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Anxiety, Depression and Pseudomyopia: A Bidirectional Relationship

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ABSTRACT

Purpose: This study aims to investigate the reciprocal relationship between anxiety, depression and pseudomyopia.

Methods: This was an analytical, multicentered, cross-sectional study conducted from July to November 2024. 30 subjects, aged 18–35years, including emmetrops and pseudomyopes (≥0.50 D reduction in spherical equivalent after cycloplegia) were included. The subjects underwent a comprehensive optometric evaluation that included cycloplegic and non-cycloplegic autorefraction. Anxiety and depression was measured using the Hospital Anxiety and Depression Scale (HADS). Group differences were investigated using Welch's t-test, Fisher's Exact and Chi-square tests for categorical associations and Pearson's coefficients for correlations. Bidirectional regression models were used to evaluate the expected interactions between anxiety, depression and pseudomyopia.

Results: When compared to emmetropes, pseudomyopes showed noticeably greater anxiety (11.81 ± 2.71 vs. 7.22 ± 1.30; p <.001) and depression (11.10 ± 2.49 vs 6.56 ± 0.88;p <.001) ratings. There was a positive correlation between pseudomyopic shift (mean 0.64 ± 0.35 D) and depression (r= 0.539,p=.002) as well as anxiety (r= 0.576,p=.001). The results of regression analyses showed a bidirectional relationship: pseudomyopic shift predicted higher anxiety (β =.576, p =.001; R^2 =.331) and depression (β=.539,p=.002; R^2 =.290), while anxiety (β=.417, p=.017) and depression (β =.349,p=.042) predicted greater pseudomyopic shift (R^2 =.428).

Conclusion: The findings suggest that there exists a reciprocal association between anxiety, depression and pseudomyopia, as well as a possible biopsychovisual feedback loop in which psychological symptoms and visual instability reinforce one another. These results demonstrate the importance of combining optometric and psychological tests in the diagnosis and treatment of pseudomyopia.

Keywords: Refractive Error, Accommodation, Pseudomyopia , Psychological Stress, Anxiety , Depression, Young Adults , Psychological Factors, Bidirectional relationship, Myopia

INTRODUCTION

Myopia is a refractive error, according to the International Myopia Institute (IMI), which occurs when parallel rays of light entering the eye focus in front of the retina while accommodation is relaxed. Although an elongated eyeball (axial myopia) is usually the reason, an extremely curved cornea or a lens with an exceptionally high refractive power can also cause this [1]. The prefix "pseudo," which comes from the Greek word "pseudo," which means "false" or "erroneous," indicates pseudomyopia, which is a temporary or short-term kind of myopia. Since secondary myopia and pseudomyopia are not interchangeable, it is crucial to comprehend their differences. A myopic shift that has a specific, identifiable cause and is not thought to be a common risk factor for the development of myopia is known as secondary myopia. Examples include systemic disorders such as diabetes mellitus [2], hyperbaric oxygen therapy [3], severe ocular trauma resulting in ciliary body edema [4] and refractive changes brought on by lens abnormalities in cataracts [5].

When the eye concentrates on a distant object, the ciliary muscles normally relax, allowing light to focus sharply on the fovea. The parasympathetic nervous system uses the Edinger-Westphal nucleus to mediate the near reflex, which includes accommodation, convergence, and miosis [6]. Pseudomyopia projects close-up images in front of the retina, resulting in blurry or distorted distance vision. Pseudomyopia typically occurs after extended near work and manifests as headaches, eye strain, blurred and fluctuating distance vision [7,8].

Pseudomyopia results from an increase in the eye's refractive power caused by overstimulating the accommodating system [9,10]. This occurs when the ciliary muscle remains partially constricted even while viewing distant objects at optical infinity due to persistent over activity or abnormal brain input [9]. Therefore, accommodation is not fully relieved unless cycloplegia is utilized to paralyze pharmacologically [11]. When cycloplegic, the eye typically shows less myopia or even appears hyperopic[12]. One important diagnostic feature of pseudomyopia is the notable difference between cycloplegic and non-cycloplegic refraction [13]. Several authors define pseudomyopia as a transient, apparent myopia that disappears when cycloplegia occur [9,12, 14-15]. The primary contributing factors of pseudomyopia have been identified as head trauma [16], demyelinating neurological conditions [17] and psychological problems [18,19].

