or Fisher's exact test. The strength of association was measured using Odds Ratios (OR) and confidence intervals (CI). Agreement between vision loss scales was assessed using the Cramer's V index. Risk models for vision loss were developed using ordinal logistic regression, with age, sex and visual pathologies as predictors. A significance level of 0.05 was used for all tests. All statistical analyses were performed by Biostatista (Palencia, Spain) using R programming language v4.4., with the following packages: broom, gtsummary, MASS and purr. To determine the percentage of patients who had VD, the patient was considered the unit of analysis. However, to assess the frequency of pathologies, the eye was used as the unit of analysis with each eye assigned an ICD-11 classification. This approach was used to facilitate

Table 1 Wecker scale.

Visual acuity		Worse eye										
Better eye		$\leq$0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
	1.0	33	24	17	13	10	7	5	4	2	1	0
	0.9	36	28	20	15	12	10	8	6	5	3	
	0.8	38	30	22	18	15	12	10	9	7		
	0.7	41	33	25	20	17	15	13	11			
	0.6	44	36	28	25	21	18	16				
	0.5	48	40	32	28	25	22					
	0.4	53	45	37	32	29						
	0.3	59	51	43	39		Degree of incapability					
	0.2	69	60	52			Partial PI between 24 and 36 %					
	0.1	84	76				Total PI between 37 and 50 %					
	$\leq$0.05	100					Absolute PI bigger than 50 %					

PI: permanent incapability.

comparisons with other studies. We excluded patients with incomplete records or those with pathologies unrelated to HM.

Results

The study included a total of 300 patients (600 eyes). Of these, 73.7 % were female, with a mean age of 57.6 ± 15.3 years. The mean SE was −13.52 ± 6.06 D for the right eye and −13.30 ± 6.0 for the left eye. The mean VA on the LogMAR scale was 0.52 ± 0.72 considering both eyes. A difference of more than 2D in SE between the two eyes was observed in 111 patients (37 %). Fifty eyes were reported to have undergone cataract surgery. Patient classification according to the ICD-10 and ICD-11 scales is presented in Figs. 1 and 2, respectively.

However, 46.7 % of patients exhibited some degree of disability when classified according to the Wecker scale as shown in Fig. 3.

Cramer's V was used to test the degree of concordance between the Wecker scale and the ICD-11 scale. A value of 0.535 was found, indicating only a moderate degree of agreement between the two scales.

Hypothesis testing was conducted to evaluate the possible influence of age and SE on VD, using ICD-11 scale for each eye. The results are presented in Table 2.

In a post-hoc analysis, patients with no disability in ICD-11 scale were found to be significantly younger compared to those with mild VD (p-value=4.30 × 10^{-4}, *one way ANOVA with Holm correction*), moderate VD (p-value=7.37 × 10^{-7}, *one way ANOVA with Holm correction*), severe VD (p-value=9.70 × 10^{-10}, *one way ANOVA with Holm correction*) and blindness (p-value=2.18 × 10^{-12}, *one way ANOVA with Holm correction*). Regarding SE, patients with no disability had less myopic SE compared to those with mild VD (p-value=1.66 × 10^{-4}, *one way ANOVA with Holm correction*), moderate VI (p-value=3.25 × 10^{-13}, *one way ANOVA with Holm correction*), severe VD (p-value=0.028, *one way ANOVA with Holm correction*) and blindness (p-value=3.83 × 10^{-8}, *one way ANOVA with Holm correction*).

Furthermore, another post-hoc analysis using Wecker scale revealed that patients with no disability were significantly younger compared to those with partial PI (p-value=2.22 × 10^{-4}, *one way ANOVA with Holm correction*), total PI (p-value=1.86 × 10^{-6}, *one way ANOVA with Holm correction*) and absolute PI (p-value=3.83 × 10^{-10}, *one way ANOVA with Holm correction*). Regarding SE, patients with no disability had less myopic SE compared to those with partial PI (p-value=0.007, *one way ANOVA with Holm correction*), total PI (p-value=0.007, one way ANOVA with Holm correction) and absolute PI (p-value=1.48 × 10^{-7}, *one way ANOVA with Holm correction*).

