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ORIGINAL ARTICLE

Vision-Related Quality of Life in Moderate-to-High Myopia Corrected with Rigid Gas Permeable Contact Lenses: A West Sumatran Cross-Sectional Study

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ABSTRACT

Background: Rigid gas permeable (RGP) contact lenses correct highly ametropic eyes better than spectacles can, but whether that optical advantage reaches the patient, and what predicts it, is unstudied in Indonesia.

Objective: To characterize vision-related quality of life, and to test whether clinical variables predict it, in adults with moderate-to-high myopia corrected with rigid gas permeable contact lenses in West Sumatra, Indonesia.

Methods: In an analytical cross-sectional study, 26 adults with a spherical equivalent of at least −3.00 dioptres who had worn RGP lenses for at least one month were recruited at the Refraction, Contact Lens and Low Vision Subdivision of Dr. M. Djamil Central General Hospital, Padang, West Sumatra, between July and August 2025. Acuity was recorded in logMAR before fitting and with the lens, and quality of life with the Indonesian National Eye Institute Visual Function Questionnaire-25; predictors were related to the composite and 12 subscales by Spearman and Mann–Whitney tests, with Benjamini–Hochberg control across all 104 tests.

Results: The median composite score was 93.21 (62.95–97.16) and 20 of 26 (76.9%, 95% CI 56.4–91.0) scored at or above the visually-normal normative mean of 85.48. Every participant gained at least 0.304 logMAR, 3.0 times the 0.10 logMAR minimum clinically important difference, the median gain being identified to 1.374–1.470 logMAR. Three tests reached $p < 0.05$ against 4.9 expected under the global null and none survived correction (smallest $q = 0.989$); with a minimum detectable $|\rho|$ of 0.557, six subscales at their ceiling and a corrected-acuity range below one such difference, the predictor analysis is uninformative rather than negative.

Conclusion: RGP correction restored near-normal function and patient-reported vision; a future Indonesian study needs about 89 participants.

1. Introduction

Myopia is the refractive state in which parallel light is brought to focus anterior to the retina in the unaccommodated eye, and it has become the single most prevalent ocular condition of the present century. Pooled estimates place the global prevalence of myopia at 29.66% between 2011 and 2019, rising to 35.81% between 2020 and 2023, with projections that half the world's population will be myopic and almost one in ten highly myopic by 2050.[1-6] East and Southeast Asia carry a disproportionate share of that burden, and the Lancet Global Health Commission on Global Eye Health identified uncorrected refractive error as the largest single contributor to the 1.1 billion people living with unaddressed vision impairment worldwide.[7-9] Indonesia, an archipelago of more than 275 million people distributed across some 17,000 islands, combines a rapidly urbanising and increasingly educated young population with an ophthalmic workforce concentrated in a small number of tertiary centres, so that the epidemiological drivers of myopia and the barriers to its optical correction operate simultaneously.[7,8,10,11] West Sumatra is a province in which formal education is culturally prioritised, so that the two most consistently replicated environmental correlates of myopia — near-work exposure and educational attainment — would be expected to be common; we measured neither, and offer this as background rather than as a finding.[12,13]

High myopia is not merely a strong spectacle prescription. Axial elongation stretches the posterior pole and generates a lifetime risk of myopic maculopathy, retinal detachment, glaucoma and cataract that rises steeply and continuously with axial length; a meta-analysis of the complications of myopia found the odds of myopic macular degeneration, retinal detachment and open-angle glaucoma all increasing monotonically across refractive strata, with no threshold below which risk disappears.[14-19] Optical correction of a highly myopic eye is itself imperfect. A spectacle lens of −10 dioptres worn at a vertex distance of 12 mm minifies the retinal image by about 11%, introduces oblique astigmatism and prismatic effects away from the optical centre, and constricts the

effective field through the spectacle frame; the higher the power, the larger each of these penalties becomes.[20-22] A rigid gas permeable (RGP) contact lens sits on the tear film, moves the correcting surface to the corneal plane, and thereby removes most of the minification and much of the peripheral aberration, while the tear lens formed behind a rigid surface neutralises a substantial proportion of anterior corneal irregularity.[20,21,23-25] These are the optical grounds on which RGP lenses have long been the correction of choice for highly ametropic and irregular corneas.

The clinical literature supports that reasoning. Randomised and observational comparisons have reported better best-corrected visual acuity (BCVA) with RGP lenses than with soft lenses or spectacles in high myopia, and slower axial elongation with rigid than with soft correction, although the landmark Contact Lens and Myopia Progression trial showed that the apparent refractive advantage of rigid lenses was largely a corneal-flattening artefact rather than a true reduction in axial growth.[26-30] Contemporary myopia control has moved towards orthokeratology, defocus-incorporating spectacle designs and low-dose atropine, each of which now has randomised evidence behind it.[6,31-34] What has not moved is the position of the RGP lens as a corrective, rather than a control, modality for the adult with established moderate-to-high myopia — the patient for whom the question is not how fast the eye will grow but how well, and how comfortably, they will see today.[35,36]

Comfort is the acknowledged weakness of rigid correction. Rigid lens edges interact with the upper lid on every blink, and a prospective study of the adaptation period found that 27% of new RGP wearers discontinued before day 15 because of foreign-body sensation, dryness and burning, with subjective comfort and vision scores reaching 9 out of 10 only by day 28.[37-39] Because the optical benefit and the comfort penalty pull in opposite directions, neither acuity alone nor symptom counts alone can express whether an RGP fitting has succeeded. That judgement requires a patient-reported outcome measure. The 25-item National Eye Institute Visual Function Questionnaire (NEI VFQ-25) is the most widely used vision-specific instrument in ophthalmology, comprising a general-health item, a general-vision item and eleven vision-targeted subscales that are averaged into a composite score;[40] its psychometric performance has been characterised in visually normal populations, its item calibrations have been re-estimated for cross-study comparison, and Rasch analyses have repeatedly shown that its subscales behave as a small number of underlying dimensions rather than twelve independent ones.[41-45] Systematic review of patient-reported outcomes in refractive error concluded that most instruments in this field, the NEI VFQ-25 included, were developed for disease populations and perform poorly at the healthy end of the scale.[46-49]

Evidence on vision-related quality of life in rigid-lens wearers is thin and almost entirely confined to keratoconus, where the optical gain is dramatic and the baseline impairment severe.[50-53] Studies of refractive error and quality of life in the general population have been conducted in South Africa, India and Thailand, but we could identify no published study measuring vision-related quality of life in adults whose moderate-to-high myopia is corrected with RGP lenses. Two Indonesian rigid-lens series have been published — a comparison of spectacle and rigid-lens acuity, and a report of rigid-lens management of severe ametropia — but neither measured quality of life.[54-58] Dr. M. Djamil Central General Hospital in Padang is the principal tertiary referral centre for West Sumatra and the teaching hospital of the ophthalmology residency programme of the Faculty of Medicine, Andalas University; its Refraction, Contact Lens and Low Vision Subdivision is one of the few services in the region that fits rigid lenses routinely, and it receives referrals from the nineteen districts and cities of West Sumatra as well as from the neighbouring provinces of Riau, Jambi and Bengkulu. The service is therefore an appropriate place to ask the question, and the answer has direct implications for how rigid lens fitting is prioritised within a national health-insurance system that reimburses optical appliances sparingly.

This study had three aims. The first was descriptive: to characterise vision-related quality of life, measured by the Indonesian NEI VFQ-25, in adults with moderate-to-high myopia wearing RGP contact lenses at a West Sumatran tertiary centre, and to benchmark it against published visually-normal norms. The second was analytical: to determine whether demographic, refractive and lens-related variables predict that quality of life. The third was methodological and, as it turned out, decisive: to establish what a study of this size and structure can and cannot determine, by re-deriving every reported statistic, bounding the quantities the aggregate record identifies only partially, and subjecting the whole family of tests to formal multiplicity control. We report all three, and we argue that the third is the finding of greatest value to the Indonesian ophthalmic community.

2. Methods

Study design and reporting

This was an analytical observational study with a cross-sectional design, reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies.[59] The unit of analysis was the individual participant; where an ocular measurement was required, the worse-seeing eye was used, so that no participant contributed two correlated eyes to any analysis. The study combines a primary clinical dataset with a set of secondary analyses — re-derivation, partial identification, multiplicity control and design-sensitivity assessment — that were specified after the

clinical data had been collected. This ordering is stated explicitly rather than described as pre-specification, and the provenance of every quantity — reported in the source clinical record, or derived here — is set out in the audit that closes the Results.

Ethics

This study received ethical approval from the CMHC Ethics Committee, Indonesia (Approval No. CMHC/EC/2025/0212). Written informed consent was obtained from all participants; the source clinical record states that all subjects participating in the study signed written informed consent forms. The study was conducted in accordance with the Declaration of Helsinki.

Setting and participants

Participants were recruited consecutively at the ophthalmology outpatient clinic and the Refraction, Contact Lens and Low Vision Subdivision of Dr. M. Djamil Central General Hospital, Padang, West Sumatra, Indonesia, between July and August 2025. Eligible participants were adults aged 18 years or older with moderate or high myopia, defined by a spherical equivalent of −3.00 dioptres or more in absolute value, who used RGP contact lenses as their primary means of correction in daily activities and who had worn them for at least one month after fitting. Moderate myopia was defined as a spherical equivalent between −3.00 and −5.99 dioptres and high myopia as a spherical equivalent beyond −6.00 dioptres, in line with the International Myopia Institute's proposed classification.[60,61] Participants with significant anterior- or posterior-segment disease capable of limiting acuity independently of refractive error — cataract, glaucoma or retinal disorder — and those with a history of refractive surgery were excluded. The one-month minimum wearing time was chosen so that all participants had passed the adaptation window during which rigid-lens symptom scores are known to be transiently elevated.[37,38]

The number of patients screened and the number excluded at each step are not recorded in the source clinical record and cannot be recovered; Figure 1A therefore states them as not reported rather than supplying a figure. This is a genuine limitation of the participant flow and is treated as such in the Discussion.

What the clinical record specifies, and what it does not

This section states the examination protocol at the level of detail the source clinical record actually supports, and names what it does not. Nothing here is reconstructed from usual practice. Distance visual acuity was recorded in the worse-seeing eye on two occasions — before RGP fitting and with the RGP lens in situ after at least one month of wear — and is reported throughout in logMAR, the logarithm of the minimum angle of resolution, so that acuities are placed on an interval scale suitable for arithmetic.[62] The chart type, the testing distance, the illumination, the identity and number of examiners and the models of any instruments used are NOT recorded, and are therefore not stated.