This study aims to investigate the reciprocal relationship between anxiety, depression and pseudomyopia. It specifically investigates whether anxiety, depression are made worse by visual abnormalities linked to pseudomyopia and whether symptoms of pseudomyopia are brought on by or made worse by high levels of stress. Knowing this connection could aid in the development of more comprehensive methods for diagnosing and treating pseudomyopia that take into account both the psychological and visual aspects.

METHODLOGY

The Declaration of Helsinki's ethical guidelines were strictly followed throughout the study. The Each participant gave written informed consent before commencing the study. The study was conducted in 2024, from July to November.

To investigate the reciprocal relationship between anxiety, depression and pseudomyopia, an analytical multi-centred cross-sectional study was conducted at the Madina Teaching Hospital in Faisalabad, Pakistan. Participants were recruited among Asian males and females aged 18 to 35 years who fulfilled the diagnostic criteria for pseudomyopia. The criteria for pseudomyopia were a subjective spherical equivalent refractive error of −0.50 diopters or more, a significant accommodating component and a decrease of at least 0.50 diopters after cycloplegic refraction. Each participant must be without any systemic neurological illnesses or ocular pathologies, have a best-corrected visual acuity (BCVA) of 1.0 or higher on the Snellen chart (equivalent to 6/6 or 20/20) and not be taking any medications that might interfere with accommodation. Individuals who demonstrated symptoms of manifest tropia, decompensating horizontal or vertical phorias or sensory

suppression were excluded. Other exclusion criteria included any prior refractive surgery or other ocular procedures known as changing the eye's refractive error as well as a history of ocular conditions, trauma or injuries that might affect refractive status. A total of 30 participants were selected using non-probability purposive sampling.

Data was collected using a self-structured questionnaire. Each participant underwent a comprehensive optometric examination, which included the recording of medical, ocular and family histories, in addition to a standard set of clinical assessments performed on both eyes. Both cycloplegic and non-cycloplegic autorefraction were evaluated. SER = sphere + (cylinder/2) is the formula used to calculate the spherical equivalent refractive error (SER).

An autorefractometer was used to measure objective refraction both before and after cycloplegia. Measurements were made 30 minutes after cyclopentolate 1% was given in two drops at 5-minute intervals, followed by cycloplegic refraction. The diagnostic standard for pseudomyopia was a reduction in spherical equivalent refraction (SER) of ≥0.50 diopters after cycloplegia. Participants were divided into two groups based on these findings: pseudomyopes (Refraction_Type = 2) and emmetropes (Refraction Type = 1). Participants also completed a structured questionnaire to collect data on their demographics and screen time.

Anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS). A validated questionnaire designed to detect anxiety and depression in medical and non-psychiatric populations. The scale's 14 items are divided equally between two subscales, each with seven questions: HADS-A (Anxiety) and HADS-D (Depression). Participants were asked to rate each item on a 4-point Likert scale (from 0 to 3), with a maximum score of 21 for each subscale. According to established guidelines, a score between 0 and 7 was considered normal, a score between 8 and 10 was considered borderline, and a score between 11 and 21 indicated a clinically significant level of anxiety or depression.