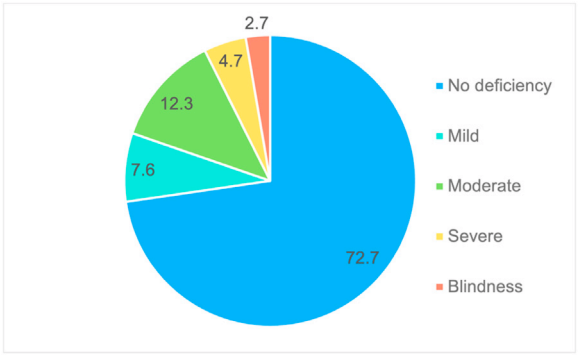

Fig. 2 Visual disability according to the ICD-11 classification.

Fig, 4 presents the percentage of eyes showing the pathological conditions considered in the study. We found no significant statistical difference in the presence of pathologies between men and women (p-value > 0.05).

Based on the study by Coco et al. [19] our sample was divided into three age groups: <50; [50-70) and ≥ 70. We then evaluated the Odds Ratio for presenting each pathology in each age group. Results are presented in Table 3, with only statistically significant odds ratios shown, as the remaining pathologies did not exhibit significance.

We also evaluated the risk of presenting pathology with each 1-diopter decrease in SE. We found that MMA (OR=1.100, 95% CI=[1.051, 1.151], p-value=4.40 × 10^{-5}), glaucoma (OR=1.089, 95% CI=[1.021, 1.163], p-value=0.010), DSM (OR=1.059, 95% CI=[1.003, 1.119], p-value=0.039), MTM (OR=1.048, 95% CI=[1.001, 1.098], p-value=0.046) were the main significant pathologies

To assess the impact of pathology on the VD scales, multinomial logistic regressions were performed. This allowed for the estimation of Odds ratios, which can be interpreted as the probability of being in a higher disability category for each unit decrease in a numerical variable or for presenting a specific pathology. The models for the ICD-11 and Wecker scale are presented in Table 4 respectively, and only statistically significant pathologies are shown.

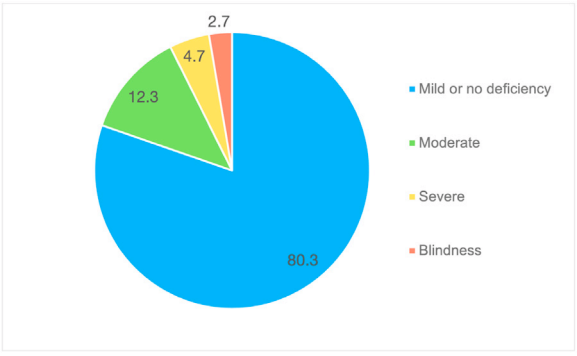

Fig. 1 Visual disability according to the ICD-10 classification.

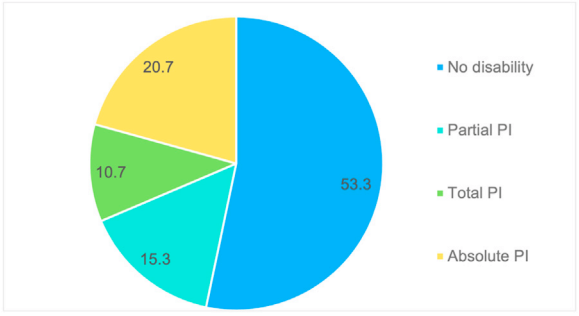

Fig. 3 Visual disability according to Wecker scale.

Table 2 Hypothesis testing of ICD-11 scale and Wecker scale with age and SE.