The recorded acuity values themselves carry information about how they were obtained. The three reported pre-fitting values are exact reduced-Snellen fractions: 0.40 logMAR is 6/15, 1.47 logMAR is 2/60 and 1.78 logMAR is 1/60, each agreeing with $\log_{10}$(denominator/numerator) to within 0.008. Acuities recorded as 2/60 and 1/60 are obtained by walking the patient towards the chart, not read from a chart at a fixed six metres, and they lie well beyond the largest optotype of a standard projected chart. The measurement convention behind the pre-fitting figures is therefore reduced-distance testing of presenting vision, and we interpret and label those values accordingly throughout (see the Discussion).

Refractive status was recorded only as the spherical equivalent classification used in the inclusion criteria — moderate between −3.00 and −5.99 dioptres, high beyond −6.00 dioptres, in line with the International Myopia Institute's proposed standards.[60,61] Sphere, cylinder and axis are not reported and could not be recovered; whether refraction was manifest or cycloplegic is not stated. The back-vertex power of the dispensed RGP lens was recorded in dioptres. This is a corneal-plane quantity and is not interchangeable with the spectacle-plane spherical equivalent that defines the inclusion criteria: at a vertex distance of 12 mm, a corneal-plane power of -9.38 D corresponds to approximately -10.6 D in spectacles. Lens power is used in this paper as a marker of ametropia and never as a substitute for the spherical equivalent.

RGP fitting was assessed and classified as optimal, flat or steep; the source does not state the assessment method, and the fluorescein technique is therefore not described here. The lens-care variable is recorded only as a dichotomy at two weeks and the record does not say what procedure the interval refers to; we report it as the authors recorded it and draw no inference about disinfection practice from it. Anterior- and posterior-segment examination was used to apply the exclusion criteria for cataract, glaucoma, retinal disorder and previous refractive surgery. Keratometry, corneal topography, axial length, intraocular pressure and optical coherence tomography were not part of the protocol; their absence constrains the mechanistic interpretation of the results and is addressed in the Discussion.

Quality-of-life assessment

Vision-related quality of life was measured with the Indonesian version of the NEI VFQ-25, administered to each participant at the study visit; the mode of administration is not recorded in the source. The instrument yields a general-health item and eleven vision-targeted subscales: general vision, ocular pain,

near activities, distance activities, vision-specific social functioning, vision-specific mental health, vision-specific role difficulties, vision-specific dependency, driving, colour vision and peripheral vision.[40] Each item is recoded onto a 0–100 scale in which 100 represents the best possible functioning; a subscale score is the arithmetic mean of the recoded scores of its constituent items, and the composite score is the mean of the eleven vision-targeted subscale scores, excluding the general-health item. Participants who do not drive are not assigned a driving score, and the composite is then averaged over the remaining ten subscales. Higher scores denote better vision-related quality of life throughout.

Recovery of the analysable sample size for each subscale

The source clinical record reports the analysable sample size as 26 for every scale. Because the driving subscale is by construction restricted to participants who drive, we tested that assumption rather than assuming it. For every reported correlation we re-submitted the printed ρ to the exact t transformation, $t = \rho\sqrt{(n-2)}/\sqrt{(1-\rho^2)}$ on n − 2 degrees of freedom, and compared the resulting two-sided p value with the printed one; we then recovered the analysed n for each cell by minimising the absolute discrepancy over n = 5 to 26. The procedure is described here, in the Methods, because its result changes the sample size used in every subsequent driving-subscale calculation, including that subscale's confidence intervals, effect sizes and power thresholds.

Statistical analysis

Continuous variables are summarised as medians with minima and maxima, reflecting the distributional shape of ordinal questionnaire scores and of a small sample; categorical variables are summarised as counts and percentages. Associations between the five continuous clinical predictors — age, pre-fitting acuity, with-lens acuity, lens back-vertex power and duration of wear — and the composite and subscale scores were quantified by Spearman's rank correlation coefficient ρ, with two-sided p values from the t transformation above. Each ρ was given a 95% confidence interval on the Fisher z scale using the Bonett–Wright standard error $\sqrt{[(1 + \rho^2/2)/(n - 3)]}$, which is appropriate for rank correlations and is not the Pearson formula.[63] Comparisons between the levels of the three binary variables — sex, degree of myopia and lens-care frequency — used the Mann–Whitney U test. Because the U statistics themselves are not recorded in the source, effect sizes for these comparisons were recovered from the reported two-sided p values as $|r| = |z|/\sqrt{n}$ under the normal approximation, with $|z| = \Phi^{-1}(1 - p/2)$; this is an approximation, it is declared as such wherever it appears, and the direction of the resulting bias is stated alongside it.

Three features of the design required treatment that the original analysis did not apply. First, the number of hypothesis tests is large relative to the sample: 65 rank correlations and 39 group comparisons, 104 in total. We therefore report, alongside every nominal p value, the Benjamini–Hochberg q value and the Holm-adjusted p value computed over the complete family, and we compare the observed number of nominally significant results with the number expected under the global null, $m \times \alpha = 5.2$ at the nominal level, or 4.95 when each test is credited with its own exact size. That expectation is a consequence of linearity and holds whatever the dependence among the tests; the accompanying binomial tail probability additionally assumes independence and is presented as a reference calculation only.[64] Second, several quantities of clinical interest are not point-identified by an aggregate report but are bounded by it. Because every with-lens acuity lies within [0.000, 0.096] logMAR, each individual acuity gain — the pre-fitting value minus the with-lens value — lies between that participant's pre-fitting acuity minus 0.096 and their pre-fitting acuity itself. Order statistics are monotone under an elementwise-bounded transformation, so the k-th smallest gain is bounded below by the k-th smallest pre-fitting acuity minus 0.096 and above by the k-th smallest pre-fitting acuity. Sharpness of the resulting interval is then established by exhibiting an admissible configuration of pre-fitting and with-lens values that attains each endpoint, which is necessary because the two degenerate configurations a reader might assume — every with-lens acuity at one end of its range — are excluded by the reported with-lens minimum and median. Third, the exact null distribution of the Mann–Whitney statistic was enumerated by the recursion $c(a, b, u) = c(a - 1, b, u - b) + c(a, b - 1, u)$ for each of the three group splits, so that the smallest attainable p value, the number of attainable p values and the actual size of the nominal 0.05 test are reported exactly rather than approximated.

Design sensitivity was quantified in three ways. The critical |ρ| that reaches p = 0.05 at a given n was obtained from the inverse t transformation, and the |ρ| detectable with 80% power at a two-sided α of 0.05 by solving $\operatorname{artanh}(\rho) = [z(\alpha) + z(\beta)] \times \sqrt{[(1 + \rho^2/2)/(n - 3)]}$, where z(α) and z(β) are the standard normal deviates for a two-sided 0.05 significance level and for 80% power. The same Bonett–Wright variance is used here as for the confidence intervals; using the Pearson variance 1/(n − 3) for the power calculation while using Bonett–Wright for the intervals would understate the minimum detectable effect, and these two quantities are distinct and are never conflated, since the first is a significance threshold and the second a power requirement. For the Mann–Whitney comparisons, power was computed against a Lehmann alternative by simulation over 200,000 replicates using the exact enumerated null, and is expressed as the probability of superiority required for 80% power. The loss of power caused by the questionnaire ceiling was estimated by simulating a latent bivariate normal pair with ρ = 0.50

at n = 26 and censoring the outcome so that m of the 26 observations tie at the maximum, over 6,000 replicates per condition (Monte-Carlo standard error ≤ 0.007). Where the manuscript's own reasoning implied that one association differed from another — for example that a predictor is related to a subscale but not to the composite — that contrast was tested explicitly by Steiger's test for dependent correlations sharing a variable, evaluated across every positive-definite value of the unreported between-scale correlation, so that the result is reported as an identified region rather than a single p value.[65]

A minimum clinically important difference of 0.10 logMAR, equivalent to one line on a logarithmic chart, was adopted for visual acuity throughout.[62,66] The smallest correlation regarded as clinically interesting was set at |ρ| = 0.30, and the question of whether the study could exclude effects of that size was addressed by inspecting the confidence intervals rather than by interpreting a non-significant p value as evidence of absence.[67,68] The integrity of the reported questionnaire statistics was verified by testing every reported subscale median, minimum and maximum against the exact scoring lattice implied by that subscale's item count, and the attainability of the composite median was checked by exact enumeration of the reachable sums of subscale scores. All analyses were performed in Python 3.11 with NumPy 2.4 and SciPy 1.17. Two-sided p values are reported to three decimal places and α was set at 0.05. Every derived statistic is produced by a function call in a single analysis script; the values transcribed from the source clinical record are held in one declarative module and are checked programmatically against the plain text of that record before use.

3. Results

Participants

Twenty-six adults were enrolled and all completed the NEI VFQ-25; the participant flow is shown in Figure 1A and the characteristics of the cohort in Table 1. Table 1 also gives, for each characteristic, the derived quantity or exact-enumeration property that it determines. The median age was 23.00 years (range 18–39), so the entire sample was of working age and no participant had reached the age at which presbyopic correction would normally be required. Nineteen participants (73.1%) were female and seven (26.9%) male. Twenty (76.9%) had high myopia and six (23.1%) moderate myopia. The median back-vertex power of the dispensed RGP lens was -9.38 D (range -19.25 to -4.00 D), confirming that the cohort sat well beyond the moderate-myopia threshold. The median duration of RGP wear was 11.5 months (range 2–192), so every participant was past the 28-day adaptation window and half had worn the lenses for nearly a year or longer. All 26 fittings (100%) were classified as optimal, with no flat or steep fits recorded, and 24 participants (92.3%) were recorded as attending to lens care at intervals of two weeks or less; the record does not state what procedure that interval refers to. The exact null distributions underlying the three group comparisons in Table 1 were enumerated in full and are summarised there.

Table 1. Demographic, refractive and contact-lens characteristics of the 26 participants with moderate-to-high myopia wearing rigid gas permeable contact lenses, Dr. M. Djamil Central General Hospital, Padang, West Sumatra.

