The Royal College of Ophthalmologists' National Ophthalmology Database study of cataract surgery: Report 17, a risk factor model for posterior capsule rupture

Running Title: RCOphth NOD posterior capsule rupture risk factor model

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Abstract

Background/Objectives

To create a risk factor model for posterior capsule rupture (PCR) during cataract surgery.

Subjects/Methods

Eligible operations between 01/04/2016 and 31/03/2022 from centres supplying data to the UK national cataract audit with complete data including patients' gender and age at surgery, anterior chamber depth (ACD) measurement and preoperative visual acuity (VA) were included. A logistic regression model was fitted to identify risk factors and calculate their odds ratios (OR) and 95% confidence intervals (CI) for PCR.

Results

This analysis included 961 208 cataract operations performed on 682 381 patients from 136 participating centres by 3 198 surgeons. 9 730 (1.01%) of surgeries were complicated by PCR. The median age was 75.7 and 76.7 years for first and second eye surgery respectively, and 5 154 (53.0%) were female. The highest risk factors for PCR were less experienced trainee surgeon (OR 3.75, 95% CI 3.33-4.24, p<0.001), pseudoexfoliation / phacodonesis (OR 3.47, 95% CI 3.05-3.94, p<0.001), younger males (OR 3.05, 95% CI 2.23–4.16, p<0.001) and brunescent / white / mature cataract (OR 2.41, 95% CI 2.24–2.60, p<0.001). Other risk factors identified were glaucoma, worse preoperative VA, previous intravitreal therapy, high myopia, previous vitrectomy, systemic diabetes, diabetic retinopathy, amblyopia, older age, shallower ACD and inability to lie flat and cooperate.

Conclusion

Various surgical, patient and ocular factors increase the risk of PCR during cataract surgery. This risk factor model permits estimation of individualised risks for patients and allows risk-adjustment for surgeons to evaluate their PCR rates based on case complexity.

Introduction

Cataract surgery continues to be the most commonly performed elective surgical procedure in the UK, with around 600 000 operations performed in the 2023-2023 NHS year. Since its inception in 2010, the Royal College of Ophthalmologists National Ophthalmology Database (RCOphth NOD) audit has established itself as an important quality assurance measure and research tool, with several analyses published over the last decade[1-13]. Given its ever expanding dataset, there is a need for continual analyses to ensure up-to-date, high-quality evidence to drive quality improvement and national benchmarking of surgical outcomes.

Posterior capsular rupture (PCR) remains one of the most common complications of cataract surgery and is a risk factor for poor visual prognosis[14]. Following PCR, there is a higher relative risk (RR) of severe vision loss (RR, 15.5) [publication pending] and secondary complications such as cystoid macular oedema (RR, 2.6)[15], endophthalmitis (RR, 7.2)[10] and retinal detachment (RR, 20.4)[3]. PCR also imposes a substantial additional financial cost burden to health care systems due to the need for additional visits and interventions[16,17].

This RCOphth NOD analysis aims to provide an update to the now 15-year-old risk stratification system for PCR from the previous Cataract National Dataset[18] and also the RCOphth NOD PCR risk adjustment model fitted in 2015[19]. Over this time period, PCR rates have more than halved from 1.95%[1] to 0.79% in the latest RCOphth NOD audit annual report for 2022-2023[20]. The observed decline has a variety of potential causes, such as the introduction of simulator training amongst trainee surgeons[6], improvement in instrumentation (e.g. use of silicone-tipped handpieces[21]) and an increasing trend toward surgery on younger and healthier eyes[22]. The determinants of PCR rate are also likely to have changed over time, with more recently reported novel risk factors for PCR such as previous intravitreal injections[23] and corneal opacities[24]. On a global scale, an up-to-date risk stratification system is required to permit meaningful comparison of the RCOphth NOD dataset with those of other

countries[24,25], to facilitate the development of a bespoke international benchmarking system and to be able to advise patients before surgery of their specific material risk.

Methods

The RCOphth NOD is open to centres performing both NHS funded and private cataract surgery in England, Northern Ireland, Scotland, Wales, and the Channel Islands which include NHS centres, independent sector treatment centres (ISTCs) and private providers. The data, compliant with the RCOphth minimum national cataract dataset, is recorded on electronic medical records (EMRs) or in-house databases and submitted annually for cataract operations using phacoemulsification to treat patients aged 18 years or older, where the primary intention was cataract surgery and not combined 'cataract + other' surgery, unless the 'other' surgery formed part of the cataract operation (e.g., an operative manoeuvre to increase pupil size). Cases where PCR is expected as part of surgery, such as posterior polar or traumatic cataracts, are excluded from NOD analyses. Further information on audit eligible cataract operations can be found on the audit website (www.nodaudit.org.uk).

The study period comprised cataract operations performed between 01/04/2016 and 31/03/2022 which constitutes 6 completed NHS years. Eligible for this analysis are National Cataract Audit eligible cataract operations with data for patients' gender and age at surgery, anterior chamber depth (ACD) and preoperative visual acuity (VA). To remove data for potentially abnormal eyes or erroneous data entry, operations are excluded if the recorded ACD was <1.5mm or >4.5mm, or if the recorded axial length (AL) was <18mm. Only data from contributing centres with at least 50 cataract operations satisfying the above are included.