ICD-11 Visual disability	Variable	No disability N=350	Mild N=44	Moderate N=94	Severe N=47	Blindness N=65	*P*-value (One way ANOVA)
	Age (years)	52.81 ± 14.89	61.95 ± 12.84	61.70 ± 13.53	67.26 ± 12.67	67.16 ± 12.65	5.81×10^{-17}
	SE (D)	−11.64 ± 4.87	−15.51 ± 5.24	−16.73 ± 6.42	−14.16 ± 5.77	−16.18 ± 7.99	7.96×10^{-13}
Wecker scale Visual disability	Variable	No disability N=160	Partial PI N=46	Total PI N=32	Absolute PI N=62		*P*-value (One way ANOVA)
	Age (years)	51.68 ± 14.54	61.22 ± 14.06	65.71 ± 13.21	65.82 ± 12.52		5.21×10^{-11}
	SE (D)	−11.63 ± 4.53	−14.58 ± 5.49	−15.02 ± 6.07	−16.29 ± 6.95		1.89×10^{-6}

ANOVA: analysis of variance; D: dioptres, ICD: international classification of diseases; N: number of eyes; PI: permanent incapability; SE: spherical equivalent.

Discussion

In this study, we aimed to evaluate the degree of VD within a potentially representative sample of patients with PM seen in an ophthalmological clinic basis. As widely recognized, PM is a leading cause of VD in numerous countries,[3] and we also found a high percentage of VD in our sample, with approximately 27 % exhibiting some degree of VD according to the ICD-11 scale, the largest group being classified as having moderate VD. Considering that the ICD-11 scale offered a significant advantage to ICD-10, which was unable to classify individuals with mild or no VD, we decided to perform our comparisons using the ICD-11 scale. We also employed the Wecker scale, the primary tool used in Spain for determining VD for work-related purposes. Using this scale, we found that the disability rate detected was even higher (46.9 % of our sample had some level of PI, and 31.4 % were eligible for an unemployment benefits due to their PI). Furthermore, Cramer's V showed only moderate agreement between the WHO scale (ICD-11) and the Wecker scale. Therefore, there is a misalignment between international scales used to assess VD and local VD scales. This reflects the lack of unified criteria for evaluating VD, where disability encompasses broader domains beyond organ malfunction. Notably, the Wecker scale identifies a greater number of individuals with VD, potentially increasing access to unemployment benefits. This discrepancy is important because in Spain, the Wecker scale primarily dictates elegibility for unemployment benefits, a crucial aspect of the social dimension of disability. However, given the ICD-11's international prevalence of use, we utilized it for comparisons with other studies.

When comparing our findings with previous research, Jonas et al reported a prevalence of 18.9 % for moderate to severe VD, closely aligning with our results. This similarity suggest that Spanish and Chinese populations may have comparable VD rates.[14] Shih et al[21] reported VD prevalences in HM of 10 % in patients aged 40 to 59 and 56 % in those over 60, while Gao et al[22] reported prevalences of 24.6 %. These values closely match our findings. However, Jiang et al[23] examined a large Asian cohort and found significantly lower rates, with 4.1 % of patients having moderate to severe VD and 0.2 % blindness. These discrepancies likely stem from differences in sample characteristics, including a younger mean age (18.5 years), and lower myopic SE (−9.9 D). Nevertheless, they also reported increased VD with age, consistent with our results. Comparisons remain challenging due to variations in sample characteristics, and to our knowledge, no similar study has been conducted on Caucasian patients.

Regarding comparison with other Spanish samples, one study identified PM as the second leading cause of blindness and VD in an institutionalized population, as previously stated.[13] Additionally, data from the ONCE confirms PM as a primary cause of VD and the leading cause of new affiliations annually, but they study the VD population, not the HM population. Furthermore, ONCE has specific affiliation criteria that may not entirely align with clinical research standards. Nonetheless, PM remains a predominant eye condition in Spain, but we found no studies on Spanish samples specifically examining the pathological features of VD in PM or the influence of age and SE.