Characteristic	Value	Derived quantity or verification
Demographic		
Age, years, median (min–max)	23.00 (18.00–39.00)	Entire sample of working age; no participant aged ≥40 years
Sex, n (%)		
Male	7 (26.9)	Exact Mann–Whitney null distribution over 657,800 splits
Female	19 (73.1)	smallest attainable two-sided p = 3.0e-06
Refractive		
Degree of myopia, n (%)		
Moderate (SE −3.00 to −5.99 D)	6 (23.1)	Exact null over 230,230 splits;
High (SE beyond −6.00 D)	20 (76.9)	smallest attainable two-sided p = 8.7e-06
RGP lens back-vertex power, D, median (min–max)	-9.38 (-19.25 to -4.00)	Measured at the corneal plane and NOT interchangeable with the spectacle-plane spherical equivalent used in the inclusion criteria; at a 12 mm vertex −9.38 D at the cornea corresponds to about −10.6 D in spectacles
Visual acuity of the worse eye (logMAR)		
Before RGP fitting, median (min–max)	1.47 (0.40–1.78)	All three values are exact reduced-Snellen fractions — 0.40 = 6/15, 1.47 = 2/60, 1.78 = 1/60 — i.e. presenting rather than chart-corrected acuity
With the RGP lens, median (min–max)	0.096 (0.000–0.096)	Median equals the maximum, so ≥14 of 26 eyes sit at 0.096 logMAR (≈20/25); between 2 and 12 eyes recorded 0.000

Individual acuity gain, logMAR	≥ 0.304 for every participant	Deductive envelope; 3.0 × the 0.10 logMAR MCID; 26 of 26 with certainty, so no test or interval is reported
Median acuity gain, logMAR	1.374–1.470 (sharp bounds)	≈ 13.7–14.7 ETDRS lines; identified to within 0.096 logMAR
Total spread of the with-lens acuity, logMAR	0.096	0.96 × MCID — the whole exposure range lies below one MCID
Contact-lens wear		
Duration of RGP wear, months, median (min–max)	11.50 (2.00–192.00)	All participants beyond the 28-day adaptation window
Fitting assessment, n (%)	Optimal fit 26 (100); flat 0 (0); steep 0 (0)	No fitting variance; the variable is constant and cannot enter any model
Lens-care frequency, n (%) — the source does not define what the interval refers to		
Every ≤2 weeks	24 (92.3)	2 vs 24 split: only 25 two-sided p values are attainable;
Every >2 weeks	2 (7.7)	smallest attainable p = 0.0062; actual size of the 0.05 test = 0.037

SE = spherical equivalent; RGP = rigid gas permeable; MCID = minimum clinically important difference; ETDRS = Early Treatment Diabetic Retinopathy Study. Values in the first two columns are transcribed from the source clinical record; every quantity in the third column is derived in this study. Snellen equivalents are computed as 20/(20 × 10^logMAR). The bounds on the acuity gain are obtained without individual-level data, from the fact that each with-lens acuity lies in [0.000, 0.096] logMAR.

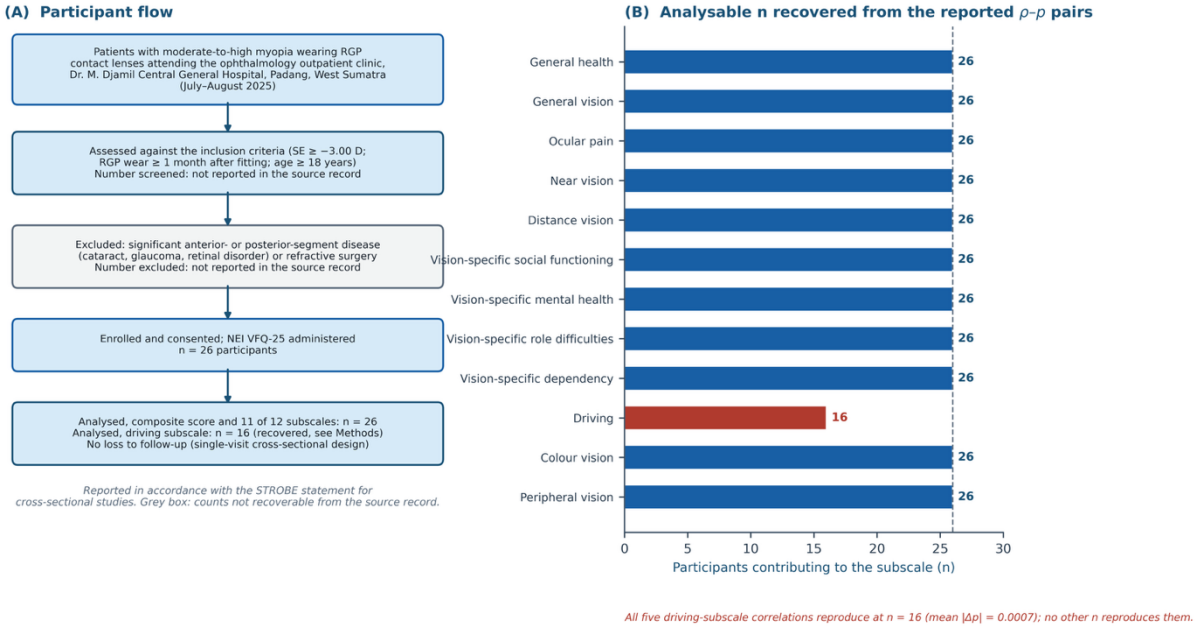

Figure 1. Participant flow and the analysable sample size of each NEI VFQ-25 scale. (A) Flow of participants through the study, reported in accordance with the STROBE statement for cross-sectional studies; the screening and exclusion counts are not recorded in the source clinical record and are shown as such rather than estimated. (B) Number of participants contributing to each scale, recovered by re-submitting every reported Spearman coefficient to the exact t transformation and identifying the sample size that reproduces the printed p value. All five driving-subscale correlations reproduce at n = 16 and at no other sample size between 5 and 26, so ten participants (38.5%) did not contribute to that subscale. The screening and exclusion counts are unrecorded, not zero.

Visual acuity before and with the rigid lens

Median acuity of the worse eye before RGP fitting was 1.47 logMAR (range 0.40–1.78), a Snellen equivalent of approximately 20/590. With the lens in place the median was 0.096 logMAR (range 0.000–0.096), that is 20/25 or better in every eye, as plotted in Figure 2A. Two structural features of this distribution govern much of what follows. First, the reported median with-lens acuity equals the reported maximum. For an even sample size that forces BOTH the thirteenth and the fourteenth order statistics to the maximum, so at least 14 of the 26 eyes recorded exactly 0.096 logMAR; combined with a minimum of 0.000, and with the fact that no Snellen line lies between 20/20 and 20/25, the with-lens acuity is in these data a two-valued variable rather than a continuous one. Second, its total spread is 0.096 logMAR, which is 0.96 times the 0.10 logMAR minimum clinically important difference — the entire range of this predictor lies below the smallest acuity difference regarded as clinically meaningful, as displayed in Figure 2B.

The magnitude of the acuity gain can be bounded exactly even though individual pairs are not available. Because every with-lens acuity lies in [0.000, 0.096] logMAR, every individual gain is at least 0.40 − 0.096 = 0.304 logMAR and at most 1.78 logMAR. The lower

endpoint is 3.0 times the minimum clinically important difference, so all 26 participants achieved a clinically important improvement. Because that conclusion is certain rather than estimated, no significance test and no confidence interval is attached to it. Applying the same monotonicity argument to the median gives an interval for the median gain of 1.374 to 1.470 logMAR, approximately 13.7 to 14.7 lines on a logarithmic chart; the width of that interval, 0.096 logMAR, is the entire residual uncertainty left by the absence of individual-level data. That interval is sharp, though not for the reason a reader might first suppose: the two degenerate configurations that would attain its endpoints — every with-lens acuity at 0.096, or every one at 0.000 — are both excluded by the reported with-lens minimum and median, so sharpness is established instead by exhibiting admissible configurations that attain each endpoint, which we do explicitly.

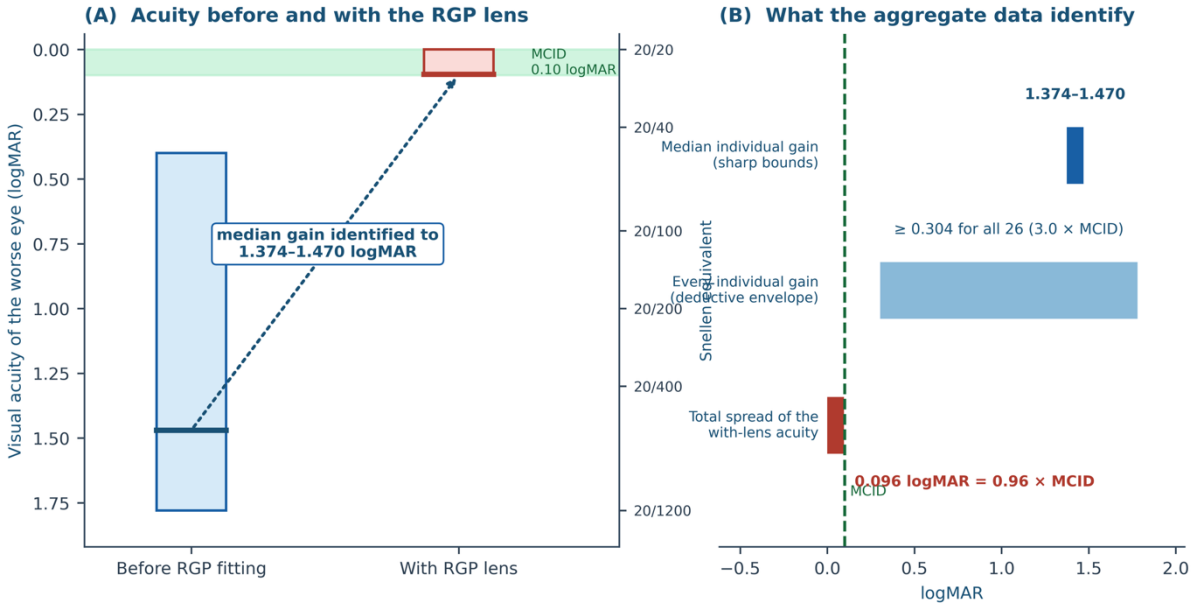

Figure 2. Visual acuity before and with the rigid gas permeable lens, and the quantities the aggregate record identifies. (A) Reported medians and ranges of the worse-eye acuity, with the Snellen equivalent on the right axis and the 0.10 logMAR minimum clinically important difference (MCID) shaded. (B) What can be determined without individual-level data: the median gain is bounded to 1.374–1.470 logMAR because every with-lens acuity lies in [0.000, 0.096] logMAR; every individual gain lies in a deductive envelope whose lower endpoint, 0.304 logMAR, is 3.0 times the MCID; and the entire spread of the with-lens acuity, 0.096 logMAR, is 0.96 of one MCID.

Vision-related quality of life

The median composite NEI VFQ-25 score was 93.21 (range 62.95–97.16). The subscale profile is given in Table 2 and displayed in Figure 3. Six of the twelve subscales — near activities, vision-specific social functioning, vision-specific role difficulties, vision-specific dependency, colour vision and peripheral vision — returned a median of exactly 100 points, which for an even sample size of 26 forces both central order statistics to the maximum and therefore requires at least 14 of the 26 participants (53.8%) to have scored the maximum on each of them. Colour vision and peripheral vision are more constrained still: with a reported minimum of 75 and a maximum of 100 on a five-point single-item lattice they can take only two values in these data, which caps the largest attainable Spearman $|\rho|$ against any predictor at 0.864, as detailed in Table 2. The lowest median was recorded for driving (66.67, range 0–100), followed by general health (75) and general vision (80); vision-specific mental health had the widest range of any subscale (25–100).