For this analysis, data was recorded on either the Medisoft EMR system (Medisoft Ophthalmology, Medisoft Limited, Leeds, UK, www.medisoft.co.uk), OpenEyes EMR system (www.openeyes.org.uk), or in-house databases compliant with the RCOphth national cataract dataset (https://www.rcophth.ac.uk/standards-and-guidance/audit-and-data/clinical-data-sets).

The grade of operating surgeon was categorised as consultant surgeons, career grade non-consultant surgeons (associate specialists, staff grades and trust doctors), more experienced trainee surgeons (fellows and specialty trainees / registrars years 3-7), and less experienced trainee surgeons (senior house officer, specialty trainees / registrars years 1-2 and foundation doctors).

Preoperative VA was defined as the best recorded distance VA (corrected or uncorrected but not pinhole) that is closest to the date of surgery, including the day of surgery and within 6 months prior to surgery. For numeric calculations, the extreme low vision estimates from the LogMAR chart representing count fingers (CF), hand movements (HM), perception of light (PL) and no perception of light (NPL) are replaced with 2.10, 2.40, 2.70 and 3.00, respectively[26].

To identify potential risk factors for PCR, a logistic regression model was fitted with cluster adjustment for robust standard errors, where surgeons, their grade and centre they operated in were used to create the clusters. Thus, surgeons with data in different centres have data considered as separate clusters for each centre, and similarly their operative record at different surgeon grades are considered as separate clusters.

The covariates considered as potential risk factors are known before cataract surgery starts. They concern surgeon, patient and ocular factors that could potentially influence the chance of PCR. All candidate covariates were first investigated using Chi-squared tests for categorical

covariates, and Student's t-tests with the Welch adjustment for unequal variance for continuous covariates. For the categorical covariates, only those indicating association at the 1% level ($p<0.01$) from the univariate analysis were considered in the risk factor modelling. This restriction did not apply to the continuous covariates, which were all carried through to the risk factor modelling due to clinical relevance and being continuous over a discreet range which could lead to significant differences over their ranges at the multivariate but not univariate level.

The categorical variables indicating univariate association at the 1% level, plus the continuous covariates and an interaction term for patients' gender and age, were fitted to a multivariate logistic regression model with cluster adjustment for surgeons, their grade and centre the operation was performed in. The final PCR risk factor model was created using backwards selection from the 'full' model to the 'best fitting' model. Covariates were first removed if there was no significance at the 1% level ($p>0.01$), and then any remaining covariates indicating significance between 0.1% and 1% ($p>0.001$ & $p<0.01$) were all individually removed and models compared using the likelihood ratio test and assessment of the Akaike Information Criterion, and retained in the model if removal indicated no improvement to model fit.

The use of stages decreasing significance thresholds was adopted due to the increased chance of detecting very small significant differences from the large sample size, and to minimise negative impacts of possible overfitting. It is feasible this approach does not produce the best model for the sample, but is practical for a very large sample where some covariates are for rare diseases, and to attempt to remove covariates with minimal clinical differences that otherwise could be found statistically significant if using a higher significance level. The full equation of the final model used to estimate the probability of PCR for each operation is detailed in Supplementary File.

The lead clinician and Caldicott Guardian (responsible nominee for data protection) at each

centre provided written approval for anonymised data extraction. Ethical permission was not required for this analysis due to being viewed as audit or service evaluation. This study was conducted in accordance with the Declaration of Helsinki and the UK Data Protection Act. All analyses were performed using STATA 18 (StataCorp. 2023. Stata Statistical Software: Release 18. College Station, TX: StataCorp LLC).

Results

Within the study period, 1 453 374 eligible cataract operations were submitted with data for patients' gender and age. Excluded from this are 492 124 (33.9%) operations for the following reasons; 297 315 had no recorded ACD measurement, 193 080 had no preoperative VA, 1 701 had a recorded ACD of <1.5mm or >4.5mm, and 28 had a recorded AL of <18mm. A further 42 operations from five centres were removed as these centres had <50 operations left in the sample after applying the exclusion criteria above.

Eligible for the risk factor modelling were 961 208 cataract operations performed in 136 participating centres: 73 English NHS trusts (578 683; 60.2%), 58 ISTCs providing NHS funded and private fee-paying surgery (365 295; 38.0%), three Welsh health boards (12 528; 1.3%), one centre from Guernsey (2 415; 0.3%) and one fully private fee-paying provider (2 287; 0.2%). The range in the number of operations performed by the centres was 144 to 28 414.

The 961 208 operations were performed on 473 074 (49.2%) left eyes and 488 134 (50.8%) right eyes from 682 381 patients by 3 198 surgeons, 686 (21.5%) of whom had data for more than one grade of surgeon; 1 521 consultant surgeons performed 738 527 (76.8%) operations, 349 career grade non-consultant surgeons performed 57 629 (6.0%) operations, 1 571 more experienced trainee surgeons performed 141 452 (14.7%) operations and 443 less

experienced trainee surgeons performed 23 600 (2.5%) operations. The median number of operations performed by surgeons was 93 (range; 1 to 21 473).