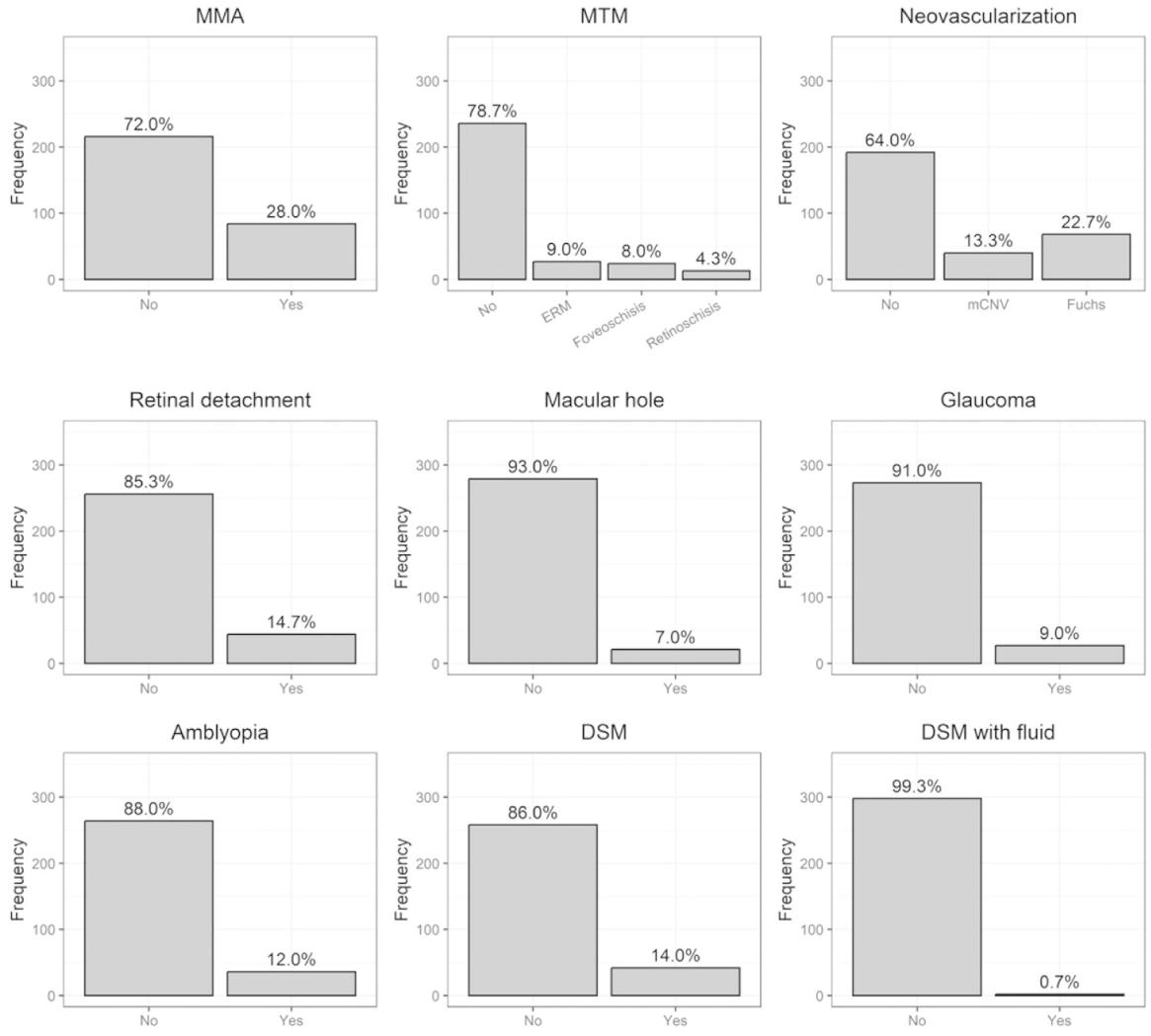

Fig. 4 Percentage of eyes with each pathology studied.
DSM: dome-shape macula; ERM: epiretinal membrane; mCNV: myopic choroidal neovascularization; MMA: myopic macular atrophy; MTM: myopic tractional maculopathy

Table 3 Odds ratio for age group and pathology.

Variable	Group (years)	Odds Ratio, [95% CI], *p*-value
MH	[50, 70)	1.813, [0.477,6.885], *p*-value = 0.382
	≥ 70	4.500, [1.167, 17.353], *p*-value = 0.029
Neovascularization (mCNV and / or Fuch spot)	[50, 70)	2.860, [1.516, 5.396], *p*-value = 0.001
	≥ 70	4.867, [2.348, 10.087], *p*-value = 2.08×10^{-5}
MMA	[50, 70)	8.222, [2.834, 23.849], *p*-value = 1.06×10^{-4}
	≥ 70	29.204, [9.548, 89.324], *p*-value = 3.30×10^{-9}
RD	[50, 70)	2.613, [1.023, 6.672], *p*-value = 0.045
	≥ 70	3.706, [1.338, 10.262], *p*-value = 0.012
Glaucoma	[50, 70)	7.588, [0.969, 59.408], *p*-value = 0.054
	≥ 70	23.608, [3.014, 184.884], *p*-value = 0.003

CI: confidence interval; mCNV: myopic choroidal neovascularization; MH: macular hole; MMA: myopic macular atrophy; RD: retinal detachment.