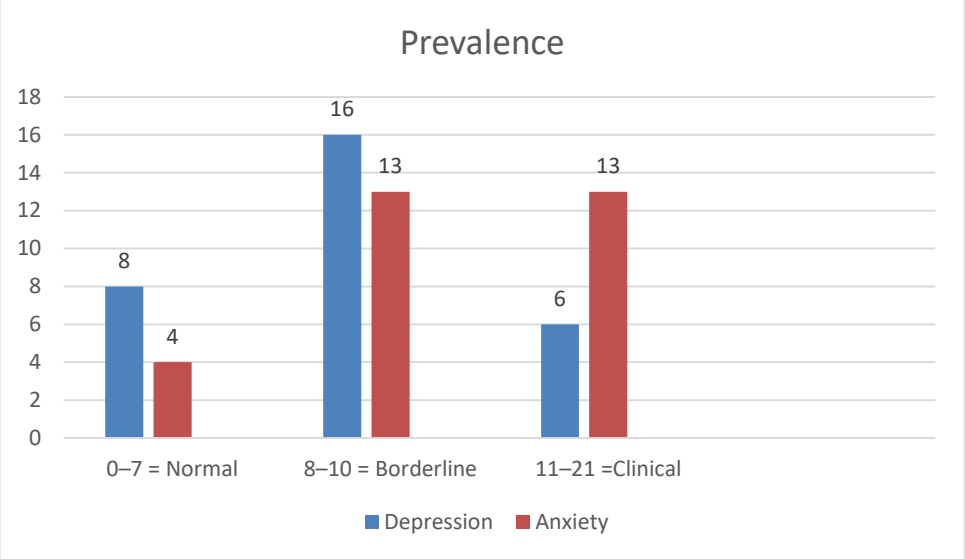
All statistical analyses were conducted using IBM SPSS Statistics (Version 23.0). Descriptive statistics, including means, standard deviations, frequencies and percentages, were computed for demographic information, refractive group classifications (emmetropic vs. pseudomyopic) and anxiety, depression as determined by the Hospital Anxiety and Depression Scale (HADS). To compare the mean depression and anxiety scores between 2 refractive groups independent t test was used. Before using independent samples t-tests, Levene's equality of variances test was used. When the assumption of homogeneity of variance was violated ($p < .05$), Welch's t-test was used to account for differential variances. Pearson's Chi-square test was used to identify categorical relationships between refractive status and psychological distress levels (normal, borderline and clinical). However, when more than 20% of the expected cell counts were less than 5, indicating a violation of the chi-square test's assumptions, Fisher's Exact Test was also performed to confirm the data' robustness. Effect sizes were interpreted using Cramer's V. To assess associations between continuous variables (pseudomyopic shift and anxiety, depression scores), pearson correlation coefficients were calculated. Additionally, multiple linear regression analyses were conducted to examine whether the degree of pseudomyopic shift was predicted by anxiety and depression scores. Additionally, separate simple linear regression analysis were performed to examine if pseudomyopic shift predicted anxiety and depression scores. Model fit was evaluated using R2 and adjusted R2, regression coefficients and the significance of F-tests. For every analysis, the cutoff value for statistical significance was $p < .05$.

RESULTS

Descriptive statistics were used to analyze the age distribution of the thirty study participants. The participants' ages ranged from minimum from 21 to maximum of 27, with a mean age of 24.13 years and a standard deviation of 1.89. The gender distribution of the sample demonstrated that 18(60%) of the participants were female and 12(40%) were male. The prevalence estimates of anxiety and depression in the participants were displayed in a bar graph with three levels: normal, borderline and clinical. The majority of subjects (53.3%) had borderline depression, followed by normal (26.7%) and clinical depression (20.0%). However, the prevalence of anxiety revealed a distinct pattern: 43.3% of people had borderline scores, 43.3% had clinical levels and only 13.3% of people had scores in the

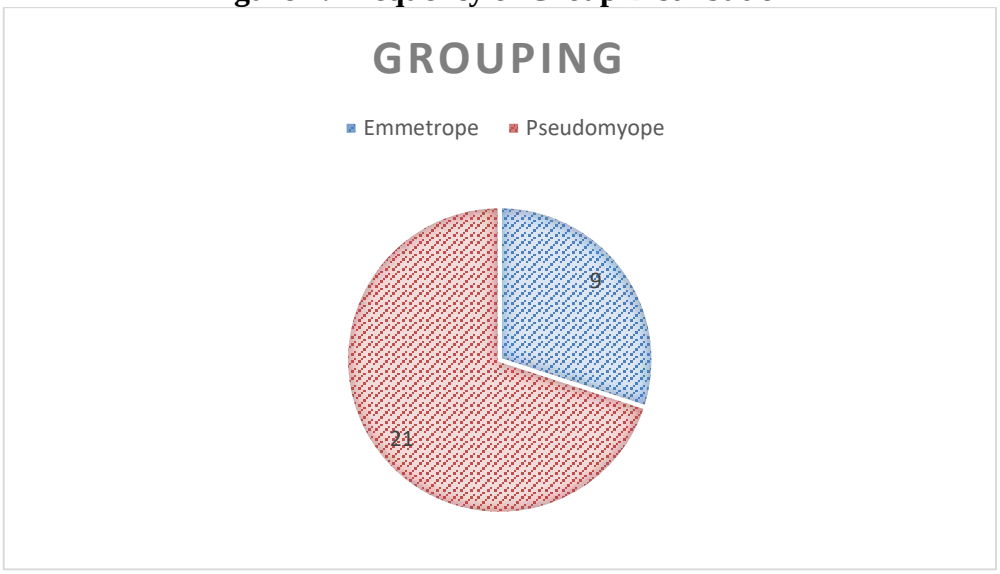
normal range (scores 0–7) (Figure 1). The participants' daily screen time ranged from 4 to 8 hours, with an average of 5.87 hours (SD = 1.16).