First eye surgery was performed in 569 154 patients where 326 572 (57.4%) were female and the median age at surgery was 75.7 years (interquartile range; 69.0–81.7 years). Second eye surgery was performed in 391 154 patients where 229 796 (58.7%) were female and the median age at surgery was 76.7 years (interquartile range; 70.2–82.3 years). Immediate sequential bilateral cataract surgery (ISBCS) was performed in 450 patients where 261 (58.0%) patients were female and the median age at surgery was 75.0 years (interquartile range; 65.2–81.8 years). Over the study period, 278 377 (40.8%) non-ISBCS patients had surgery to both eyes, where the median time between the two operations was 3.0 months (range one day to 6.0 years).

PCR risk factor model

At the univariate level all categorical covariates showed association at the 1% level ($p>0.01$) except for Fuchs endothelial dystrophy ($p=0.052$), inherited eye disease ($p=0.040$), oculomotor disease ($p=0.068$) and other macular pathology ($p=0.943$). For continuous covariates, univariate analysis did not show any association for ACD ($p=0.440$) (Table 1).

During the risk factor model fitting process, the following covariates were removed due to no association at the 1% level ($p>0.01$); age-related macular degeneration, no fundal view / vitreous opacity, other retinal vascular pathology, previous trabeculectomy surgery and uveitis / synechiae. Both amblyopia and corneal pathology implied association between the 0.1% and 1% level ($p>0.001$ & $p<0.01$). Removing amblyopia did not improve the model fit and was retained. A similar finding was seen for corneal pathology but a decision was made to not include this due to the implied protective effect from its presence, and also because there can

be large variation in why a surgeon would record this (e.g. a small peripheral scar or full thickness central opacity).

The final model included the following surgical and patient factors: surgeon grade, patients' age and gender, ability to lie flat and cooperate, diabetic status and an interaction term between age and gender. Ocular factors were first or second eye surgery, ACD, preoperative VA, previous intravitreal anti-vascular endothelial growth factor (VEGF) therapy, pupil size, amblyopia, brunescent / white / mature cataract, diabetic retinopathy, glaucoma, high myopia, previous vitrectomy surgery and pseudoexfoliation / phacodonesis (Table 2).

The final model had an area under the receiver curve estimate of 70.0%. The highest influencing risk factors were surgery by less experienced trainee surgeon and pseudoexfoliation / phacodonesis, where the odds ratios were >3 (Supplementary Figure), as was the case for male gender but this large odds ratio is mitigated by the age/gender interaction which reduces the risk for a male patient according to his age, where the older a male patient is, the lower his PCR risk is compared to that of a female patient of the same age (Figure 1). Certain identified risk factors such as systemic diabetes, diabetic retinopathy, small pupil and previous vitrectomy were more prevalent in male than female patients (Supplementary Table).

The underlying risk of PCR for preoperative VA follows a near linear progression where worse levels of VA have a higher risk of PCR (Figure 2). For ACD, the underlying risk of PCR is higher for eyes with a shallow AC (<2.2mm) (Figure 3). For the continuous covariates, interpretation of the odds ratios is such that a one-unit change alters the odds by the percentage the ratio implies. For example, each one-year increase in age leads to a 1.5% increase in the age odds whereas each 1.00 LogMAR increase leads to a 51.0% increase in the VA odds (0.10 LogMAR increase leads to a 5.1% increase in the VA odds).

Risk of PCR examples

An example for first eye surgery performed by a consultant surgeon on an 80-year-old female patient who can lie flat and cooperate with systemic diabetes, median ACD of 3.08mm, median preoperative VA of 0.50 LogMAR, a large pupil, no previous intravitreal anti-VEGF therapy, and none of the ocular comorbidities, the estimated probability of PCR is 0.77%. If the surgery had been performed by a less experienced trainee the estimated probability is 2.82%. For a male patient with the same age and ocular characteristics, the estimated probability of PCR is 0.82% when surgery was performed by a consultant surgeon, and 3.02% when performed by a less experienced trainee surgeon. Conversely, the estimated probability of PCR is 0.42% for a 40-year-old female patient operated on by a consultant, compared to 0.76% for a 40-year-old male patient with the same ocular characteristics.

Discussion

The current analysis covers the 2016-2021 NHS years and includes the largest UK national sample size to date. The selected interval coincides with the period operations have been performed with access to annual national benchmarks published by the RCOphth NOD, increasing use of surgical simulators in training and growing provision of surgery by the independent sector. In addition to providing an update to the current statistical model for case complexity adjustment, the current analysis has confirmed previously known risk factors for PCR (advancing age, trainee surgeon, male gender, inability to lie flat and cooperate, systemic diabetes, diabetic retinopathy, smaller pupil size, mature cataract, glaucoma and pseudoexfoliation / phacodonesis), corroborated more recently reported risk factors (previous intravitreal anti-VEGF therapy[23,27,28] and worse preoperative VA[24]) and quantified the impact of additional risk factors (high myopia, previous vitrectomy, shallow ACD and amblyopia).