Benchmarked against the published visually-normal normative composite mean of 85.48, 20 of the 26 participants (76.9%, 95% CI 56.4–91.0%) scored at or above the norm. We do not attach a significance test to that proportion: 85.48 is the mean of a bounded and left-skewed normative distribution, so the proportion of a visually normal sample lying above it is not one half, is not known to us, and cannot serve as a null value. The remaining 6 participants (23.1%) scored below it.

All 36 reported subscale medians, minima and maxima lie exactly on the scoring lattice determined by the number of items in the corresponding subscale — for example, the ocular-pain median of 81.25 is the midpoint of two adjacent points on the two-item lattice of multiples of 12.5, and the vision-specific mental-health median of 90.63 is the midpoint of two adjacent points on the four-item lattice of multiples of 6.25, both of which are listed in Table 2. The check is a genuine one, but it is weaker than it looks: 18 of the 36 tested values are 100, which lies on every lattice by construction, and of the twelve subscales only vision-specific mental health has an item count that its own three values identify uniquely. It is nonetheless consistent with the questionnaire having been scored by the published algorithm, and it passes without exception.

Table 2. National Eye Institute Visual Function Questionnaire-25 profile, scoring-lattice verification and ceiling structure (n = 26; driving subscale n = 16).

Scale	Items (lattice step)	Median (min–max)	On the NEI VFQ-25 scoring lattice?	Participants at the 100-point ceiling	Largest attainable |ρ|
Composite score	11 subscales	93.21 (62.95–97.16)	Yes — both extremes reproduce exactly on the 11-subscale lattice	—	—
General health	1 (steps of 25.00)	75 (50.00–100.00)	Yes (median, minimum and maximum)	not forced by the reported values	0.943
General vision	1 (steps of 25.00)	80 (60.00–100.00)	Yes (median, minimum and maximum)	not forced by the reported values	0.943
Ocular pain	2 (steps of 12.50)	81.25 (37.50–100.00)	Yes (median, minimum and maximum)	not forced by the reported values	0.981
Near vision	3 (steps of 8.33)	100 (66.67–100.00)	Yes (median, minimum and maximum)	≥ 14 of 26 (≥ 53.8%)	0.916
Distance vision	3 (steps of 8.33)	91.67 (58.33–100.00)	Yes (median, minimum and maximum)	not forced by the reported values	0.978
Vision-specific social functioning	2 (steps of 12.50)	100 (75.00–100.00)	Yes (median, minimum and maximum)	≥ 14 of 26 (≥ 53.8%)	0.906
Vision-specific mental health	4 (steps of 6.25)	90.63 (25.00–100.00)	Yes (median, minimum and maximum)	not forced by the reported values	not enumerated (13 levels)
Vision-specific role difficulties	2 (steps of 12.50)	100 (37.50–100.00)	Yes (median, minimum and maximum)	≥ 14 of 26 (≥ 53.8%)	0.917
Vision-specific dependency	3 (steps of 8.33)	100 (33.33–100.00)	Yes (median, minimum and maximum)	≥ 14 of 26 (≥ 53.8%)	0.918
Driving	3 (steps of 8.33), n = 16	66.67 (0.00–100.00)	Yes (median, minimum and maximum)	not forced by the reported values	not enumerated (13 levels)
Colour vision	1 (steps of 25.00)	100 (75.00–100.00)	Yes (median, minimum and maximum)	≥ 14 of 26 (≥ 53.8%)	0.864
Peripheral vision	1 (steps of 25.00)	100 (75.00–100.00)	Yes (median, minimum and maximum)	≥ 14 of 26 (≥ 53.8%)	0.864

Scoring lattice: each NEI VFQ-25 item is recoded to a value in {0, 25, 50, 75, 100} (general vision to {0, 25, 40, 60, 80, 100}) and a subscale score is the mean of its items, so the attainable subscale values form a fixed lattice; for an even sample size the median may additionally fall midway between two lattice points. All 36 reported subscale statistics lie exactly on their own lattice, although the check discriminates weakly between item allocations: only vision-specific mental health is uniquely identified by its own values, and 18 of the 36 tested values are 100, which lies on every lattice by construction. Because the median equals the maximum in 6 of 12 subscales, and because for an even sample size a median equal to the maximum forces BOTH central order statistics to the maximum, at least 14 of 26 participants (53.8%) must sit at 100 points in each of them. The final column is the largest Spearman |ρ| attainable against a tie-free predictor, maximised by exhaustive enumeration over every multiplicity vector admissible under that subscale's reported minimum, maximum and median and its own item lattice; it is left blank for the two subscales whose level count makes exhaustive enumeration infeasible. Colour and peripheral vision admit only two levels (75 and 100), which caps their attainable |ρ| at 0.864. The composite medianof 93.21 is not attainable as the mean of two 11-subscale composites but is attainable when one of the two central observations is averaged over 10 subscales, which independently corroborates the missing driving data recovered in the audit that closes the Results; that detector would have failed to fire 52.8% of the time even had data been missing, so it is corroboration and not proof.

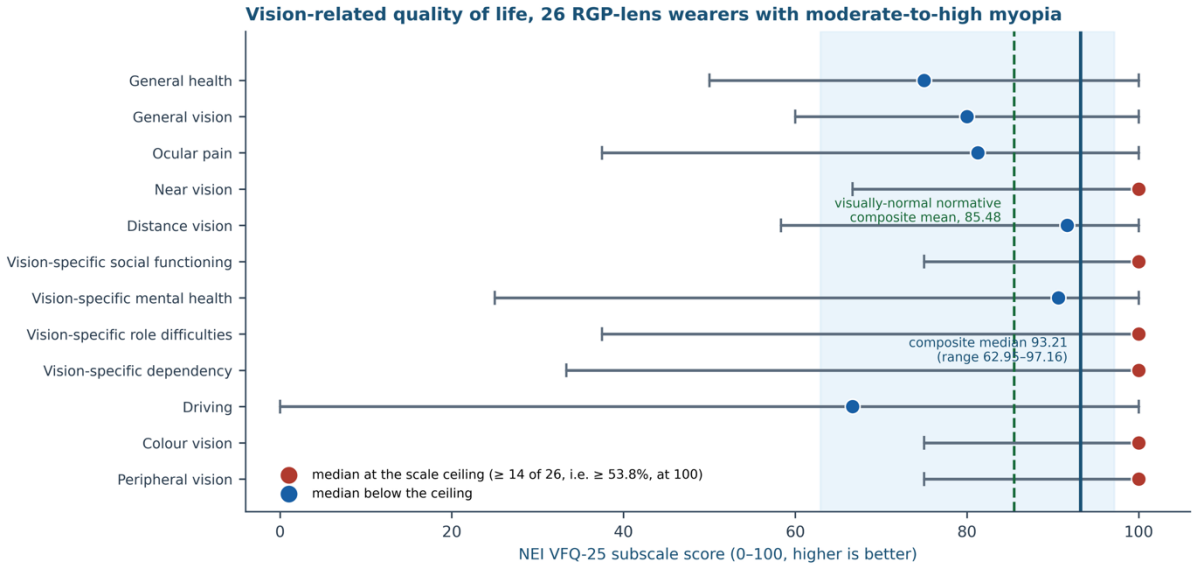

Figure 3. Vision-related quality of life measured by the NEI VFQ-25 in 26 rigid gas permeable lens wearers with moderate-to-high myopia. Circles are subscale medians and horizontal bars the observed ranges; red circles mark the six subscales whose median equals the scale maximum, which for an even sample of 26 forces both central order statistics to the maximum and therefore requires at least 14 of the 26 participants (53.8%) to score 100. The vertical line and shaded band show the composite median of 93.21 and its range, and the dashed line the visually-normal normative composite mean of 85.48 reported in the Los Angeles Latino Eye Study. The driving subscale is computed on 16 participants.

Analysable sample size for the driving subscale

The 65 reported correlations account for themselves as follows. 57 reproduce exactly at n = 26 when the printed ρ is re-submitted to the t transformation; one further cell is uninformative because its coefficient is censored in the source as ρ < 0.001 with p = 1.00 (ocular pain against with-lens acuity); five reconcile at a different sample size, and two reconcile at none, which is 65 of 65 accounted for. All five correlations involving the driving subscale reproduce instead at n = 16, with a mean absolute discrepancy of 0.0007 in the p value, and reproduce at no other value of n between 5 and 26, as shown in Figure 1B. Ten participants, 38.5% of the cohort, therefore did not contribute to the driving analysis — the expected consequence of a subscale that is administered only to those who drive, but a fact that the source record does not state and that changes the confidence intervals, effect sizes and power calculations for that subscale.

An entirely independent line of evidence supports the same conclusion. The composite score is the mean of eleven vision-targeted subscale scores, each of which is confined to its own lattice, so the set of attainable composite values can be enumerated exactly; there are 1,948 attainable subscale sums. Exhaustive search shows that the reported composite median of 93.21 cannot be expressed as the mean of two eleven-subscale composites to the precision at which it is printed, and remains unattainable when subscales are additionally allowed to be averaged over any subset of their items. It becomes attainable as soon as one of the two central observations is averaged over ten subscales — that is, as soon as at least one participant has no driving score. Two methods that share no assumptions thus point to the same undisclosed structure.

Two cells reconcile with no analysable n. For general health against pre-fitting acuity the printed ρ of −0.013 implies p = 0.950 at n = 26 rather than the printed 0.943; a ρ of −0.0147 would reconcile the pair at n = 26. Extending the search to n = 200 shows that the printed pair first fits at n = 33, which is larger than the study and therefore inadmissible; the discrepancy is thus an internal inconsistency rather than a rounding artefact, and it exceeds the three-decimal rounding half-width by more than an order of magnitude. For distance vision against with-lens acuity the printed ρ of −0.16 implies p = 0.435, far from the printed 0.937; the printed p value corresponds to a ρ of −0.016, which differs from the printed coefficient by a single decimal position. We treat the latter as a typographical error in the coefficient and analyse the cell under both readings; neither reading is significant and neither changes any conclusion.

Associations between clinical variables and quality of life

The complete correlation matrix, with Bonett–Wright confidence intervals, re-derived p values and Benjamini–Hochberg q values, is given in Table 3; the group comparisons are set out in Table 4. None of the five clinical predictors was associated with the composite score. The strongest composite-level association was with lens back-vertex power (ρ = -0.326, 95% CI -0.64 to 0.08, p = 0.104, q = 0.989); the with-lens acuity gave the weakest (ρ = -0.088, p = 0.668). Sex, degree of myopia and lens-care frequency were likewise unrelated to the composite score (p = 0.364, 0.176 and 0.960 respectively), with recovered effect sizes of |r| = 0.178, 0.265 and 0.010.

Three of the 104 tests reached a nominal p below 0.05: age with vision-specific mental health (ρ = 0.426, 95% CI 0.03 to 0.71, p = 0.030), with-lens acuity with general vision (ρ = 0.396, 95% CI -0.01 to 0.69, p = 0.045) and pre-fitting acuity with distance activities (ρ = -0.392, 95% CI -0.68 to 0.01, p = 0.048). Every one of the three confidence intervals includes values close to zero.