Table 4 Multinomial logistic regression analysis for ICD-11 and Wecker scale.

	ICD-11 Odds Ratio, [95% CI], *p*-value	Wecker scale Odds Ratio, [95% CI], *p*-value
MMA	7.816, [4.961, 12.312], p-value = 2.2×10^{-16}	6.254, [3.414, 11.456], p-value = 2.91×10^{-9}
RD	3.956, [2.219,7.053], p-value = 3.14×10^{-6}	2.153, [1.115, 4.161], p-value = 0.022
Amblyopia	3.455, [1.816, 6.575], p-value = 1.59×10^{-4}	
Neovascularization (mCNV and / or Fuchs' spot)	2.668, [1.778, 4.005], p-value = 2.17×10^{-6}	2.023, [1.200, 4.038], p-value = 2.17×10^{-6}
SE	1.115, [1.081, 1.151], p-value = 6.94×10^{-12}	1.122, [1.070, 1.176], p-value = 1.72×10^{-6}
Age	1.040, [1.025, 1.055], p-value = 5.47×10^{-8}	1.036, [1.015, 1.057], p-value = 5.68×10^{-4}

CI: confidence interval; MMA: myopic macular atrophy, RD: retinal detachment; SE: spherical equivalent.

When evaluating the impact of age and SE on VD using the ICD-11 scale, we found that individuals with any degree of VD were older and had more negative SE compared to those without VD. Similar results were observed also using Wecker scale. These findings are consistent with previous studies.[14] However, we did not observe statistically significant differences between the different VD categories, potentially due to the small sample size in certain groups. It appears that patients in higher VD categories tend to be older, with a mean age of 67 years in the severe and blindness groups. Obviously, older patients were more likely to develop severe PM complications, resulting in greater VD. This makes the disability have a greater impact because vision deficit is combined with advanced age. Regarding SE, the data are less conclusive, as SE was higher in the moderate VD group compared to the severe or blindness groups. Nonetheless, SE was significantly more negative in patients with any degree of VD compared to those without VD. Although we did not have AL we must consider that it is ussually associated with SE, and these results suggest that a greater SE/AL increases the likelihood of PM-related complications. Nevertheless, larger sample sizes may be needed to detect statistically significant differences.

We have also analyzed the specific pathological conditions contributing to VD within a potentially representative sample of patients with PM. In our sample, the most common findings were myopic MMA in 28 % of cases, Fuchs' spot in 22.7 %, and RD history in 14.7 %, but we must remember that our study focused on vision-threatening pathologies rather than providing a comprehensive overview of all pathological findings. Moreover, we found no statistically significant differences in the frequency of pathological features between men and women despite myopia being more prevalent in women,[24] and considering that nearly two-thirds of our sample were female. This finding does not align to other studies[25] that have suggested that men may be more prone to developing pathological features such as RD, retinal tears, or retinoschisis, whereas women are more likely to have conditions like MMA, mCNV or MH. Authors state that these differences may be largely driven by the fact men are more likely to suffer from RD. Besides, comparing our results to those of these studies could be inappropriate due to differences in sample characteristics. Additionally, we found no significant difference in VD prevalence between men and women, whereas other studies[23] have reported that women are 2.4 times more likely to developing VD due to HM, potentially due to lifestyle factors, such as greater engagement in near-vision tasks among Asian women. However, behavioural differences among Spanish women or genetic factors may play a role in our findings. This highlights the importance of our study, as behavioural differences among populations could be affecting the progression rates and the development of VD, and this should be investigated.