Of particular note compared to the previous UK Cataract National Dataset analysis, the

elevated odds ratio for PCR observed for younger male patients was found to be one of the highest with an adjusted odds ratio of 3.05, however the age/gender interaction term diminishes this ratio in older patients such that there is parity of risk between the genders by age 85, and above 90 years of age females are seen to be at a higher risk of PCR (Figure 1). The inclusion of the interaction term is an attempt to account for the differences across the age range, and assessment of different risks between male and female patients has to be considered in relation to the patient's age. The reasons for these differences are likely to be complex and postulated contributing factors may include greater lifetime accumulation of ocular trauma[29] and less willingness to engage with healthcare services[30] in younger males. Some of the identified risk factors in this analysis were also more prevalent in male than female patients, although the converse is seen for other risk factors, consequently these differences cannot account for all of the observed higher risk for male gender (Supplementary Table).

Our finding of prior intravitreal anti-VEGF injections being associated with increased risk of PCR is consistent with previous studies[23,27,28]. There is currently evidence to suggest that the risk of PCR is dose-dependent and higher for eyes that have received >10 injections[23,28]. However, in our analysis, we were not able to specifically look at the number of prior intravitreal injections so there may be some underestimation of effect. We also found preoperative high myopia to be a significant risk factor for PCR; this is somewhat expected based on prior studies [31,32]. One theorised mechanism for this is the longer AL inherent in these eyes which may make surgery more challenging. However, previous analyses have found no significant association between AL and risk of PCR[2,8], which would suggest other possible contributory mechanisms in high myopia such as higher cataract density[33].

Previous studies on the risk of intraoperative complications in eyes with prior pars plana vitrectomy (PPV) have reported mixed findings[24,34]. We found a significantly higher rate of PCR in eyes with previous PPV which could be conferred by altered fluid dynamics[35], unstable posterior capsules[36] or posterior lenticular touch during vitrectomy[37]. The pathophysiology

underlying the increased risk of PCR in vitrectomised eyes may also have some overlap with that of high myopia given the strong correlation between the two[38]. Similar to previous PPV, there is currently no consensus on whether shallow ACD increases the risk of PCR[39–41]. We found that a shallow ACD of <2.2mm was associated with a significant increase in PCR rates. One possible explanation for this may be that iris prolapse is more common so surgeons make longer tunnels, increasing corneal distortion and impairing visualisation, or more directly increasing proximity of instruments to the posterior capsule in a shallow anterior chamber.

In contrast to the recent European registry analysis which found corneal opacities to be the most significantly associated risk factor for PCR[24], we found a protective effect of corneal pathology against PCR. The interpretation of this discrepancy is made difficult by the heterogeneity in definition of “corneal opacities” and “corneal pathology” which includes a broad spectrum of phenotype. Nonetheless, one possible explanation for the protective effect of corneal pathology is that there might be a lower threshold for earlier (and hence easier) cataract surgery in affected eyes due to their worse baseline vision.

This study has several limitations. In this analysis, 40.8% patients had bilateral cataract surgery which can introduce patient level correlation impacting on statistical comparisons. Attempting to account for potential patient level correlation was not part of the model fitting, instead cluster adjustment for robust standard errors focused on the operating surgeon, by considering their operations in different centres and for different surgeon grades as separate clusters. This attempted to account for surgeons with different responsibilities and experience over the study period, and them working with different theatre teams and in different hospitals. The decision was made to consider surgeons as clusters instead of patients, as patients will have at most two operations, whereas surgeons can operate on thousands of patients. Furthermore, some ocular diseases can develop as bilateral disease, and some are linked to age and be more prevalent in second treated eyes.

It is possible that not all recorded first treated eye operations were patients' actual first eye surgery, as patients could have their first eye surgery prior to a centre adopting an EMR, or performed in a different centre, and at present the audit cannot link patients' data if collected at different centres. It was also not possible to separate pseudoexfoliation and phacodonesis to fit as individual terms in the modelling due to the current option to record both as a combined term on the EMR systems. Potentially influencing risk factors that were not considered were AL and social deprivation. AL was not considered as it is correlated with ACD and previous studies have shown that AL is not a significant influencer for PCR risk[2,8]. Social deprivation was not considered because the audit did not receive this information from all contributing centres due to the differing data collection systems used, and that there are different indices for the different UK nations.

The PCR risk factor model was not a perfect fit, the area under the operating receiver curve value of 70.0% implies there is unaccounted for variation, and the number of significant covariates is a concern regarding possible overfitting, although this is also a reflection of the various clinical factors that can influence the risk of PCR and is linked to a large sample with many covariates having low event rates. Consequently, the interpretation of p-values require caution as they are likely to be too low, especially for covariates with extremely low event rates.

In summary, this analysis provides an update to the current risk adjustment model for PCR with the quantification of additional risk factors. This will facilitate a bespoke, contemporary risk assessment tailored to an individual patient's operation, thereby allowing more informed patient counselling, appropriate case allocation and adoption of precautionary measures to minimise the risk of PCR during surgery.

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The full list of the 136 participating centres included in this study is detailed in Supplementary File.

Conflict of Interest: All authors declare no conflict of interest.

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Author Contribution

PYS, PHJD, ACD and JCB conceptualised the study. PHJD prepared the study data and performed the statistical analysis. All authors contributed to interpretation of the results. PYS

and PHD wrote the first draft of the manuscript. All authors contributed to critical revision of the manuscript and approved the final manuscript. JCB is the overall content guarantor.