Two of these three, together with the strongest sub-threshold association in the matrix, run in the direction opposite to the clinical convention. A higher logMAR value denotes worse acuity and a higher NEI VFQ-25 score denotes better quality of life, so a positive correlation between with-lens acuity and a vision subscale states that participants who saw less well reported seeing better. That is the sign observed for general vision (ρ = 0.396) and, at p = 0.058, for general health (ρ = 0.377). The source record reports these coefficients without remark. Only the pre-fitting-acuity association with distance activities runs in the expected direction.

Table 3. Spearman rank correlations between clinical predictors and NEI VFQ-25 scores, with Bonett–Wright 95% confidence intervals, re-derived exact p values and Benjamini–Hochberg q values across the whole family of 104 tests.

NEI VFQ-25 scale	Age (years)	Pre-fitting acuity (logMAR)	With-lens acuity (logMAR)	Lens power (D)	Duration of wear (months)
Composite score	0.202 (-0.21 to 0.55) 0.322; q = 0.989	-0.198 (-0.55 to 0.21) 0.331; q = 0.989	-0.088 (-0.46 to 0.31) 0.668; q = 0.989	-0.326 (-0.64 to 0.08) 0.104; q = 0.989	-0.191 (-0.54 to 0.22) 0.350; q = 0.989
General health	-0.046 (-0.43 to 0.35) 0.824; q = 0.989	-0.013 (-0.40 to 0.38) 0.943; q = 0.989	0.377 (-0.03 to 0.67) 0.058; q = 0.989	0.157 (-0.25 to 0.51) 0.443; q = 0.989	0.054 (-0.34 to 0.43) 0.793; q = 0.989
General vision	0.247 (-0.16 to 0.58) 0.224; q = 0.989	0.131 (-0.27 to 0.49) 0.522; q = 0.989	0.396 (-0.01 to 0.69) 0.045; q = 0.989	0.212 (-0.20 to 0.56) 0.299; q = 0.989	0.069 (-0.33 to 0.44) 0.739; q = 0.989
Ocular pain	0.129 (-0.27 to 0.49) 0.530; q = 0.989	0.121 (-0.28 to 0.49) 0.556; q = 0.989	<0.001 (1.000, 1.000)*	-0.141 (-0.50 to 0.26) 0.492; q = 0.989	-0.053 (-0.43 to 0.34) 0.796; q = 0.989
Near vision	0.111 (-0.29 to 0.48) 0.591; q = 0.989	-0.109 (-0.48 to 0.29) 0.596; q = 0.989	-0.166 (-0.52 to 0.24) 0.419; q = 0.989	-0.274 (-0.60 to 0.13) 0.176; q = 0.989	-0.013 (-0.40 to 0.38) 0.949; q = 0.989
Distance vision	0.169 (-0.24 to 0.52) 0.409; q = 0.989	-0.392 (-0.68 to 0.01) 0.048; q = 0.989	-0.160 (-0.52 to 0.24) 0.937; q = 0.989	-0.263 (-0.59 to 0.15) 0.194; q = 0.989	-0.343 (-0.65 to 0.06) 0.086; q = 0.989
Vision-specific social functioning	0.177 (-0.23 to 0.53) 0.386; q = 0.989	-0.157 (-0.51 to 0.25) 0.445; q = 0.989	0.204 (-0.20 to 0.55) 0.317; q = 0.989	-0.011 (-0.40 to 0.38) 0.957; q = 0.989	-0.106 (-0.47 to 0.29) 0.606; q = 0.989
Vision-specific mental health	0.426 (0.03 to 0.71) 0.030; q = 0.989	0.116 (-0.29 to 0.48) 0.573; q = 0.989	0.316 (-0.09 to 0.63) 0.116; q = 0.989	0.097 (-0.30 to 0.47) 0.637; q = 0.989	-0.015 (-0.40 to 0.37) 0.942; q = 0.989
Vision-specific role difficulties	0.112 (-0.29 to 0.48) 0.588; q = 0.989	-0.289 (-0.61 to 0.12) 0.152; q = 0.989	-0.185 (-0.54 to 0.22) 0.365; q = 0.989	-0.247 (-0.58 to 0.16) 0.224; q = 0.989	-0.190 (-0.54 to 0.22) 0.353; q = 0.989
Vision-specific dependency	0.077 (-0.32 to 0.45) 0.708; q = 0.989	-0.078 (-0.45 to 0.32) 0.706; q = 0.989	0.105 (-0.30 to 0.47) 0.608; q = 0.989	-0.080 (-0.45 to 0.32) 0.698; q = 0.989	-0.065 (-0.44 to 0.33) 0.752; q = 0.989
Driving (n = 16)	0.358 (-0.18 to 0.73) 0.174; q = 0.989	0.184 (-0.35 to 0.63) 0.496; q = 0.989	-0.014 (-0.51 to 0.49) 0.959; q = 0.989	-0.049 (-0.53 to 0.46) 0.856; q = 0.989	0.367 (-0.17 to 0.74) 0.161; q = 0.989
Colour vision	0.269 (-0.14 to 0.60) 0.184; q = 0.989	-0.197 (-0.55 to 0.21) 0.334; q = 0.989	0.234 (-0.17 to 0.57) 0.251; q = 0.989	-0.147 (-0.51 to 0.26) 0.474; q = 0.989	-0.255 (-0.59 to 0.15) 0.209; q = 0.989
Peripheral vision	0.049 (-0.35 to 0.43) 0.814; q = 0.989	-0.110 (-0.48 to 0.29) 0.592; q = 0.989	-0.066 (-0.44 to 0.33) 0.750; q = 0.989	-0.281 (-0.61 to 0.13) 0.164; q = 0.989	0.089 (-0.31 to 0.46) 0.666; q = 0.989

*Each cell gives Spearman ρ (95% confidence interval by the Bonett–Wright standard error $\sqrt{[(1 + \rho^2/2)/(n - 3)]}$ on the Fisher z scale), then the two-sided p value and the Benjamini–Hochberg q value computed over all 104 tests reported in this study (65 correlations and 39 group comparisons). Nominally significant results (p < 0.05) are shown in bold. No q value falls below 0.05; the smallest is 0.989 and the smallest Holm-adjusted p is 1.000. At n = 26 an |ρ| of 0.388 reaches p = 0.05, an |ρ| of 0.557 is needed for 80% power, and an |ρ| of 0.636 would be needed to survive Bonferroni correction. *The source reports ρ < 0.001 with p = 1.00 for this cell.*

Table 4. Group comparisons of NEI VFQ-25 scores (Mann–Whitney U test) with effect sizes recovered from the reported p values, and the exact properties of each design.

NEI VFQ-25 scale	Sex (7 male vs 19 female)	Degree of myopia (6 moderate vs 20 high)	Lens care (2 >2 weeks vs 24 ≤2 weeks)
Composite score	0.364; q = 0.989 |r| = 0.178	0.176; q = 0.989 |r| = 0.265	0.960; q = 0.989 |r| = 0.010
General health	1.000; q = 1.000 |r| = 0.000	0.533; q = 0.989 |r| = 0.122	1.000; q = 1.000 |r| = 0.000
General vision	0.735; q = 0.989 |r| = 0.066	0.744; q = 0.989 |r| = 0.064	0.886; q = 0.989 |r| = 0.028
Ocular pain	0.735; q = 0.989 |r| = 0.066	0.494; q = 0.989 |r| = 0.134	0.812; q = 0.989 |r| = 0.047
Near vision	0.534; q = 0.989 |r| = 0.122	0.324; q = 0.989 |r| = 0.193	0.615; q = 0.989 |r| = 0.099
Distance vision	0.651; q = 0.989 |r| = 0.089	0.573; q = 0.989 |r| = 0.111	0.554; q = 0.989 |r| = 0.116
Vision-specific social functioning	0.866; q = 0.989 |r| = 0.033	0.882; q = 0.989 |r| = 0.029	0.677; q = 0.989 |r| = 0.082
Vision-specific mental health	0.692; q = 0.989 |r| = 0.078	0.929; q = 0.989 |r| = 0.017	0.498; q = 0.989 |r| = 0.133

Vision-specific role difficulties	0.306; q = 0.989 |r| = 0.201	0.219; q = 0.989 |r| = 0.241	0.886; q = 0.989 |r| = 0.028
Vision-specific dependency	0.651; q = 0.989 |r| = 0.089	0.836; q = 0.989 |r| = 0.041	0.615; q = 0.989 |r| = 0.099
Driving (n = 16)	0.299; q = 0.989 |r| = 0.260	0.770; q = 0.989 |r| = 0.073	0.200; q = 0.989 |r| = 0.320
Colour vision	0.611; q = 0.989 |r| = 0.100	0.882; q = 0.989 |r| = 0.029	0.960; q = 0.989 |r| = 0.010
Peripheral vision	0.910; q = 0.989 |r| = 0.022	0.614; q = 0.989 |r| = 0.099	0.812; q = 0.989 |r| = 0.047

Each cell gives the two-sided p value reported in the source clinical record, the Benjamini–Hochberg q value across all 104 tests, and the rank-biserial-scale effect size $|r| = |z|/\sqrt{n}$ recovered from that p value under the normal approximation. Because the tie pattern of the underlying scores is not recoverable from an aggregate report, these effect sizes are approximations and are declared as such; the massive ceiling tying documented in Table 2 makes the true standardised statistics smaller in absolute value. |r| is a strictly monotone transformation of the p value in the same cell and therefore adds no information within a column; it is given so that magnitudes can be judged on a familiar scale, and it is NOT comparable across columns, because the largest |r| attainable at complete separation differs by design (0.915 for 7 versus 19, 0.872 for 6 versus 20 and only 0.537 for 2 versus 24). Largest recovered |r| = 0.320; median |r| = 0.082. Exact enumeration of the tie-free null distributions gives 657,800, 230,230 and 325 equally likely arrangements for the three designs; the smallest attainable two-sided p values are 3.0e-06, 8.7e-06 and 0.0062. Under a Lehmann alternative, located by bisection against the exact null, 80% power required a probability of superiority of 0.838, 0.854 and 0.947 respectively — that is, near-complete separation of the two groups. No q value falls below 0.05.

