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Original Article

Effect of Near Work on Comparison of Cycloplegic and Non-Cycloplegic Refraction in Young Myopes

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ABSTRACT

Background: Near work may increase accommodative demand and influence non-cycloplegic refractive measurements in young myopic individuals, potentially leading to overestimation of myopia. Cycloplegic refraction minimizes accommodative activity and may provide a more accurate estimate of refractive status when residual accommodation is suspected. **Objective:** To compare post-near-work non-cycloplegic and cycloplegic mean spherical equivalent refraction in young myopes and to assess whether refractive variability is associated with daily near-work duration or duration of myopia. **Methods:** This cross-sectional analytical study included 80 myopic participants aged 16–25 years recruited from two tertiary hospitals in Pakistan between January and April 2026. Participants completed a standardized 10-minute digital near-work task at 25–30 cm. Non-cycloplegic refraction was performed immediately afterward using autorefractometry followed by subjective refraction. Cycloplegia was induced with cyclopentolate 1%, and cycloplegic refraction was performed 40 minutes after the final drop using retinoscopy. Paired t-tests and correlation analyses were performed. **Results:** Non-cycloplegic refraction was more myopic than cycloplegic refraction in both eyes. Mean refractive differences were 0.68 ± 0.42 D in the right eye and 0.63 ± 0.44 D in the left eye, both statistically significant ($p < 0.001$). Refractive variability was not significantly associated with daily near-work duration or duration of myopia. **Conclusion:** Young myopes showed clinically meaningful accommodative influence on post-near-work non-cycloplegic refraction. Cycloplegic refraction may be considered when accurate refractive evaluation is required. **Keywords:** Cycloplegic Refraction; Non-Cycloplegic Refraction; Mean Spherical Equivalent; Near Work; Young Myopes; Near-Induced Transient Myopia.

INTRODUCTION

Myopia is one of the most common refractive conditions worldwide and remains a major contributor to visual impairment when uncorrected or inaccurately corrected. Its clinical importance extends beyond blurred distance vision because progressive myopia increases the risk of sight-threatening retinal and macular complications, making accurate refractive assessment essential in both clinical and public health practice (1,2). Although genetic susceptibility contributes to myopia onset and progression, environmental exposures such as reduced outdoor activity, prolonged academic work, and sustained digital near tasks have become increasingly relevant, particularly among adolescents and young adults who frequently perform visually demanding near work for long durations (3).

Near work places continuous demand on the accommodative system, and this demand may influence refractive measurements when accommodation is not adequately controlled. In young individuals, especially those with active accommodative responses, non-cycloplegic refraction may record a more myopic spherical equivalent than the true refractive state because residual accommodation can persist during testing. This issue is clinically important because even modest overestimation of myopia may

contribute to overminus prescribing, visual discomfort, asthenopic symptoms, headaches, and reduced tolerance for sustained near tasks (3,4). In myopic individuals, prolonged near work has also been associated with accommodative lag, altered binocular visual function, and near-induced transient myopia, suggesting that the refractive state measured immediately after near activity may not fully represent the relaxed refractive condition (5,6).

Digital screen use may further intensify accommodative demand because screen-based near tasks often require sustained fixation, repeated refocusing, and visual processing under variable contrast and luminance conditions (7,8). When accommodation remains active during refraction, pseudomyopia or accommodative spasm may be mistaken for true myopic refractive error, particularly if cycloplegic assessment is not performed. Cycloplegic refraction temporarily inhibits ciliary muscle activity and is therefore considered a more reliable method for estimating refractive error when accommodative influence is suspected (9,10). This distinction is especially relevant in young myopes because their accommodative ability is still strong, and routine non-cycloplegic measurements may overestimate the degree of myopia if performed soon after sustained near work.

Previous studies have compared cycloplegic and non-cycloplegic refraction in children and adults and have generally shown that non-cycloplegic measurements may be more myopic than cycloplegic findings, although the magnitude of difference varies by age, refractive status, measurement method, and accommodative demand before testing (11,12). Evidence on near-work-induced transient myopia also supports the possibility that near tasks can produce short-term accommodative after-effects that influence refraction (13). However, limited regional evidence is available for South Asian young adults, particularly those aged 16–25 years, despite their high exposure to academic near work and digital screen use. Most available local or regional work has focused on younger children or general refractive patterns, leaving uncertainty about the magnitude of post-near-work refractive variability between cycloplegic and non-cycloplegic measurements in young myopic adults (14).