Figure 1: Prevalence Estimates of Anxiety and Depression



A pie graph was used to show the participants' distribution by refractive grouping, notably emmetrope and pseudomyope. Out of the whole sample of 30, nine individuals (30%) were identified as emmetrope, while 21 participants (70%) were identified as pseudomyope (Figure 2).

Figure 2: Frequency of Group Distribution



Independent t test was used to compare the psychological factors (anxiety & depression scores) of emmetropic and pseudomyopic subjects. Compared to emmetropes 6.56± 0.88, pseudomyopes had significantly greater depression scores 11.10 ±2.49. Similarly, emmetropes scored lower on anxiety 7.22 ±1.30 than pseudomyopes 11.81 ± 2.71. The significant findings of Levene's Test for Equality of Variances for anxiety ($p = .030$) and depression ($p = .046$) demonstrate that the homogeneity of variance assumption was broken. Consequently, Welch's t-test was employed and the results showed statistically significant differences between the groups in the anxiety ($t(27.45) = -6.25$, $p < .001$, 95% CI [-6.09, -3.08]) and depression ($t(27.53) = -7.35$, $p < .001$, 95% CI [-5.81, -3.27]) scores (Table 1).

Table 1: Comparison of Anxiety & Depression Scores between Emmetropic and Pseudomyopic Subjects

Variable	Group	Mean (SD)	Welch's t(df)	p-value	95% CI of Mean Difference
Depression	Emmetrope	6.56 (0.88)	-7.35 (27.53)	< .001	[-5.81, -3.27]
	Pseudomyope	11.10 (2.49)			
Anxiety	Emmetrope	7.22 (1.30)	-6.25 (27.45)	< .001	[-6.09, -3.08]
	Pseudomyope	11.81 (2.71)			
Welch's t-test was used due to violation of homogeneity of variance (Levene's Test $p < .05$).					

There was a significant association between the category of depression and refractive status ($\chi^2(2) = 25.54$, $p < .001$). Because of the low projected frequencies in more than 20% of the cells, Fisher's Exact Test was conducted, and the findings verified the significance ($p = .000$). Similarly, a significant relationship was found between refractive status and anxiety category ($\chi^2(2) = 15.35$, $p < .001$; Fisher's Exact Test: $p = .000$). Refractive error and psychological factors were shown to be strongly correlated, with effect sizes for depression being substantial (Cramer's V =.923) and for anxiety being moderate-to-large (Cramer's V =.715). These findings showed that those with pseudomyopic changes were significantly more likely to experience borderline or clinical levels of anxiety and depression than emmetropic individuals (Table 2).

Table 2: Association between Psychological Distress and Refractive Status (Emmetrope vs. Pseudomyope)

Psychological Distress	**Grouping**	**Normal (0–7)**	**Borderline (8–10)**	**Clinical (11–21)**	**χ^2 (df)**	**p-value**	**Cramer's V**	**Fisher's Exact p**
Depression	Emmetrope	8	1	0	25.54 (2)	.000	.923	.000
	Pseudomyope	0	15	6				
Anxiety	Emmetrope	4	5	0	15.35 (2)	.000	.715	.000
	Pseudomyope	0	8	13				
χ^2 = Pearson Chi-square test statistic; df = degrees of freedom; p-values are from Pearson Chi-square test.								

The pseudomyopia shift was calculated as the difference between the spherical equivalent refraction (SER) measurements obtained before and after cycloplegia. The pre-cycloplegic SER averaged 1.14 diopters (SD = 0.68), the post-cycloplegic SER averaged 0.49 diopters (SD = 0.39), and the mean pseudomyopic shift was 0.64 diopters (SD = 0.35). The average anxiety score was 10.43 (SD = 3.18) and the average depression score was 9.73 (SD = 2.99). Descriptive statistics and correlation results are shown in Table 3. Anxiety and depression levels were revealed to be considerably positively connected with the degree of pseudomyopic shift. A moderate to significant association was found between anxiety ($r = 0.576$, $p = 0.001$) and depression ($r = 0.539$, $p = 0.002$), indicating a relationship between greater pseudomyopic change and anxiety & depression.