Multiplicity, precision and what the design could detect

Across the whole family of 104 tests, 3 reached $p < 0.05$. The number expected under the global null hypothesis is $m \times \alpha = 5.2$, or 4.95 when the exact size of each test is used in place of the nominal level, an expectation that holds regardless of the correlation among the tests; the observed count is therefore below, not above, what chance alone would produce, and the corresponding reference binomial probability of observing no more than 3 under independence is 0.231. After Benjamini–Hochberg control, applied across the 65 correlations listed in Table 3 and the 39 group comparisons set out in Table 4 together, the smallest q value in the entire family is 0.989; after Holm correction the smallest adjusted p is 1.000. Because the tests are positively dependent through the shared outcome scales, we also applied the Benjamini–Yekutieli procedure, whose dependence factor here is 5.23; its smallest q value is 1.000. Under Bonferroni correction the threshold is 0.00048, which at n = 26 would require $|\rho| \geq 0.636$. Not one association in this study survives any of the three procedures, as plotted in Figure 4 and summarised in section C of Table 5. Figure 4A also shows that the observed p values lie systematically above the uniform expectation across most of their range, the pattern produced by discrete, heavily tied rank statistics and consistent with a global null.

The absence of surviving associations is a statement about the design, not about the biology. At n = 26 an $|\rho|$ of 0.388 is sufficient to reach $p = 0.05$, but an $|\rho|$ of 0.557 is required for 80% power; all three nominally significant coefficients (0.426, 0.396 and −0.392) fall between those two values, which is precisely the region in which a significant estimate is more likely than not to be an overestimate of its own effect. For the driving subscale, on 16 participants, the two thresholds rise to 0.497 and 0.700. Detecting a correlation of 0.426 with 80% power would have required 45 participants, and detecting the smallest correlation we regarded as clinically interesting, 0.30, would require 89; both thresholds are plotted against sample size in Figure 5A. Nor can the study establish the absence of association. None of the five composite-score confidence intervals excludes ±0.30, and their median half-width is 0.378 — wider than the smallest effect of interest itself. A 95% interval of half-width 0.30 around a null correlation would require 44 participants and one of half-width 0.20 would require 97. The correct summary of the predictor analysis is that it is uninformative, not that it is negative.

Three structural features compound the problem. The questionnaire ceiling removes power directly: simulating a true latent correlation of 0.50 at n = 26, power falls from 0.70 with no ceiling to 0.60 when the 14 observations that a median equal to the maximum forces tie at the maximum — the situation in six of the twelve subscales — and to 0.44 when 20 tie, as plotted in Figure 5B. The lens-care comparison is more constrained still: with 2 participants in one group and 24 in the other there are only 325 distinct rank arrangements and 25 attainable two-sided p values, the smallest being 0.0062, and 80% power against a Lehmann alternative requires a probability of superiority of 0.95, which is near-complete separation of the two groups. And the fitting variable is constant: all 26 fits were optimal, so fitting quality could not be related to anything.

Finally, the comparisons that the source record's own narrative implies were never performed. Reporting that a predictor correlates with a subscale but not with the composite asserts a difference between two dependent correlations. Steiger's test for that difference requires the correlation between the two outcome scales, which an aggregate report does not contain; evaluated across every positive-definite value of that unknown, the p value for the age comparison ranges from below 0.001 to 0.516, and for the with-lens-acuity comparison from below 0.001 to 0.212. Restricting the unknown to the values that are clinically plausible for a subscale against a composite that contains it, $\rho \geq 0.5$, separates the two cases. The age comparison remains unidentified, reaching $p = 0.249$ at the plausible upper end. The with-lens-acuity

comparison does not: its admissible range for the between-scale correlation is itself bounded above at 0.879, and over the whole plausible region the contrast is significant at every admissible value ($p \leq 0.013$). We report that because it runs against the direction of our own argument; it does not, however, survive the multiplicity correction applied to everything else in this paper, and the association it concerns is the one whose sign is clinically paradoxical.

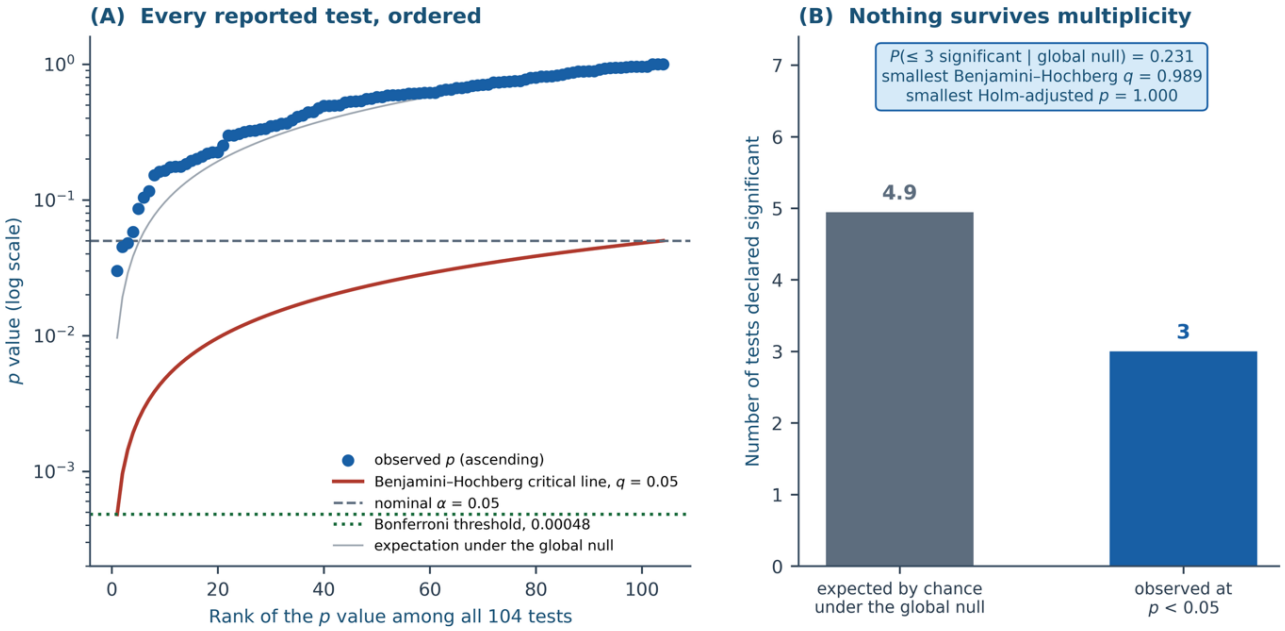

Figure 4. Multiplicity across the complete family of 104 hypothesis tests. (A) All reported p values in ascending rank order on a logarithmic scale, against the Benjamini–Hochberg critical line, the nominal significance level, the Bonferroni threshold and the uniform expectation under the global null; the observed values lie systematically above the uniform expectation, the pattern produced by discrete, heavily tied rank statistics. (B) The three nominally significant results among all 104 tests against the 4.95 expected by chance under the global null when each test is credited with its own exact size, an expectation that holds whatever the dependence among the tests.

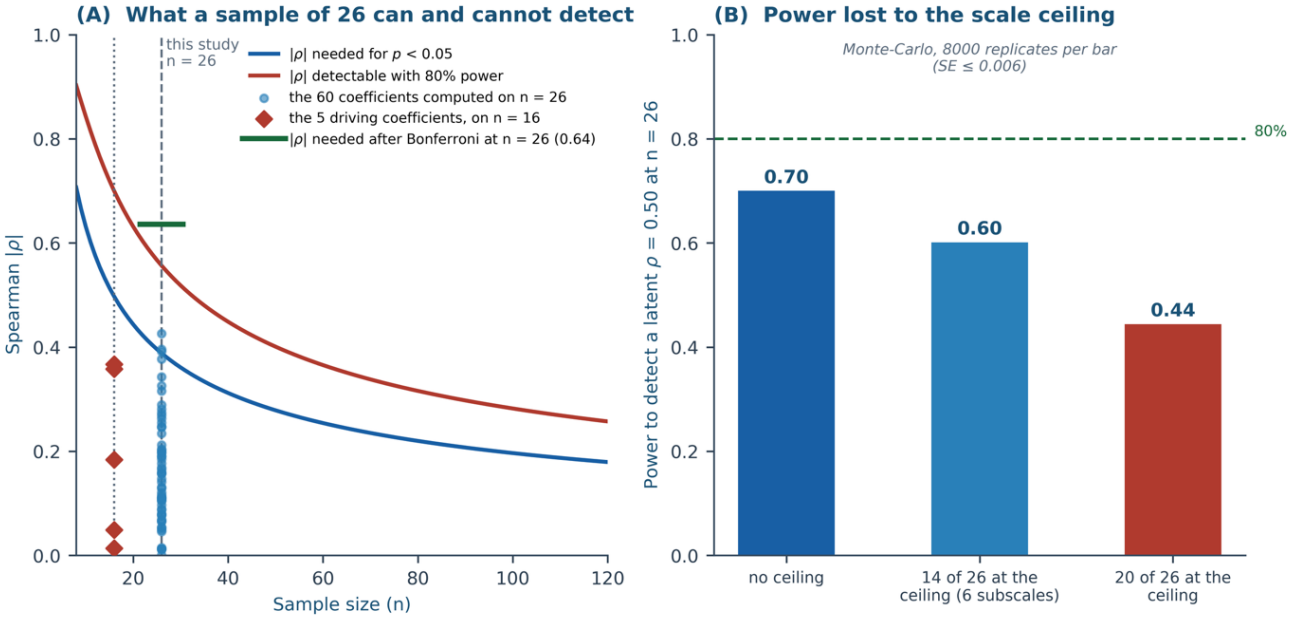

Figure 5. Design sensitivity. (A) The Spearman |ρ| that reaches p = 0.05 and the |ρ| detectable with 80% power, as functions of sample size, with the 65 reported coefficients plotted at n = 26 and the five driving coefficients at n = 16; all three nominally significant coefficients lie between the two curves, the region in which a significant estimate is more likely than not to overstate its own effect. The green marker at n = 26 is the |ρ| that would be required there to survive Bonferroni correction. The minimum detectable |ρ| is computed under the same Bonett–Wright variance as the confidence intervals. (B) Power to detect a latent correlation of 0.50 at n = 26 when m of the 26 observations tie at the questionnaire ceiling, by Monte-Carlo simulation; m = 14 is the minimum that a median equal to the maximum forces at n = 26.

Table 5. Data-integrity audit, partial identification and design-sensitivity summary: what the reported aggregate record does and does not determine.