Therefore, in terms of the population, intervention/exposure, comparison, and outcome framework, this study focused on young myopic individuals aged 16–25 years, evaluated after a standardized near-work task, compared non-cycloplegic refraction with cycloplegic refraction, and measured the resulting difference in mean spherical equivalent. The study aimed to quantify the difference between post-near-work non-cycloplegic and cycloplegic spherical equivalent refraction in young myopes and to determine whether this refractive variability was associated with daily near-work duration or duration of myopia

MATERIALS AND METHODS

This cross-sectional analytical study with repeated within-participant refractive measurements was conducted at two tertiary hospitals in Pakistan from January 2026 to April 2026. The study was designed to evaluate refractive variability in young myopic individuals by comparing non-cycloplegic refraction performed immediately after a standardized near-work task with cycloplegic refraction performed after pharmacologic relaxation of accommodation. The primary outcome was the difference in mean spherical equivalent between non-cycloplegic and cycloplegic refraction, defined as refractive variability. Secondary analyses assessed whether this refractive variability was associated with daily near-work duration and duration of myopia.

Participants were recruited using a non-probability convenience sampling technique. Eligible participants were young myopic individuals aged 16 to 25 years who were already wearing spectacles, had best-corrected visual acuity of 6/6 or 6/9, and had low to moderate myopia based on spherical equivalent refraction. Participants were included only after initial ocular screening confirmed the absence of clinically evident ocular pathology. Individuals were excluded if they had any ocular disease, previous ocular surgery, strabismus, binocular vision anomaly, or known hypersensitivity to cycloplegic medication. Written informed consent was obtained from all participants before enrollment, and consent

from guardians was obtained where required according to participant age and institutional requirements.

Before refractive assessment, each participant underwent a structured screening procedure. Demographic information, history of spectacle use, duration of myopia, and average daily near-work duration were recorded using a standardized data collection form. Visual acuity was measured using a LogMAR visual acuity chart. External and anterior segment screening was performed with a pen torch and slit-lamp biomicroscope to confirm eligibility and exclude visible ocular abnormalities. Best-corrected visual acuity status and refractive history were reviewed before proceeding to the experimental near-work protocol.

All enrolled participants completed a standardized near-work task before non-cycloplegic refraction. The task consisted of digital puzzles performed at a working distance of approximately 25–30 cm under uniform illumination for 10 minutes. Participants were not informed of the exact duration of the task to reduce behavioral modification during near work. Immediately after completion of the near-work task, non-cycloplegic refraction was assessed. Objective refraction was first performed using an autorefractometer, followed by subjective refinement with a trial lens set. The mean spherical equivalent was calculated for each eye using the standard formula of spherical power plus half of cylindrical power.

After non-cycloplegic refraction, cycloplegia was induced using cyclopentolate 1%. Three doses were instilled at 10-minute intervals. Cycloplegic refraction was then performed 40 minutes after the final drop using retinoscopy. Refraction findings for the right eye and left eye were recorded separately. Cycloplegic spherical equivalent was calculated using the same spherical equivalent formula. The difference between cycloplegic and non-cycloplegic spherical equivalent was used to quantify refractive variability for each eye.

The main exposure variable was standardized near-work exposure before non-cycloplegic refraction. Additional participant-level variables included age, gender, daily near-work duration, and duration of myopia. Daily near-work duration was recorded in hourly categories, and myopia duration was recorded according to participant history. The primary dependent variable was refractive variability in diopters, calculated separately for the right and left eyes. Non-cycloplegic and cycloplegic mean spherical equivalent values were treated as paired measurements because both were obtained from the same participant under two refractive conditions.

To reduce measurement bias, the same standardized clinical sequence was followed for all participants, beginning with eligibility screening, followed by controlled near-work exposure, non-cycloplegic refraction, cycloplegia, and cycloplegic refraction. The near-work task, working distance, illumination conditions, drug concentration, dosing interval, and timing of post-cycloplegic measurement were kept uniform across participants. Data were entered on a structured recording form by the optometrist performing the assessment to maintain consistency in clinical documentation.