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Table and Figure legends

Table 1

Univariate analysis for covariates under consideration for the PCR risk factor modelling. The PCR rate for the continuous covariates is the overall PCR rate for the sample. N = 961 208 cataract operations performed in 136 centres by 3 198 surgeons.

Table 2

Final PCR risk factor model estimates. N = 961 208 cataract operations performed in 136 centres by 3 198 surgeons.

Figure 1

Observed PCR rates for patients' age and gender displayed in 5-year age bandings. N = 961 208 cataract operations performed in 136 centres by 3 198 surgeons. 95% confidence intervals derived using the Fliess quadratic continuity correction. Estimates plotted at the boundary -0.25 for females and +0.25 for males for display purposes.

Figure 2

Observed PCR rates for preoperative LogMAR visual acuity displayed in 0.10 LogMAR bandings. N = 961 208 cataract operations performed in 136 centres by 3 198 surgeons. 95% confidence intervals derived using the Fliess quadratic continuity correction.

Figure 3

Observed PCR rates for anterior chamber depth displayed in 0.1 mm increments. N = 961 208 cataract operations performed in 136 centres by 3 198 surgeons. 95% confidence intervals derived using the Fliess quadratic continuity correction.

Table 1: Univariate analysis for covariates under consideration for the PCR risk factor modelling. The PCR rate for the continuous covariates is the overall PCR rate for the sample. N = 961 208 cataract operations performed in 136 centres by 3 198 surgeons.

PCR risk factor model covariates univariate analysis	**No PCR**	**PCR**	**Total**	**PCR %**	**p-value**
Number of operations	951 478	9 730	961 208	1.01	N/A
Surgical factors					
Surgeon grade					
Consultant surgeon	732 857	5 670	738 527	0.77	
Career grade non-consultant surgeon	56 908	721	57 629	1.25	<0.001
More experienced trainee surgeon	138 728	2 724	141 452	1.93	
Less experienced trainee surgeon	22 985	615	23 600	2.61	
Patient factors					
Age at surgery (year)					
Mean	74.52	75.00	74.52	1.01	<0.001
Standard deviation	9.81	10.65	9.82		
Gender					
Female	551 736	5 154	556 890	0.93	<0.001
Male	399 742	4 576	404 318	1.13	
Ability to lie flat and cooperate					
Yes	919 597	9 312	928 909	1.00	<0.001
No	31 881	418	32 299	1.29	
Systemic diabetes					
No	807 527	7 577	815 104	0.93	<0.001
Yes	143 951	2 153	146 104	1.47	
Ocular factors					
First or second treated eye*					
First	563 894	6 160	570 054	1.08	<0.001
Second	387 584	3 570	391 154	0.91	
Previous intravitreal anti-VEGF therapy					
No	929 424	9 239	938 663	0.98	<0.001
Yes	22 054	491	22 545	2.18	
Pupil size					
Small	51 309	928	52 237	1.78	
Medium	277 382	2 967	280 349	1.06	<0.001
Large	595 129	5 533	600 662	0.92	
Not recorded	27 658	302	27 960	1.08	

Anterior chamber depth (mm)					
Mean	3.08	3.08	3.08	1.01	0.440
Standard deviation	0.42	0.46	0.42		
Preoperative visual acuity (LogMAR)					
Mean	0.59	0.82	0.60	1.01	<0.001
Standard deviation	0.50	0.68	0.50		
Ocular comorbidities					
Age-related macular degeneration					
No	853 235	8 632	861 867	1.00	0.002
Yes	98 243	1 098	99 341	1.11	
Amblyopia					
No	936 791	9 502	946 293	1.00	<0.001
Yes	14 687	228	14 915	1.53	
Brunescent / white / mature cataract					
No	900 525	8 164	908 689	0.90	<0.001
Yes	50 953	1 566	52 519	2.99	
Corneal pathology					
No	882 269	9 209	891 478	1.03	<0.001
Yes	69 209	521	69 730	0.75	
Diabetic retinopathy					
No	902 058	8 864	910 922	0.97	<0.001
Yes	49 420	866	50 286	1.72	
Fuchs endothelial dystrophy					
No	949 186	9 716	958 902	1.01	0.052
Yes	2 292	14	2 306	0.61	
Glaucoma					
No	864 599	8 147	872 746	0.93	<0.001
Yes	86 879	1 583	88 462	1.79	
High myopia					
No	920 242	9 310	929 552	1.00	<0.001
Yes	31 236	420	31 656	1.33	
Inherited eye disease					
No	945 734	9 687	955 421	1.01	0.040
Yes	5 744	43	5 787	0.74	
No fundal view / vitreous opacity					
No	925 708	9 096	934 804	0.97	<0.001
Yes	25 770	634	26 404	2.40	
Oculomotor disease					
No	949 782	9 705	959 487	1.01	0.068
Yes	1 696	25	1 721	1.45	