To conducted the odds ratio analysis to assess the risk of developing pathological features with age, we divided the data into three age intervals. We did this based on Coco-Martín et al.'s paper, which identified two age intervals associated with the progression of atrophic and neovascular features; these intervals were the ones used in the present study.[19] In this analysis, we found an increased risk of developing macular holes, MMA, mCNV, RD, and glaucoma, particularly in individuals aged 70 or older, although the 50—70 age group also showed a significant higher risk for these pathologies. Our findings are consistent with those of Coco-Martín et al. (2021), from our group, whose study had similar sample characteristics.[19] But this also aligns with previous research indicating that PM worsens with age.[21]

Furthermore, we assessed the risk of developing pathology with each 1-dioptre decrease in SE. We found statistically significant odds ratios for MTM, DSM, glaucoma, and MMA. For these conditions, each 1-diopter decrease in SE corresponded to a 5—10 % higher risk. As SE decreases, axial elongation increases,[2] leading to greater tractional forces in the macular area, deformation of the optic nerve head, and a higher occurrence of MMA. Given that the mean SE in our sample was slightly lower than -13 dioptres in both eyes, this confirms a substantial increase in risk with higher degrees of myopia. Thus, myopia control and myopia onset delay interventions may play a crucial role in the future as they become more accessible to worldwide population.[26] VD prevalence in HM patients will hopefully be reduced in their future due to the reduction of AL and SE because of these interventions.

A predictive model for VD was developed based on pathology and sample characteristics. The four primary pathologies contributing to VD progression were MMA, RD, neovascularization and amblyopia, with MMA being the most significant. MMA refers to the enlargement and macular involvement of lacquer cracks and patchy atrophy, resulting in irreversible central scotomas and vision loss. Shih et al[21] also found that VD was more common in patients with advanced MMA according to the META-PM classification. On the other hand, neovascularization included both active CNV and Fuchs' spot, both of which result in macular damage and vision loss. Our group previously reported[19] that mCNV is more common in women and that it appears around

45-50 years of age. Thus, CNV appears in early stages of PM and it is well known that its appearance worsens the disease more quickly as the atrophy around the CNV increases over the following years. Therefore, Spanish HM patients could develop VD earlier in life as result of this mCNV. Additionally, RD is a major cause of vision loss not only in PM patients, who are at increased risk of RD regardless of lens status.[27] Although we did not evaluate macular involvement in RD cases, it is logical that RD significantly contributes to VD, particularly if it affects central vision. Besides, amblyopia played a role, likely due to the low vision achieved in some anisometropic eyes despite the treatments done in childhood, which makes it more probable to end up with VD when pathology occurs in the fellow eye.[28] It is difficult to determine whether amblyopia is a direct factor contibutring to VD in an eye with a higher SE, as it is not directly related to pathological signs in PM. However, it seems that patients with HM and coexisting amblyopia are at a greater risk of developing VD. Finally, age and SE were relevant factors in our model. This model can help identify those patients at higher risk of developing VD and understanding the pahtological features that significantly impact VD can aid in identifying patients who benefit most from rehabilitation interventions.

Some contributing pathologies were found to be statistically significant when considering the regression model for the Weceler scale. Notably, amblyopia itself does not seem to be relevant when VD is assessed using this scale. The reasons behind this remain elusive but may be related to the fact that this scale considers the VA of both eyes, or the way the categories within the classification have been made. Sample size may also play a role, so further studies may be needed.

These findings should encourage optometrists and ophthalmologists to closely examine HM patients and to schedule proper follow-up visits. HM patients and those who are older, have a more negative SE, and present with the conditions stated before should be carefully monitored and referred to low vision rehabilitation if needed.

Effective rehabilitation strategies include the use of optical aids, training in eccentric viewing techniques, and the provision of psychological support.[29] These interventions enable patients to use their remaining vision more effectively to accomplish daily tasks. Currently, visual aids often represent the primary means by which ophthalmologists assist patients suffering from PM to use at their maximum their residual vision, but maybe in the future, preventive therapies targeting staphyloma and eye deformity are expected to be available before vision-threatening complications develop and become irreversible.[2]