The sample size was calculated using G*Power software with a 95% confidence level and 80% study power, resulting in a required sample of 80 participants. Data were analyzed using IBM SPSS Statistics version 27.0. Descriptive statistics were used to summarize demographic and clinical characteristics. Continuous variables were presented as mean and standard deviation, while categorical variables were presented as frequency and percentage. Paired-samples t-tests were used to compare mean spherical equivalent values between non-cycloplegic and cycloplegic refraction for the right and left eyes separately. Pearson correlation analysis was used to assess the relationship between refractive variability and daily near-work duration, as well as between refractive variability and duration of myopia. A p-value of less than 0.05 was considered statistically significant.

Ethical approval was obtained before data collection. All participants were informed about the study procedures, including the use of cycloplegic drops, before enrollment. Written informed consent was

obtained before participation. Participant confidentiality was maintained by recording data on standardized forms without unnecessary personal identifiers, and all measurements were performed according to the same clinical protocol to support reproducibility and data integrity.

RESULTS

A total of 80 young myopic participants were included in the analysis. The sample had an equal gender distribution, with 40 males and 40 females. The mean age was 19.55 ± 2.47 years, and the largest age subgroup was 16–18 years, comprising 32 participants. Most participants reported high daily near-work exposure, with 50 participants reporting 8–9 hours per day and 24 participants reporting 6–7 hours per day. Myopia duration was most commonly 3–4 years and 5–6 years, with each category including 25 participants.

Table 1. Baseline Demographic and Near-Work Characteristics of Participants

Variable	Category / Summary	n (%) or Mean ± SD
Total participants	—	80
Age	Overall	19.55 ± 2.47 years
Age group	16–18 years	32 (40.0%)
Gender	Male	40 (50.0%)
Gender	Female	40 (50.0%)
Daily near-work duration	4–5 hours/day	2 (2.5%)
Daily near-work duration	6–7 hours/day	24 (30.0%)
Daily near-work duration	8–9 hours/day	50 (62.5%)
Daily near-work duration	10–11 hours/day	4 (5.0%)
Duration of myopia	3–4 years	25 (31.3%)
Duration of myopia	5–6 years	25 (31.3%)
Duration of myopia	≥9 years	7 (8.8%)

Following the standardized near-work task, non-cycloplegic refraction showed a more myopic mean spherical equivalent than cycloplegic refraction in both eyes. In the right eye, the mean non-cycloplegic spherical equivalent was −2.59 ± 1.46 D, compared with −1.91 ± 1.37 D after cycloplegia. In the left eye, the mean non-cycloplegic spherical equivalent was −2.50 ± 1.42 D, compared with −1.87 ± 1.22 D after cycloplegia. The highest frequency of non-cycloplegic refraction values was within the −1.25 to −3.00 D range, whereas cycloplegic values were most frequently within the −1.25 to −2.00 D range.

Table 2. Comparison of Non-Cycloplegic and Cycloplegic Mean Spherical Equivalent by Eye

Eye	Non-Cycloplegic MSE After Near Work, Mean ± SD (D)	Cycloplegic MSE, Mean ± SD (D)	Mean Difference ± SD (D)	Approx. 95% CI for Difference (D)	Paired t-test	p-value	Effect Size, Cohen's dz
Right eye (OD)	−2.59 ± 1.46	−1.91 ± 1.37	0.68 ± 0.42	0.59 to 0.77	−14.28	<0.001	1.60
Left eye (OS)	−2.50 ± 1.42	−1.87 ± 1.22	0.63 ± 0.44	0.53 to 0.73	−12.74	<0.001	1.42

The paired comparison demonstrated statistically significant refractive differences between non-cycloplegic and cycloplegic measurements in both eyes. The right eye showed a mean refractive difference of 0.68 ± 0.42 D, with a 95% confidence interval of approximately 0.59 to 0.77 D. The left eye showed a mean difference of 0.63 ± 0.44 D, with a 95% confidence interval of approximately 0.53 to 0.73 D. The magnitude of the difference was slightly greater in the right eye, although both eyes showed a clinically meaningful shift exceeding 0.60 D. The effect size was large for both eyes, with Cohen's dz values of 1.60 for the right eye and 1.42 for the left eye.