Other macular pathology					
No	914 577	9 354	923 931	1.01	0.943
Yes	36 901	376	37 277	1.01	
Other retinal vascular pathology					
No	942 729	9 583	952 312	1.01	<0.001
Yes	8 749	147	8 896	1.65	
Previous trabeculectomy					
No	948 226	9 678	957 904	1.01	0.001
Yes	3 252	52	3 304	1.57	
Previous vitrectomy					
No	936 330	9 473	945 803	1.00	<0.001
Yes	15 148	257	15 405	1.67	
Pseudoexfoliation / phacodonesis					
No	943 449	9 322	952 771	0.98	<0.001
Yes	8 029	408	8 437	4.84	
Uveitis / synechiae					
No	945 760	9 647	955 407	1.01	0.001
Yes	5 718	83	5 801	1.43	

*First treated eye surgery includes both eyes from ISBCS patients

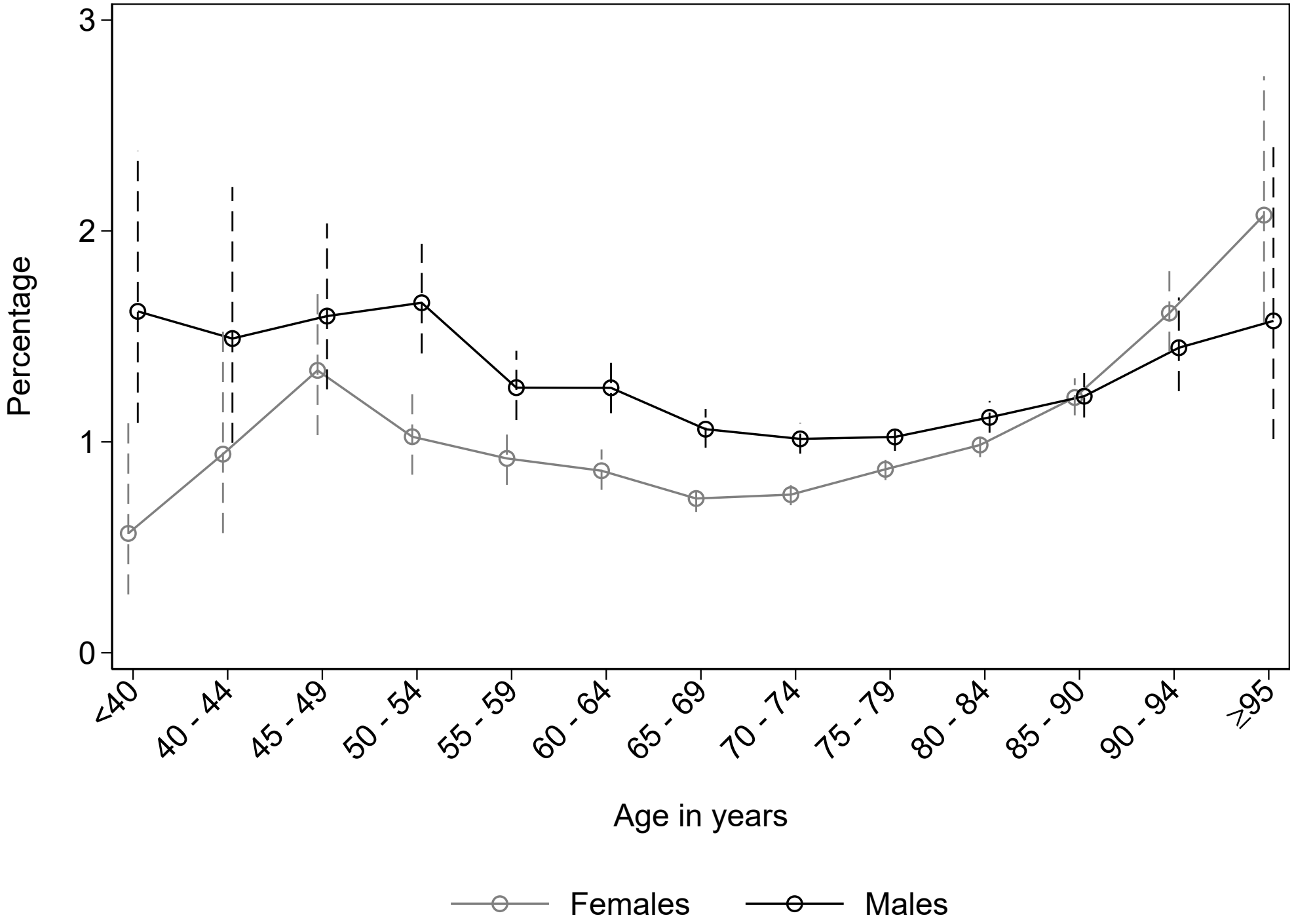
Table 2: Final PCR risk factor model estimates. N = 961 208 cataract operations performed in 136 centres by 3 198 surgeons.