Table 3: Key Variable Descriptive Statistics and Correlation Summary (N = 30)

Variable	Mean	SD	Min	Max	Correlated Variable	*r*	*p*-value
Anxiety Score (HADS)	10.43	3.18	5.00	17.00	Pseudomyopia Shift	0.576**	0.001
Depression Score (HADS)	9.73	2.99	5.00	17.00		0.539**	0.002
Pseudomyopia Shift (D)	0.64	0.35	0.00	1.25	—	—	—
r = Pearson correlation coefficient , SD = Standard deviation ** Correlation is significant at the 0.01 level (2-tailed).							

A bidirectional linear regression technique was used to investigate the directionality of the relationship between pseudomyopia and anxiety & depression.
The impact of psychological variables on pseudomyopic shift was investigated in direction A. Anxiety (β =.417, p =.017) and depression (β =.349, p =.042) were also significant predictors of pseudomyopia, according to a multivariate linear regression. The model explained 42.8% of the variation (R2 =.428, F(2, 27) = 10.11, p <.001). Scores for depression and anxiety were significantly predictive. This suggests a strong correlation between increased anxiety and depression and a high pseudomyopic shift. According to unstandardized coefficients, pseudomyopic shift rises by about 0.047 and 0.042 diopters for every point increase in anxiety and depression levels, respectively. In contrast, Direction B evaluated whether psychological impacts were anticipated from pseudomyopia. Both anxiety (β =.576, p =.001) and depression (β =.539, p =.002) were strongly predicted by pseudomyopic shift, as shown by two different simple linear regressions. Anxiety increased by 5.12 points for every diopter increase in shift, while depression scores increased by 4.51 points for every diopter increase in shift with 29.0% and 33.1% explained variances, respectively. These findings provide evidence that depression and anxiety are both predicted and influenced by pseudomyopic shift, suggesting that psychological factors and pseudomyopia may have a reciprocal connection (Table 4). These results suggest that psychological factor and pseudomyopia are correlated, with increased anxiety and depression potentially contributing to and resulting from changes in pseudomyopia. This highlights the importance of integrating optometric and psychological assessment.

Table 4: Pseudomyopic Shift and Depression & Anxiety: A Bidirectional Linear Regression Analysis

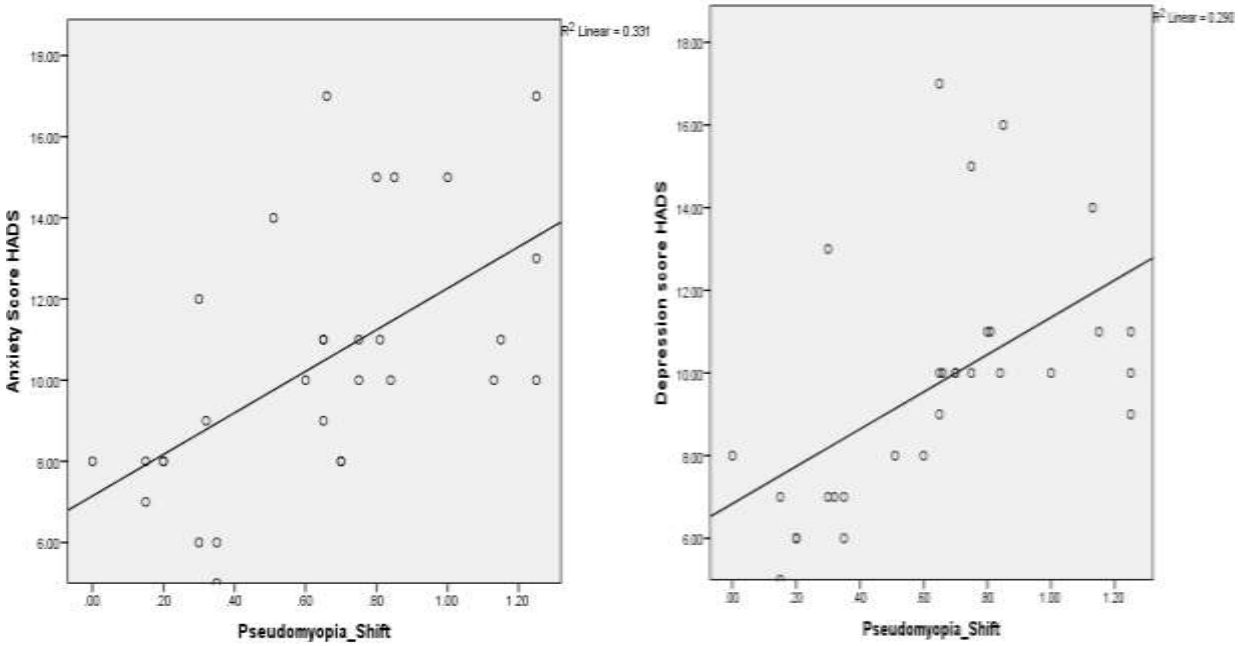
Direction	**Dependent Variable**	**Predictor**	**B**	**SE**	**β**	**t**	**p**	**R^2**	**Adjusted R^2**	**F(df)**
A	Pseudomyopia Shift	Anxiety Score HADS	0.047	0.018	0.417	2.552	.017	.428	.386	10.11 (2, 27)
		Depression Score HADS	0.042	0.020	0.349	2.139	.042			
B	Anxiety Score HADS	Pseudomyopia Shift	5.116	1.373	0.576	3.725	.001	.331	.307	13.87 (1, 28)
	Depression Score HADS	Pseudomyopia Shift	4.507	1.332	0.539	3.384	.002	.290	.265	11.45 (1, 28)