Limitations

There are several limitations to our study. First, the origin of our sample—a specialized ophthalmology clinic—restricts the generalizability of our findings to the broader population, although the sample includes patients that came for refractive surgery, and it is not what would be a more biases retina-specialized clinic only. Despite this, patients in this setting may present with more frequent and advanced pathology, lower VA, and consequently, higher rates of VD. Moreover, we defined PM based solely on SE, because due to the retrospective nature of this study, AL measurements were not routinely assessed. This could have introduced some bias, especially when considering patients having a SE closer to -6 D. These patients may not suffer from the common PM complications, as AL may not be long enough. Nevertheless, we ensured that SE data were complete, excluding patients without recorded measurements. For those patients who were pseudophakic, their pre-surgery SE was noted. Additionally, we excluded patients with HM who exhibited other central pathologies unrelated to PM, which may have influenced our analysis of how pathology affects VD classification, but our primary objective was to focus specifically on PM-related pathology. Staphyloma presence and type, often considered significant variables that influence PM-related pathologies,[2] were not included data due to insufficient clinical documentation of this feature in our records. Besides, we did not incorporate visual field data into our definition of VD, as most of patients in our sample lacked visual field-testing results, for two reasons: either because most of them had not been told to undergo this test, as there was no suspicion of any impairment, or because their vision was so poor that it was impossible to collect a reliable test. This is a single-center study, which may limit its applicability to other regions. Lastly, it was not feasible to gather any psychoeducational variables for our analysis.

Conclusion

In conclusion, our findings highlight the high prevalence of VD in this retrospective HM sample. Age was the primary factor influencing the development of severe pathology and the progression to VD, while SE also played a significant, though comparatively lesser, role. Among the pathologies contributing to VD, MMA was identified as the most critical factor as previously described. No significant differences were observed between men and women in terms of VD occurrence or frequency of PM-related lesions in our sample. These data should be considered to improve clinical management and rehabilitation programs and provide a foundation for future comparisons with other samples.

Funding

The author(s) disclosed no financial support for the research, authorship, and/or publication of this article.

Data availability statement

All data generated or analyzed during this study are included in this article. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of Interest

The author(s) declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgments

During the preparation of this work the authors used ChatGPT4 to improve readability and language of the manuscript. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