PCR risk factor model covariates	Odds ratio	Coefficient	Standard error	p-value	95% confidence interval for odds ratio
Constant	0.002	-6.391	<0.001	<0.001	0.001 to 0.002
Surgical factors					
Surgeon grade					
Consultant surgeon	REF	REF	N/A	N/A	N/A
Career grade non-consultant surgeon	1.586	0.461	0.164	<0.001	1.294 to 1.943
More experienced trainee surgeon	2.484	0.910	0.100	<0.001	2.296 to 2.688
Less experienced trainee surgeon	3.754	1.323	0.231	<0.001	3.328 to 4.235
Patient factors					
Age at surgery (year)	1.015	0.015	0.002	<0.001	1.012 to 1.018
Gender					
Female	REF	REF	N/A	N/A	N/A
Male	3.046	1.114	0.485	<0.001	2.229 to 4.162
Gender and age interaction*	0.987	-0.013	0.002	<0.001	0.983 to 0.991
Ability to lie flat and cooperate					
Yes	REF	REF	N/A	N/A	N/A
No	1.186	0.171	0.063	0.001	1.069 to 1.317
Systemic diabetes					
No	REF	REF	N/A	N/A	N/A
Yes	1.239	0.215	0.043	<0.001	1.157 to 1.327
Ocular factors					
First or second treated eye					
First	REF	REF	N/A	N/A	N/A
Second	0.904	-0.101	0.019	<0.001	0.868 to 0.942
Previous intravitreal anti-VEGF therapy					
No	REF	REF	N/A	N/A	N/A
Yes	1.427	0.356	0.075	<0.001	1.287 to 1.582
Pupil size					
Small	REF	REF	N/A	N/A	N/A

Medium	0.655	-0.424	0.032	<0.001	0.596 to 0.720
Large	0.648	-0.434	0.027	<0.001	0.596 to 0.703
Not recorded	0.657	-0.420	0.059	<0.001	0.550 to 0.783
Anterior chamber depth (mm)	1.113	0.107	0.033	<0.001	1.051 to 1.178
Preoperative visual acuity (LogMAR)	1.510	0.412	0.028	<0.001	1.457 to 1.566
Ocular comorbidities**					
Amblyopia	1.205	0.187	0.083	0.007	1.052 to 1.380
Brunescent / white / mature cataract	2.409	0.879	0.092	<0.001	2.236 to 2.595
Diabetic retinopathy	1.176	0.162	0.058	0.001	1.068 to 1.294
Glaucoma	1.713	0.538	0.074	<0.001	1.574 to 1.863
High myopia	1.395	0.333	0.075	<0.001	1.256 to 1.550
Previous vitrectomy	1.241	0.216	0.084	0.001	1.086 to 1.417
Pseudoexfoliation / phacodonesis	3.466	1.243	0.228	<0.001	3.048 to 3.942