A strong positive correlation was observed between non-cycloplegic and cycloplegic spherical equivalent values in both eyes, with a paired-measure correlation coefficient of r = 0.96 for the right eye and r = 0.96 for the left eye. This indicates that participants with higher myopic values under one refractive condition also tended to show higher myopic values under the other condition, despite the consistent shift toward less myopic values after cycloplegia.

Table 3. Correlation Between Non-Cycloplegic and Cycloplegic Refraction

Eye	Correlation Between Paired MSE Measures (r)
Right eye (OD)	0.96
Left eye (OS)	0.96

Correlation analysis was performed to determine whether the magnitude of refractive variability was associated with participant-reported daily near-work duration or duration of myopia. No statistically significant association was observed between daily near-work duration and refractive variability in either eye. The correlation was weak in the right eye ($r = 0.072$, $p = 0.525$) and left eye ($r = 0.063$, $p = 0.578$). Similarly, duration of myopia was not significantly associated with refractive variability in the right eye ($r = 0.136$, $p = 0.230$) or left eye ($r = 0.035$, $p = 0.760$).

Table 4. Association of Refractive Variability With Near-Work Duration and Duration of Myopia

Variable	Right Eye, r	Right Eye, p-value	Left Eye, r	Left Eye, p-value
Daily near-work duration	0.072	0.525	0.063	0.578
Duration of myopia	0.136	0.230	0.035	0.760

Overall, the results showed that non-cycloplegic refraction after near work produced more myopic spherical equivalent values than cycloplegic refraction in both eyes. The mean difference was statistically significant and clinically relevant in each eye, with a slightly larger shift in the right eye than in the left eye. However, the magnitude of refractive variability was not significantly related to reported daily near-work duration or duration of myopia, indicating that the observed difference between refractive conditions was present across participants regardless of these history-based variables.

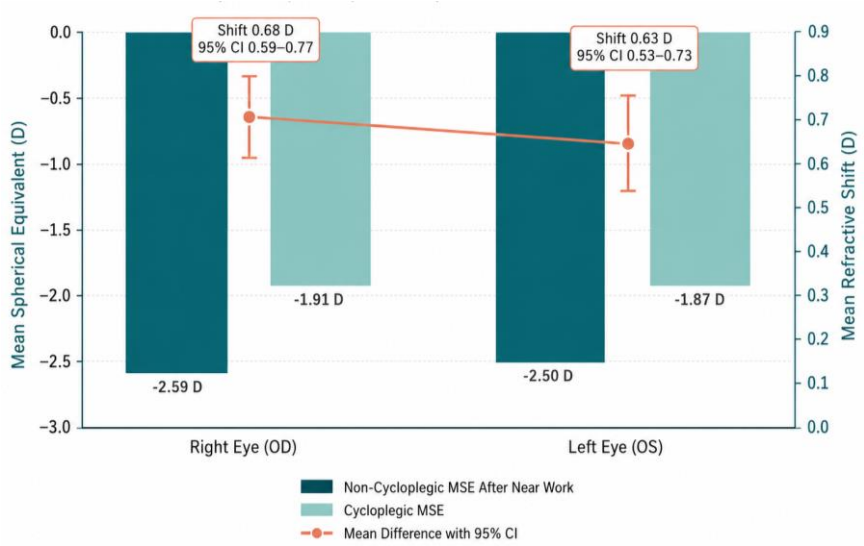

Figure 1. Post-Near-Work Refractive Shift Between Non-Cycloplegic and Cycloplegic Refraction

The figure shows that non-cycloplegic refraction after near work produced consistently more myopic mean spherical equivalent values than cycloplegic refraction in both eyes. In the right eye, the mean spherical equivalent shifted from −2.59 D under non-cycloplegic conditions to −1.91 D after cycloplegia, producing a mean refractive difference of 0.68 D with an approximate 95% confidence interval of 0.59–0.77 D. In the left eye, the corresponding values shifted from −2.50 D to −1.87 D, with a mean difference of 0.63 D and an approximate 95% confidence interval of 0.53–0.73 D. The closely comparable shifts across both eyes indicate a bilateral and clinically meaningful accommodative influence on post-near-work non-cycloplegic refraction.