Question addressed	Method used in this study	Result
A. Reproducibility of the reported statistics		
Do the reported ρ and p agree with one another at n = 26?	Each ρ was re-submitted to the t transformation $t = \rho\sqrt{(n-2)}/\sqrt{(1-\rho^2)}$ on 24 degrees of freedom and the resulting two-sided p compared with the printed value (tolerance 0.0025)	57 of 65 cells reproduce exactly
Do the remaining cells correspond to a different analysed n?	The analysed n was recovered by minimising $\lvert p(\rho, n) - p_{reported}\rvert$ over n = 5…26	All 5 driving-subscale cells reproduce at n = 16 (mean $\lvert\Delta p\rvert$ = 0.0007) and at no other n
Is that missing-data pattern corroborated independently?	Attainability of the composite median on the NEI VFQ-25 scoring lattice, by exact enumeration of the reachable subscale sums	93.21 is unattainable as the mean of two 11-subscale composites but attainable when one central observation is averaged over 10 subscales (driving omitted)
Do any reported values remain irreconcilable?	Residual analysis of the cells that fit no admissible n, extended to n = 200 to see how far the search must go before each pair fits	Two of 65, with the censored cell (ocular pain × with-lens acuity, ρ < 0.001, p = 1.00) accounting for the sixty-fifth. General health × pre-fitting acuity (ρ = -0.013, p = 0.943) fits no n ≤ 26 and first fits at n = 33, which is inadmissible; ρ = 0.0147 would reconcile it at n = 26. Distance vision × with-lens acuity (ρ = -0.16, p = 0.937) implies p = 0.435; the printed p corresponds to ρ = 0.016
Are the questionnaire scores internally coherent?	Every reported subscale median, minimum and maximum tested against the exact scoring lattice implied by that subscale's item count	36 of 36 values lie exactly on their lattice. The check is weak, not strong: 18 of the 36 values are 100, which lies on every lattice, and only vision-specific mental health has an item count uniquely identified by its own values
B. What the aggregate record identifies without individual data		
How large was the median acuity gain?	Order statistics are monotone under an elementwise-bounded transform: with every with-lens acuity in [0, 0.096] logMAR, $d(k) \in [pre(k) - 0.096, pre(k)]$. Sharpness is then established by exhibiting admissible configurations that attain each endpoint, not by assuming a degenerate with-lens distribution that the reported minimum and median exclude	1.374 to 1.470 logMAR, ≈13.7–14.7 ETDRS lines. Both endpoints are attained: the lower by 25 eyes at 0.096 and one at 0.000, the upper by 12 eyes at 0.000 placed on the two central and ten lowest pre-fitting ranks
How many participants achieved a clinically important gain?	Deductive minimum gain = minimum pre-fitting acuity − maximum with-lens acuity, compared with the 0.10 logMAR MCID. No significance test and no confidence interval are attached, because the count follows with certainty from the reported ranges and is not an estimate	Every gain ≥ 0.304 logMAR = 3.0 × MCID; 26 of 26
How does the cohort compare with visually normal norms?	Descriptive comparison against the visually-normal normative composite MEAN of 85.48 reported in the source record. No test against a null proportion of one half is reported: 85.48 is a mean of a bounded, left-skewed distribution, so the proportion of a normative sample above it is not one half and is unknown to us	20 of 26 (76.9%, 95% CI 56.4–91.0%) at or above the norm
C. Design sensitivity and multiplicity		
How many tests were performed in total?	Complete enumeration of the reported analyses	104 (65 correlations, 39 group comparisons); 3 reached p < 0.05
Is that more than chance would produce?	Expectation under the global null is the sum of the actual sizes of the tests, which holds whatever the dependence between them; the reference binomial probability assumes independence and is reported in the direction the claim requires	Expected 5.2 at a nominal α of 0.05, or 4.95 using the exact size of each test; observed 3. P(≤ 3 | global null) = 0.231
Does anything survive multiplicity control?	Benjamini–Hochberg, Benjamini–Yekutieli and Holm procedures over the full family	No. Smallest q = 0.989; smallest Benjamini–Yekutieli q = 1.000 (dependence factor 5.23); smallest Holm-adjusted p = 1.000; Bonferroni threshold 0.00048
What could this sample have detected?	Critical $\lvert\rho\rvert$ from the inverse t transformation and the 80%-power minimum detectable $\lvert\rho\rvert$ under the SAME Bonett–Wright variance used for the confidence intervals	$\lvert\rho\rvert \geq 0.388$ reaches p = 0.05, but $\lvert\rho\rvert \geq 0.557$ is required for 80% power (n = 16: 0.497 and 0.700). Using the Pearson variance instead would understate the requirement as 0.526
Was the study able to establish absence of association?	Bonett–Wright intervals for the five composite-score correlations against a smallest effect of interest of $\lvert\rho\rvert$ = 0.30	No: 0 of 5 intervals exclude ±0.30; median half-width 0.378. n = 44 would be needed for a half-width of 0.30 and n = 89 for 80% power at ρ = 0.30

How much power does the questionnaire ceiling remove?	Monte-Carlo simulation (8000 replicates) of a latent bivariate normal with ρ = 0.50, the outcome censored so that m of 26 observations tie at the ceiling	Power 0.70 with no ceiling, 0.60 with the 14 that a median equal to the maximum forces, and 0.44 with 20 tied
Are the reported directions of association coherent?	Sign audit against the clinical convention that a higher logMAR value is worse acuity and a higher NEI VFQ-25 score is better quality of life	2 of the 4 strongest acuity–quality-of-life associations run in the paradoxical direction (worse with-lens acuity accompanying better reported vision)
Are the implied between-scale contrasts identified?	Steiger's test for dependent correlations, evaluated across every positive-definite value of the unreported between-scale correlation, and separately across the sub-region that is clinically plausible for a subscale against a composite containing it (ρ ≥ 0.5)	Not in general. For age × mental health versus age × composite the admissible p spans <0.001 to 0.516 and reaches 0.249 at the plausible upper end. For with-lens acuity × general vision versus × composite the admissible range for the between-scale correlation is bounded above at 0.879, and over the plausible region that contrast is uniformly significant (p ≤ 0.013) — although it does not survive multiplicity control either

MCID = minimum clinically important difference; ETDRS = Early Treatment Diabetic Retinopathy Study. Section A re-derives quantities that the source clinical record already reported; sections B and C report quantities that are new to this study. Each partial-identification bound is accompanied by an explicit admissible configuration that attains it. The count of tests excludes the descriptive statistics in Tables 1 and 2.

4. Discussion

Principal findings

In 26 adults with moderate-to-high myopia wearing RGP contact lenses at the principal tertiary referral centre of West Sumatra, vision-related quality of life measured by the Indonesian NEI VFQ-25 was high: a median composite score of 93.21, with 20 of 26 participants (76.9%) at or above the visually-normal normative mean. Correcting the eye with a rigid lens was accompanied by a large and uniformly clinically important improvement in acuity: every participant gained at least 0.304 logMAR, and the median gain is identified to 1.374–1.470 logMAR. Against those two positive descriptive findings stands a wholly negative analytical one. Of 104 hypothesis tests, 3 reached nominal significance where 4.9 were expected by chance, none survived multiplicity control, and the design had 80% power only for correlations of 0.557 or greater. The honest reading is that this cohort does well and that the study cannot say why.

Quality of life in rigid-lens wearers, in context

The composite score observed here is high by the standards of the ophthalmic literature. In the Los Angeles Latino Eye Study the mean composite among visually normal participants was 85.48, and the present cohort's median exceeds that by more than seven points.[41] The comparison should not be over-read: the normative sample was Latino, population-based and older, whereas ours is Minangkabau, clinic-based and young, and the NEI VFQ-25 is known to behave differently across language versions and age strata.[42-45] What the comparison does establish is that these participants do not report the functional burden that their refractive status might lead one to expect. That is consistent with the only comparable rigid-lens data available, from keratoconus, where quality of life with rigid correction approaches that of non-lens-wearing controls across every subscale.[50,51,52,53] It also sits comfortably with the finding that patients who have passed the adaptation window report comfort and vision scores of 9 out of 10 by day 28; our inclusion criterion of at least one month of wear selected exactly that population.[37-39]

The subscale profile is informative in a way the composite is not. Driving returned the lowest median (66.67) and the widest possible range, and it is also the subscale on which ten participants gave no answer at all. In an Indonesian provincial city where motorcycle use is near-universal but car ownership is not, and where a substantial proportion of young adults do not hold a driving licence, a driving subscale designed for a North American population may be measuring access to a car rather than visual function. Vision-specific mental health showed the widest range of any subscale shown in Figure 3 (25–100), indicating that a minority of these young high myopes carry considerable vision-related worry despite excellent corrected acuity — an observation that deserves direct study, because it is the one dimension on which this otherwise well-functioning cohort is heterogeneous.[46-49]

Who these patients were

The cohort was predominantly female (73.1%) and young (median age 23 years). Both features are typical of contact-lens populations rather than of myopia populations: retrospective and survey data from several countries show a consistent female preponderance among lens wearers and a concentration in the second and third decades, attributed to cosmetic preference, participation in sport and the practical inconvenience of high-powered spectacles.[69,70] Lens-care behaviour was also good, in the sense the record captures it, with 92.3% of participants attending to lens care at least fortnightly. We draw no inference from that figure about disinfection practice, because the record does not say what procedure the interval refers to and a fortnightly interval would be wholly inadequate for daily disinfection; what the wider literature establishes is that non-compliance with cleaning, replacement and follow-up schedules is common and is the principal modifiable determinant of lens-related

complications.[71-74] One caution about the refractive description: the only dioptric quantity recorded for each participant is the back-vertex power of the dispensed rigid lens, a corneal-plane measurement. It is not the spectacle-plane spherical equivalent that defines the moderate and high strata, and at a 12 mm vertex the median of −9.38 D at the cornea corresponds to roughly −10.6 D in spectacles; the two should not be compared with published spherical-equivalent distributions without that conversion. No microbial keratitis, giant papillary conjunctivitis or corneal infiltrate was recorded in this cohort, but a cross-sectional sample of 26 established wearers has essentially no power to estimate the incidence of rare adverse events and should not be read as evidence of safety.

The acuity gain, and what the 'before' measurement most likely was

The improvement documented here is very large. A median gain of 1.374–1.470 logMAR is approximately fourteen lines on a logarithmic chart. That figure is roughly 2.7 times the largest RGP-associated acuity improvement reported in the studies the source record itself cites — Li and colleagues observed a change from a mean of 0.62 to 0.11 logMAR, a gain of 0.51 logMAR, after six months of rigid-lens wear in unilateral high myopia.[29,30] A gain of that size is not attainable by moving a correcting lens from the spectacle plane to the corneal plane. Spectacle magnification for a −10 D lens at a 12 mm vertex distance is $1/(1 - dF) = 0.893$, an 11% minification worth about 0.05 logMAR — a fraction of a line of acuity, not fourteen; even the aberration and field penalties of very high spectacle powers are measured in fractions of a logMAR unit.[20,21,22]

The most parsimonious explanation is definitional, and the recorded numbers settle it. The source record defines the 'before' value as the best acuity achieved before fitting and lens wear, but all three reported values are exact reduced-Snellen fractions: 0.40 logMAR is 6/15, 1.47 logMAR is 2/60 and 1.78 logMAR is 1/60, each matching $\log_{10}$(denominator/numerator) to within 0.008. Acuities of 2/60 and 1/60 are recorded by bringing the patient towards the chart; they lie beyond the largest optotype of a standard chart at six metres and are the notation of presenting rather than best-corrected vision. A distribution running from 6/15 to 1/60 is exactly what uncorrected or habitually corrected acuity looks like in eyes requiring −4.00 to −19.25 D of correction, and is not what spectacle-corrected acuity looks like in eyes that reach 20/25 or better with a rigid lens. We therefore interpret the pre-fitting figure as presenting acuity and have labelled it as such throughout, and we recommend that the authors confirm the measurement convention in the clinical record. The distinction matters for the claim being made: under the presenting-acuity reading, the finding is that rigid-lens correction restores near-normal acuity in eyes that are severely impaired without it, which is important and unsurprising; under the best-corrected reading it would imply an optical benefit over spectacles of a magnitude never reported and would require an unmeasured corneal irregularity — keratoconus or another ectasia — that the inclusion criteria did not screen for and that the absence of topography could not have excluded.[24,25,75,76] Either way the observation that every participant improved by at least three times the minimum clinically important difference stands, because it follows from the reported ranges alone.