References

1. Flitcroft DI, He M, Jonas JB, et al. IMI – defining and classifying myopia: a proposed set of standards for clinical and epidemiologic studies. *Invest Ophthalmol Vis Sci*. 2019;60:M20–M30.
2. Ohno-Matsui K, Pei-Chang W, Yamashiro K, et al. IMI pathologic myopia. *Investig Ophthalmol Vis Sci*. 2021:62. https://doi.org/10.1167/iovs.62.5.5.
3. Holden BA, Fricke TR, Wilson DA, et al. Global prevalence of myopia and high myopia and temporal trends from 2000 through 2050. *Ophthalmology*. 2016;123:1036–1042.
4. Wong TY, Ferreira A, Hughes R, Carter G, Mitchell P. Epidemiology and disease burden of pathologic myopia and myopic choroidal neovascularization: an evidence-based systematic review. *Am J Ophthalmol*. 2014;157:9–25.
5. Williams KM, Bertelsen G, Cumberland P, et al. Increasing prevalence of myopia in europe and the impact of education. *Ophthalmology*. 2015;122:1489–1497.
6. Yokoi T, Moriyama M, Hayashi K, et al. Predictive factors for comorbid psychiatric disorders and their impact on vision-related quality of life in patients with high myopia. *Int Ophthalmol*. 2014;34:171–183.
7. Hashemi H, Fotouhi A, Yekta A, et al. Global and regional estimates of prevalence of refractive errors: systematic review and meta-analysis. *J Curr Ophthalmol*. 2018;30:3–22. https://doi.org/10.1016/j.joco.2017.08.009.
8. Buch H, Vinding T, Nielsen NV. Prevalence and causes of visual impairment according to world health organization and United States criteria in an aged, urban scandinavian population the copenhagen city eye study. *Ophthalmology*. 2001;108:2347–2357.
9. Cedrone C, Nucci C, Scuderi G, et al. Prevalence of blindness and low vision in an Italian population: a comparison with other European studies. *Eye*. 2006;20:661–667.
10. Iwase A, Araie M, Tomidokoro A, et al. Prevalence and causes of low vision and blindness in a Japanese adult population. The Tajimi study. *Ophthalmology*. 2006;113:1354–1362.e1.
11. Xu L, Wang Y, Li Y, et al. Causes of blindness and visual impairment in urban and rural areas in Beijing. The Beijing eye study. *Ophthalmology*. 2006;113(1134):e1–1134.e11.
12. Fricke TR, Jong M, Naidoo KS, et al. Global prevalence of visual impairment associated with myopic macular degeneration and temporal trends from 2000 through 2050: systematic review, meta-analysis and modelling. *Br J Ophthalmol*. 2018;102:855–862.
13. Sainz-Gómez C, Fernández-Robredo P. Salinas-Alamán A.,et al. Prevalence and causes of bilateral blindness and visual impairment among institutionzalized elderly people in Pamplona, Spain. *Eur J Ophthalmol*. 2010;20:442–450.
14. Jonas JB, Jonas RA, Xu J, Wang YX. Prevalence and cause of loss of visual acuity and visual field in highly myopic eyes: the Beijing eye study. *Ophthalmology*. 2024;131:58–65.
15. Modjtahedi BS, Ferris FL, Hunter DG, Fong DS. Public health burden and potential interventions for myopia. *Ophthalmology*. 2018;125:628–630. https://doi.org/10.1016/j.ophtha.2018.01.033. Preprint at.
16. United Nations. Convention on the Rigths of Persons with Disabilities. (2007).
17. World Health Organization. *State of the world's sight : VISION 2020 : the Right to Sight : 1999–2005*. 2005. https://iris.who.int/handle/10665/43300.
18. Bourne RRA, Flaxman SR, Braithwaite T, et al. Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis. *Lancet Glob Health*. 2017;5:e888–e897.
19. Coco-Martin RM, Belani-Raju M, de la Fuente-Gomez D, Sanabria MR, Fernández I. Progression of myopic maculopathy in a Caucasian cohort of highly myopic patients with long follow-up: a multistate analysis. *Graefe's Arch Clin Exp Ophthalmol*. 2021;259:81–92.
20. Ohno-Matsui K, Kawasaki R, Jonas JB, et al. International photographic classification and grading system for myopic maculopathy. *Am J Ophthalmol*. 2015;159:877–883.e7.
21. Shih YF, Ho TC, Hsiao CK, Lin LLK. Visual outcomes for high myopic patients with or without myopic maculopathy: a 10 year follow up study. *Br J Ophthalmol*. 2006;90:546–550.
22. Qin Gao L, Liu W, Liang YB, et al. Prevalence and characteristics of myopic retinopathy in a rural Chinese adult population the handan eye study. *Arch Ophthalmol*. 2011;129:1199-204.
23. Jiang Y, Wang D, Han X, et al. Visual impairment in highly myopic eyes: the ZOC-BHVI high myopia cohort study. *Clin Exp Ophthalmol*. 2020;48:783–792.
24. Gong JF, Xie HL, Mao XJ, et al. Relevant factors of estrogen changes of myopia in adolescent females. *Chin Med J (Engl)*. 2015;128:659–663.
25. Ludwig CA, Boucher N, Saroj N, Moshfeghi DM. Differences in anterior peripheral pathologic myopia and macular pathologic myopia by age and gender. *Graefe's Arch Clin Exp Ophthalmol*. 2021;259:3511–3513. https://doi.org/10.1007/s00417-021-05217-w. Preprint at.
26. Gifford KL, Richdale K, Kang P, et al. IMI – clinical management guidelines report. *Invest Ophthalmol Vis Sci*. 2019;60:M184–M203.
27. Ludwig CA, Vile D, Al-Moujahed M, et al. Epidemiology of rhegmatogenous retinal detachment in commercially insured myopes in the United States. *Sci Rep*. 2023;13:9430.
28. Birch EE. Amblyopia and binocular vision. *Progr Retinal Eye Res*. 2013;33:67–84. https://doi.org/10.1016/j.preteyeres.2012.11.001. Preprint at.
29. Maria Vingolo E, Napolitano G, Casillo L. Pathologic myopia: complications and visual rehabilitation. *Intraocular Lens*. IntechOpen; 2020. https://doi.org/10.5772/intechopen.85871.