DISCUSSION

The present study demonstrated a statistically significant difference between non-cycloplegic refraction performed after a standardized near-work task and cycloplegic refraction in young myopic participants. Non-cycloplegic measurements were consistently more myopic than cycloplegic measurements in both eyes, with a mean refractive shift of 0.68 D in the right eye and 0.63 D in the left eye. These findings

indicate that residual accommodative activity after near work can meaningfully influence refractive assessment in young myopes. The magnitude of this difference is clinically relevant because a shift of more than half a diopter may affect spectacle prescribing decisions, particularly in young individuals with active accommodation and high academic or digital near-work demands. The paired comparison further showed large effect sizes in both eyes, supporting that the observed difference was not only statistically significant but also clinically meaningful.

The finding that post-near-work non-cycloplegic refraction was more myopic than cycloplegic refraction is consistent with the physiological role of accommodation in near visual tasks. During sustained near work, the ciliary muscle remains contracted to maintain clear near vision, and relaxation may not occur immediately after the task ends. This residual accommodative response can shift the measured refractive state toward greater minus power when refraction is performed without cycloplegia. Cycloplegia reduces this accommodative influence by temporarily inhibiting ciliary muscle activity, allowing a more relaxed estimate of the refractive state. Therefore, the observed difference between the two refractive conditions supports the clinical concern that non-cycloplegic refraction, particularly when performed immediately after near work, may overestimate myopia in young patients.

The results align with previous evidence showing that non-cycloplegic refraction can produce more myopic values than cycloplegic refraction, especially in populations with stronger accommodative ability. Wilson et al. reported meaningful differences between cycloplegic and non-cycloplegic refraction in children, emphasizing the role of accommodation in refractive assessment (15,16). Similarly, Hashemi et al. observed differences between cycloplegic and non-cycloplegic techniques in adults, indicating that accommodative influence may persist beyond childhood, although its magnitude may vary according to age, refractive status, and measurement conditions (17). The present findings extend this clinical concern to young myopic adults aged 16–25 years, a group that remains highly exposed to academic near work and digital visual tasks but is less frequently emphasized than younger pediatric populations.

Near-induced transient myopia provides a plausible explanatory framework for the observed refractive shift. Sustained near activity may produce a temporary myopic after-effect due to delayed accommodative relaxation after cessation of the task. Sivaraman et al. described near-work-induced transient myopia and accommodative changes after near tasks, supporting the concept that short-term visual activity can influence immediate refractive measurements (18). In the present study, a 10-minute digital near-work task was followed by non-cycloplegic refraction, and the subsequent comparison with cycloplegic refraction showed a bilateral shift exceeding 0.60 D. Although this design does not isolate the independent effect of near work without a pre-near-work baseline, the findings are compatible with an accommodative after-effect that can influence clinical measurements taken soon after near visual effort.

The strong positive correlation between non-cycloplegic and cycloplegic measurements in both eyes indicates that the two methods followed a similar ranking pattern across participants; individuals with higher myopic values under one condition also tended to have higher myopic values under the other. However, the presence of a strong correlation does not imply agreement or interchangeability. Two measurement methods may be highly correlated while still differing by a clinically important amount. In this study, the consistent mean difference of approximately 0.6–0.7 D shows that non-cycloplegic and cycloplegic refraction should not be interpreted as equivalent in young myopes when clinical precision is required.

Daily near-work duration was not significantly associated with the magnitude of refractive variability in either eye. The correlation coefficients were weak for both the right eye and left eye, indicating that self-reported daily near-work duration did not meaningfully predict the difference between non-cycloplegic and cycloplegic refraction. Similarly, duration of myopia showed no significant association with refractive variability. These findings suggest that history-based indicators such as reported daily near-work hours or years since myopia onset may not be sufficient to identify which young myopes are most

likely to show accommodative influence during non-cycloplegic refraction (19). Clinically, this is important because reliance on history alone may fail to detect patients in whom non-cycloplegic refraction overestimates myopia.