Why no predictor was found, and why that is not a negative result

Four separate mechanisms, each quantified above, explain the uniform absence of association, and none of them is 'there is no relationship'. The first is multiplicity. The source analysis performed 104 tests and interpreted three nominal p values below 0.05 as findings; the expected number under a global null is 5.2. In other words, this study produced fewer significant results than a set of pure noise variables would have produced, and the smallest false-discovery-rate q value in the whole family is 0.989.[64] Every q value reported in Tables 3 and 4 exceeds 0.9. The second is power. With 26 participants the study had 80% power only for $|\rho| \geq 0.557$, an effect size larger than almost any reported association between a clinical variable and an NEI VFQ-25 score.[67,68] The third is the ceiling. In six of the twelve subscales the median equals the maximum, which forces at least half the sample into a single score, and our simulations show that this alone reduces the power to detect a latent correlation of 0.50 from 0.70 to 0.60, or to 0.44 if 20 of 26 tie. The NEI VFQ-25 was constructed for populations with eye disease and is known to compress at the healthy end; in a cohort whose corrected acuity is 20/25 or better it is being used close to the limit of its measurement range.[40,44,45,66,77]

The fourth mechanism is the most instructive and is specific to this design. Two of the five continuous predictors carry almost no usable variance. With-lens acuity takes only two values in these data and spans 0.096 logMAR in total, which is 0.96 of a single minimum clinically important difference; a predictor whose entire range is smaller than the smallest difference anyone would act on cannot generate a clinically meaningful association even in principle, and any correlation with it is a two-group comparison in disguise. Fitting quality is worse still: all 26 fits were optimal, so the variable is constant and carries no information at all. Restricting the range of an exposure attenuates its correlation with any outcome, and here the restriction is a direct consequence of clinical success — the service fitted these lenses well and the patients see well, which is excellent care and poor study design. Recognising this changes the recommendation for future work from 'recruit more patients' to 'recruit patients who differ'.

It is equally important not to over-correct in the other direction. A non-significant result is not evidence of no association, and this study cannot exclude clinically relevant effects: none of the five composite-level confidence intervals excludes ±0.30, and the median half-width of 0.378 is wider than that threshold.[67,68] Two of the three nominally significant associations, moreover, run in a direction that no mechanism predicts, with worse corrected acuity accompanying better reported vision; that pattern is what one expects when a two-valued predictor with almost no range is correlated against a heavily tied outcome in a small sample, and it is a further reason to treat the three findings as noise rather than as leads.

Missing data that were not declared

The recovery of the driving-subscale sample size illustrates a general point about aggregate reporting. Nothing in the source record states that ten participants were omitted from the driving analysis, yet the printed coefficients and p values are internally consistent only at n = 16, and the printed composite median is attainable only if at least one participant lacks a driving score. The omission is entirely legitimate — the instrument is designed that way — but the consequences are not trivial: the critical |ρ| for that subscale rises from 0.388 to 0.497, its 80%-power threshold from 0.557 to 0.700, and any confidence interval computed at n = 26 would be too narrow. The general lesson is that per-analysis denominators should be reported in every table of a patient-reported-outcome study, and that a reader who has only the aggregate table can often recover them — which is a reason for authors to state them rather than a substitute for doing so.[59]

Clinical implications for West Sumatra

For the ophthalmology residents of the Faculty of Medicine, Andalas University and the staff of the Refraction, Contact Lens and Low Vision Subdivision of Dr. M. Djamil Central General Hospital, three practical conclusions follow. First, RGP fitting in moderate-to-high myopia at this service is working: every participant achieved a clinically important acuity gain, every fit was optimal, and vision-related quality of life is at or above visually-normal norms in three-quarters of the cohort. That is a defensible basis for expanding rigid-lens fitting capacity, and it is worth stating explicitly in a health system in which rigid lenses are frequently regarded as a specialist curiosity rather than a mainstream correction for high ametropia.[35,36] Second, the search for patient characteristics that predict quality of life should not be repeated in this form. A single-centre sample of twenty-six, a questionnaire that saturates at the healthy end, a corrected-acuity variable with two levels, a fitting variable with one level and a hundred hypothesis tests cannot yield a defensible predictor. Third, nothing in this study discriminated between patients in any inferential sense, but two subscales — driving and vision-specific mental health — were the only ones not uniformly at their ceiling, and they are therefore where any remaining functional burden would be visible; they should direct both counselling and the next study.

The wider service implications concern access. Dr. M. Djamil serves the nineteen districts and cities of West Sumatra and receives inter-provincial referrals from Riau, Jambi and Bengkulu, and it is one of a small number of centres in the region equipped to fit rigid lenses. Uncorrected refractive error remains the largest single cause of vision impairment globally and the modelled lifetime productivity loss attributable to myopia is substantial.[7-9] Within the Indonesian national health insurance scheme, optical appliances attract limited reimbursement, so the cost of a rigid lens and of the multiple fitting visits it requires falls largely on the patient; a demonstration that the modality restores near-normal function in the eyes least well served by spectacles is directly relevant to that reimbursement debate. Extending rigid-lens fitting to district-level services would also require a training pathway, and the residency programme at Andalas University is the natural vehicle for it.

What the next study should look like

A study capable of answering the question this one asked would differ in five respects. It would enrol at least 89 participants for 80% power at ρ = 0.30, or 44 if the aim is estimation with a 95% interval half-width of 0.30 rather than hypothesis testing.[63,67,68] It would nominate a single primary outcome — the composite score — and a small number of pre-specified predictors, reporting the remainder as exploratory with explicit false-discovery-rate control. It would recruit across the range of the exposures of interest, following the evidence-based practice framework for contact-lens research,[72,74] which for corrected acuity means including eyes that do not reach 20/25 and for fitting quality means including suboptimal fits, most naturally by assessing patients prospectively from the fitting visit rather than cross-sectionally among established wearers. It would use a measurement model that does not saturate: either Rasch- or item-bank-scored vision instruments, or the recalibrated NEI VFQ-25C item parameters, both of which spread scores at the healthy end where the raw scoring compresses.[42-47] And it would add the biometric measurements this protocol lacked — keratometry, corneal topography and axial length — without which no optical or structural mechanism for a quality-of-life difference can be tested at all.[16,17,60,61] A multicentre design across Sumatra and Java would additionally address the referral bias inherent in a single tertiary service.

Strengths

The study has four strengths. It addresses a question on which, to our knowledge, no data exist: vision-related quality of life in adults whose moderate-to-high myopia is corrected with rigid lenses, and none at all from

Indonesia. It uses a validated, internationally comparable instrument administered in the participants' own language, so the results can be placed directly beside published norms. Its clinical measurements were made in a single specialist subdivision under a uniform protocol, which removes the between-examiner variation that limits multicentre refractive studies. And its analysis is fully reproducible and self-checking: every reported statistic was re-derived from the source record before it was used, all 36 questionnaire statistics were verified against the instrument's own scoring lattice, 57 of 65 reported correlations were confirmed exactly, the two that were not are named and quantified, and the quantities the aggregate record cannot identify are reported as bounds rather than as point estimates, as set out in Table 5.

Limitations

The limitations are substantial and largely determine the interpretation. The sample of 26 is small, single-centre and recruited from a tertiary referral service, so it represents patients who reached specialist care and persisted with rigid lenses; those who abandoned the modality during adaptation — a group that comprised 27% of new wearers in one prospective series — are by construction absent, and their exclusion will bias quality of life upwards.[37,38,39] The screening and exclusion counts are not recorded, so the participant flow shown in Figure 1A is incomplete and selection cannot be characterised. The design is cross-sectional and single-visit, so the pre-fitting acuity is a retrospective record rather than a measurement made under study conditions, no causal claim about the effect of the lens on quality of life is available, and the acuity comparison plotted in Figure 2 describes a before-and-after contrast without a control group. The definition of the pre-fitting acuity is ambiguous and, as argued above, is most consistent with presenting rather than best-corrected vision; we have interpreted it accordingly and flagged it for confirmation.

5. Conclusion

Among 26 adults with moderate-to-high myopia wearing rigid gas permeable contact lenses at Dr. M. Djamil Central General Hospital, West Sumatra, vision-related quality of life measured by the Indonesian NEI VFQ-25 was high, with a median composite score of 93.21 and 76.9% (95% CI 56.4–91.0) of participants at or above the visually-normal normative mean of 85.48. Rigid-lens correction was accompanied by an acuity gain of at least 0.304 logMAR in every participant — 3.0 times the 0.10 logMAR minimum clinically important difference — with a median gain identified to 1.374–1.470 logMAR. No demographic, refractive or lens-related variable predicted quality of life: 3 of 104 tests reached nominal significance against 4.9 expected by chance, and none survived false-discovery-rate control (smallest q = 0.989). That result is uninformative rather than negative, because the design had 80% power only for $|\rho| \geq 0.557$, six of twelve subscales had at least 14 of 26 participants at their ceiling, and the corrected-acuity predictor spanned less than one minimum clinically important difference. For practice at Dr. M. Djamil and comparable Indonesian referral services, these data support rigid-lens fitting as a means of restoring near-normal visual function and patient-reported vision in moderate-to-high myopia, and they identify driving and vision-specific mental health as the two scales on which reported function was not uniformly at ceiling.

Declarations

Ethical approval and consent

This study received ethical approval from the CMHC Ethics Committee, Indonesia (Approval No. CMHC/EC/2025/0212). Written informed consent was obtained from all participants, as recorded in the source clinical record. The study was conducted in accordance with the Declaration of Helsinki.

Data availability

The aggregate data supporting the findings, together with the complete analysis code, the transcription checker and the verification harness, are available from the corresponding author on reasonable request.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

RR conceived the study, collected the clinical data, contributed to the analysis and drafted the manuscript. RW supervised the refraction, contact-lens fitting and low-vision assessment protocol, contributed to the interpretation of the optical and contact-lens findings and critically revised the manuscript. Both authors have read and approved the final version and agree to be accountable for all aspects of the work.

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Generative AI disclosure

The authors declare that no generative artificial intelligence tools were used in the design, analysis, or writing of this manuscript.

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