*For the gender and age interaction, the reference would be female patients

**For all ocular comorbidities, the reference category is absence of the condition (i.e., eyes without the condition)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40 - 44
45 - 49
50 - 54
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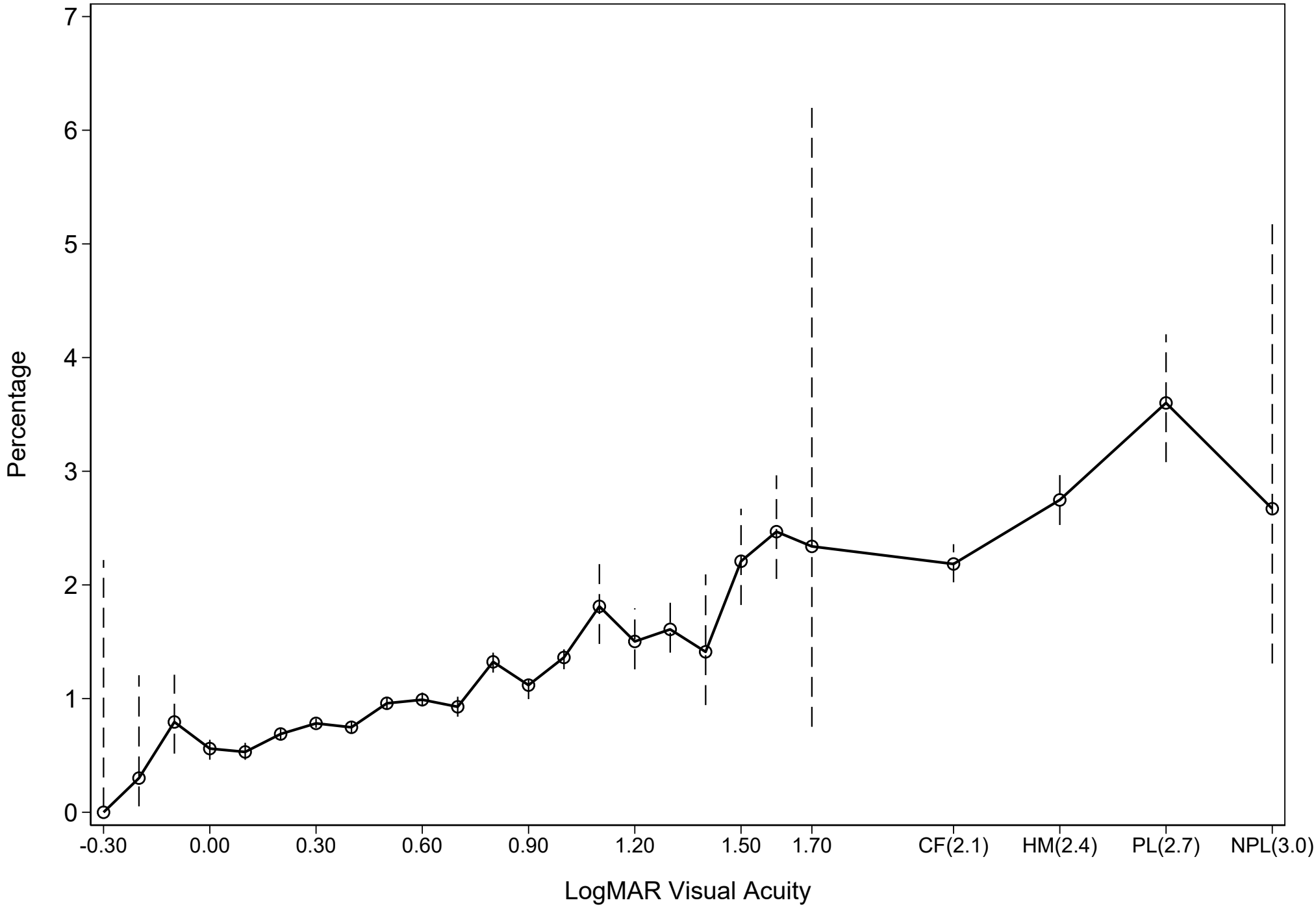
65 - 69
70 - 74
75 - 79
80 - 84
85 - 90
90 - 94
≥95
Age in years
Females
Males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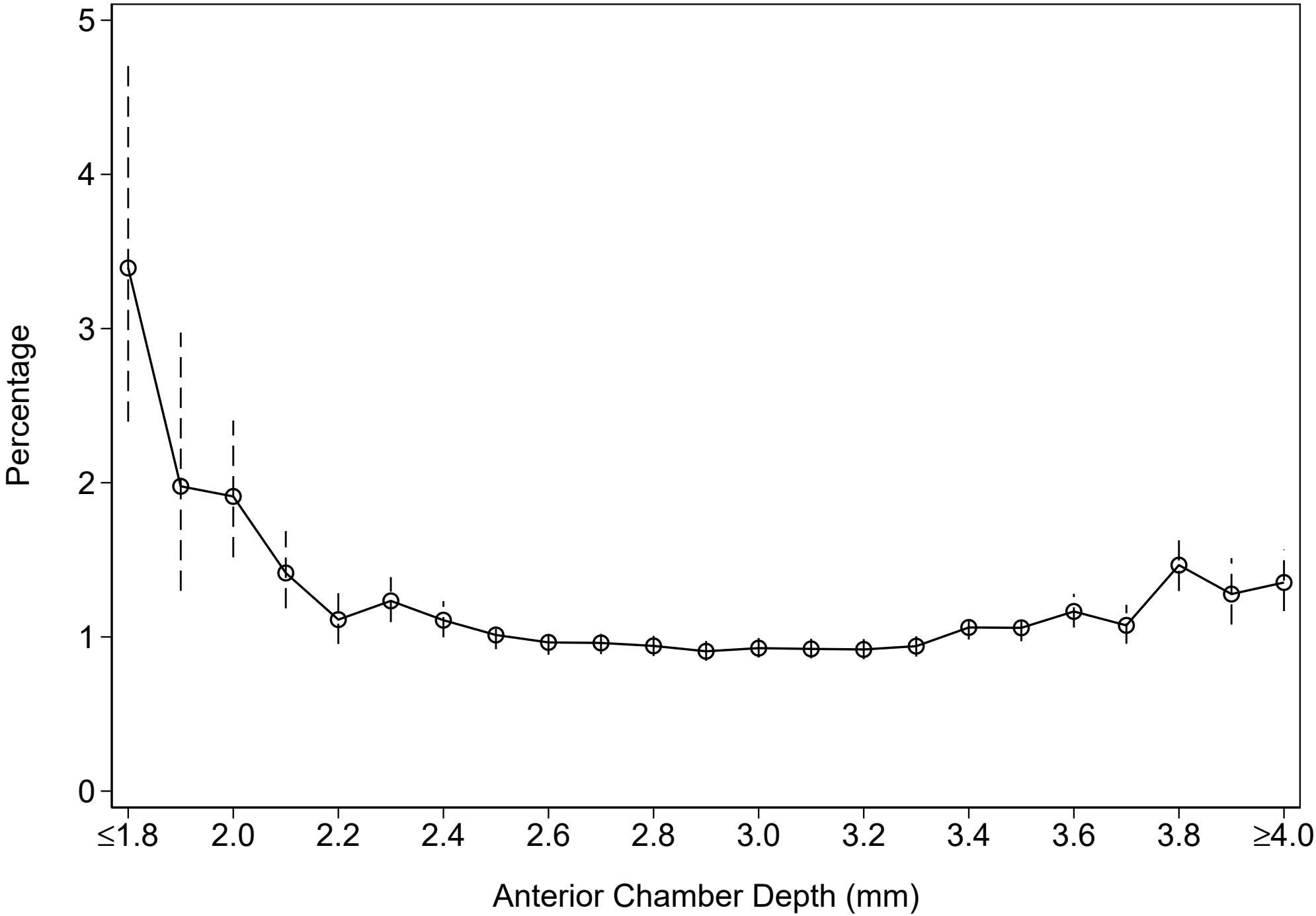
PL(2.7)
NPL(3.0)
LogMAR Visual Acuity


5
4
3
2
1
0
Percentage
≤1.8
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
≥4.0
Anterior Chamber Depth (mm)