B = Unstandardized regression coefficient; SE = Standard error; β = Standardized regression coefficient; t = t-statistic; p = Significance level; R^2 = Coefficient of determination (model-level). All predictors were entered using the Enter method. Significance was assessed at α = .05
Model 1: Multiple linear regression predicting pseudomyopia shift. Models 2 & 3: Simple linear regressions with pseudomyopia as predictor
Direction A = Psychological Factors (Anxiety & Depression) → Pseudomyopic Shift; Direction B = Pseudomyopic Shift → Psychological Factors (Anxiety & Depression)

Overall, these findings suggest that psychological discomfort, such as depression and anxiety, is influenced and predicted by pseudomyopia, suggesting a potentially cyclical relationship between both of them. It was found that there was a positive linear relationship between pseudomyopic shift and both depression (R2 = 0.290) and anxiety (R2 = 0.331). Figures 3 (A and B) show these relationships. Each dot represents a distinct participant. The common x-axis displays the pseudomyopic shift (in diopters). Trendlines are a sign of linear regression. Each dot represents a

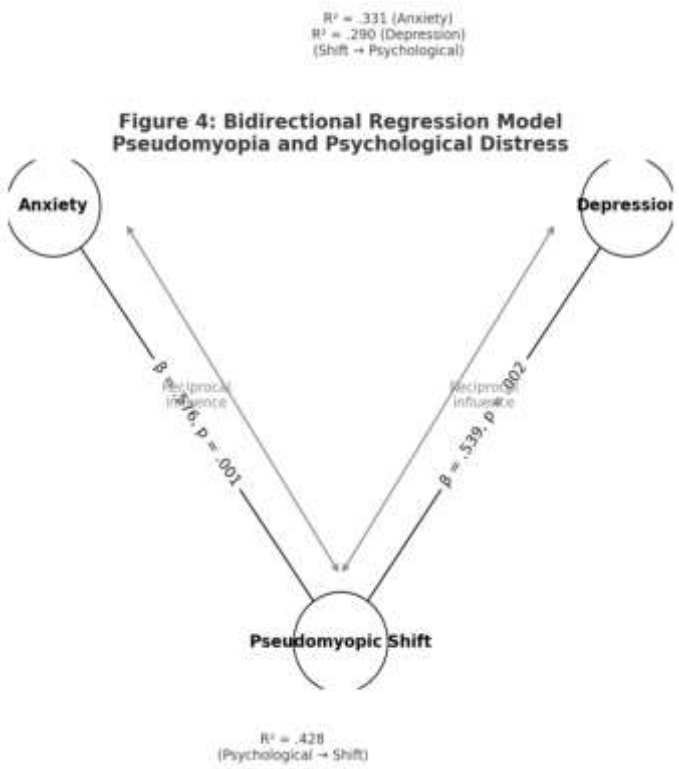
distinct participant. The common x-axis displays the pseudomyopic shift (in diopters). Trendlines are a sign of linear regression.