The lack of significant association with daily near-work duration should be interpreted carefully. Most participants reported high near-work exposure, particularly 8–9 hours per day, which may have reduced variability across exposure categories and limited the ability to detect a dose-response relationship. In addition, daily near-work duration was based on participant report, which may be affected by recall error and may not capture important details such as working distance, type of near task, screen brightness, posture, breaks, or continuous versus intermittent near work. These factors may influence accommodative stress more directly than total reported hours. Therefore, the absence of a significant correlation does not exclude a role of near-work behavior in refractive variability; rather, it suggests that crude duration alone may be an insufficient predictor.

The absence of a significant relationship between myopia duration and refractive variability also has clinical implications. Participants with longer histories of myopia did not necessarily show greater refractive shift between non-cycloplegic and cycloplegic measurements. This suggests that accommodative influence during refraction may occur across different stages of myopia history and may not be restricted to newly diagnosed or recently progressive myopes. The finding supports a broader clinical approach in which cycloplegic refraction is considered based on the need for diagnostic accuracy rather than on myopia duration alone.

From a clinical perspective, the observed refractive difference may influence prescribing decisions. A non-cycloplegic measurement that is approximately 0.6 D more myopic could lead to an overminus prescription if accommodation is not adequately relaxed or clinically recognized. Overminus correction may contribute to symptoms such as eyestrain, headache, blurred near vision, or visual fatigue during sustained near tasks, particularly in students and young adults. Although the present study did not evaluate symptom outcomes or long-term refractive progression, the magnitude of the observed difference supports the practical value of cycloplegic assessment when refractive findings are inconsistent, symptoms are present, or accurate baseline refraction is required.

This study has several strengths. It focused on a clinically relevant age group of young myopes who are frequently exposed to academic and digital near work. The use of a standardized near-work task before non-cycloplegic refraction allowed all participants to undergo a comparable visual demand before measurement. The paired within-participant design also strengthened comparison between refractive conditions because each participant served as their own control for the cycloplegic and non-cycloplegic measurements. In addition, the study reported results separately for the right and left eyes, showing consistent bilateral findings.

Several limitations should also be considered. First, the study did not include a pre-near-work non-cycloplegic baseline measurement, so the independent contribution of the 10-minute near-work task cannot be separated from the general difference between non-cycloplegic and cycloplegic refraction. Second, different refractive techniques were used under the two conditions: non-cycloplegic refraction involved autorefractometry followed by subjective refraction, whereas cycloplegic refraction was performed using retinoscopy. This methodological difference may have contributed to the observed refractive shift and should be considered when interpreting the findings. Third, daily near-work duration and duration of myopia were self-reported, which introduces potential recall bias. Fourth, the convenience sampling method and sample size of 80 participants may limit generalizability beyond similar young myopic clinical populations. Finally, the study did not include additional measures such as axial length, accommodative lag, accommodative facility, binocular vision parameters, or symptom scores, which could have helped explain the physiological and clinical significance of the refractive differences more comprehensively.

Overall, the findings indicate that young myopes may show clinically meaningful differences between post-near-work non-cycloplegic and cycloplegic refraction. The results support the use of cycloplegic refraction when accurate refractive assessment is required, especially in young patients with substantial near-work exposure or when non-cycloplegic findings appear inconsistent with symptoms or visual performance. Future studies using baseline refraction before near work, identical measurement techniques under both refractive conditions, objective near-work exposure metrics, and accommodative or binocular function testing would help clarify the specific contribution of near work to transient refractive variability.

CONCLUSION

Young myopic adults demonstrated a statistically significant and clinically meaningful difference between non-cycloplegic refraction performed after near work and cycloplegic refraction, with non-cycloplegic measurements showing greater myopic spherical equivalent values in both eyes. The mean refractive shift exceeded 0.60 D bilaterally, indicating that residual accommodation may substantially influence refractive assessment when cycloplegia is not used. Refractive variability was not significantly associated with daily near-work duration or duration of myopia, suggesting that history-based factors alone may not reliably identify individuals at risk of accommodative overestimation. These findings support the consideration of cycloplegic refraction when accurate refractive evaluation is required in young myopes, particularly in clinical situations where near-work exposure, symptoms, or inconsistent refractive findings may affect prescribing decisions.

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