Figure 3: Relationship between pseudomyopic shift and psychological Factors (Anxiety & Depression)**. Panel A: A scatter plot showing the relationship between HADS-Anxiety levels and pseudomyopic shift (R2 = 0.331). Panel B: A scatter plot showing the relationship between HADS-Depression scores and pseudomyopic shift (R2 = 0.290).**



Conceptual diagram showing the findings of a bidirectional regression between pseudomyopic shift and psychological factors (depression and anxiety)(Figure 4). Solid arrows denote statistically significant ($p<.05$) pathways, and the associated standardized regression coefficient (β) is displayed for each path. Higher anxiety (β =.417, p =.017) and depression (β =.349, p =.042) scores were significantly predictive of greater pseudomyopic shift in Direction A, accounting for 42.8% of the variance (R2 =.428). In Direction B, pseudomyopic shift was a significant predictor of anxiety (β =.576, p =.001; R^2 =.331) and depression (β =.539, p =.002; R^2 =.290). Double-headed arrows show that the associations are reciprocal, suggesting that psychological distress and pseudomyopia may influence one another.

Figure 4: Bidirectional regression model between pseudomyopia and psychological distress (anxiety and depression)



DISCUSSION

This study provides compelling evidence of a reciprocal relationship between psychological distress, specifically anxiety and depression, and pseudomyopic shift. These results showed that higher levels of anxiety (β =.417, p =.017) and depression (β =.349, p =.042), which explained 42.8% of the variance, significantly predicted greater pseudomyopic shift. On the other hand, with explained variances of 33.1% and 29.0%, respectively, pseudomyopic shift was a strong predictor of increases in anxiety (β =.576, p =.001) and depression (β =.539, p =.002). This reciprocal pattern suggests that a cyclical feedback mechanism may reinforce psychological distress and pseudomyopia.

Previous studies support this relationship. Khalid et al., [20] claim that anxiety and depression are the causes of accommodative spasm and refractive instability, indicating that pseudomyopia could be a physical manifestation of psychological distress. Kara et al.,[19] found that accommodating response and anxiety-somatization ratings were significantly correlated. More than 70% of teenagers with pseudomyopia had comorbid mental health conditions. These results align with our findings and support the hypothesis that psychological discomfort contributes to pseudomyopic phenomena.

From a physiological perspective, autonomic dysregulation seems to be the mechanism by which stress affects ocular accommodation. Stress-related pseudomyopia frequently results in short-term myopia because ciliary muscle contraction is triggered by parasympathetic overactivation [13]]. Our findings are significant because they add to the literature by demonstrating that psychological discomfort might be made worse by the pseudomyopic shift itself. This suggests a psychological feedback structure in which symptoms of anxiety and depression are exacerbated by visual instability and functional impairment, which could increase accommodative dysfunction.

From a clinical perspective, these results emphasize the importance of integrated treatment. Eye care professionals should consider screening for mental health issues when a patient exhibits fluctuating refraction. Professionals in mental health should also be aware of visual cues that may make patients' suffering worse. Therefore, interdisciplinary approaches could improve diagnosis, treatment and patient outcomes.

One of our methodological strengths is the use of bidirectional regression, which provides information beyond unidirectional models. However, because of the cross-sectional design, causal inference is not practicable. The use of self-report scales (HADS) and the comparatively small sample size restrict generalizability and could result in reporting bias. Longitudinal studies should clarify causality, even

though interventional trials could look at whether treating anxiety or depression mitigates pseudomyopic shifts or whether controlling pseudomyopia improves psychological outcomes. The underlying mechanisms may be clarified by neurobiological research that examines autonomic function, stress biomarkers or neuroimaging.

CONCLUSION

This study provides new evidence of a reciprocal relationship between pseudomyopic shift and psychological distress in young adults supporting the idea of a biopsychovisual feedback loop in which psychological conditions and visual instability reinforce one another. To improve patient outcomes, these findings emphasize the value of integrated diagnostic and therapeutic approaches combined optometric and psychological testing, as well as prospects for interdisciplinary interventions and further study.

DECLARATION

Funding: This study was not funded by any organization.
Patients' Consent: Researchers followed the guide lines set forth in the Declaration of Helsinki.
Conflict of Interest: Authors declared no conflict of interest.
Ethical Approval: The University of Faisalabad's Institutional Review Board provided ethical permission (IRB permission Number: TUF/IRB/317/24, issued on June 5, 2024).

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