ORIGINAL RESEARCH

Evaluation of the Effect of Psychological Resilience on Anxiety in Patients with Diabetic Retinopathy Through the Mediating Effect of Perceived Stress: A Moderated Mediation Model

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Objective: To investigate the anxiety status of Chinese patients with diabetic retinopathy (DR) and its relationship with psychological resilience and perceived stress.

Methods: A sampling method was used to select 606 DR patients, and the 10-item Connor-Davidson Resilience Scale (CD-RISC-10), Perceived Stress Scale short-form (PSS-10), and General Anxiety Disorder-7 (GAD-7) were used for the survey. We used SPSS 26.0 to analyse the data and employed PROCESS v4.1 for the mediating effect test.

Results: The incidence of anxiety in DR patients was approximately 53.63%, with psychological resilience (CD-RISC-10 average=27.51±8.32) and perceived stress (PSS-10 average=15.97±6.54). Anxiety was negatively correlated with psychological resilience ($r=-0.569$, $P<0.01$) and positively correlated with perceived stress ($r=0.638$, $P<0.01$). Additionally, psychological resilience was negatively correlated with perceived stress ($r=-0.681$, $P<0.01$). Perceived stress had a positive predictive effect on anxiety (total effect $= -0.327$, 95% bootstrap CI $= -0.363$ to -0.291), and it played a mediating role in the relationship between psychological resilience and anxiety, with a mediating effect size of 54.13%.

Conclusion: Psychological resilience and perceived stress directly or indirectly affect anxiety, Perceived stress moderates the relationship between psychological resilience and anxiety as a mediating variable. By analyzing this psychological mechanism, this study provides a new perspective for applying psychology to chronic diseases and a scientific basis for medical staff to develop targeted psychological intervention measures.

Keywords: diabetic retinopathy, perceived stress, psychological resilience, mediating effect

Introduction

According to 2019 statistics from the International Diabetes Federation (IDF), the number of diabetes mellitus (DM) patients worldwide has reached 463 million, and it is expected to reach 700 million by 2045.[1] Diabetic retinopathy (DR) is the most common and specific complication of DM. Microvascular lesions lead to decreased retinal perfusion, increased vascular permeability and neovascularization, which can lead to irreversible visual impairment.[2] With the annually increasing prevalence of diabetes, DR has become an important public health issue worldwide.[3] Extensive research indicates that the occurrence and development of DR are influenced by various factors, including age, gender, visual changes, surgical treatment, hypoglycaemic medications, etc.[4] Research has revealed that there is an interaction between diabetes and DR with respect to psychological factors and that psychological factors are significantly related to the occurrence and development of DR,[5] providing new directions for exploring the pathogenesis of DR.[6] Compared with

other chronic diseases (such as hypertension, diabetes, etc)., DR patients need to face the fear of disease caused by irreversible loss of vision, and the psychological impact more directly affects their quality of life.[7] Positive diabetes health management and psychological intervention can slow the progression of DR.[8] Potential psychological stress may accelerate the progression of DR through biological pathways, and it can also do so through behavioural pathways (such as smoking, drinking, prolonged sitting, and lack of exercise), leading to poor blood sugar control and increased DR risk.[9] Therefore, it is important to actively explore the psychological mechanism of DR onset and progression, quickly identify and interfere with the psychological problems associated with DR, and provide new treatment strategies for controlling blood sugar and preventing and controlling vision disorders.

Previous studies have suggested that DR affects the psychological state of patients through a combination of biological and psychological mechanisms. Biological mechanisms mainly involve: (1) Insulin resistance in brain and eye tissues. Insulin resistance destroys neuronal plasticity and transmitter regulation through receptor dysfunction and signal transmission disorders, ultimately leading to brain metabolic disorders, cognitive decline and emotional disorders.[10] Hyperglycemia and insulin resistance can aggravate oxidative stress responses, leading to abnormalities in the retinal neural tissue and microvascular system, and aggravate DR progression.[11] (2) The interaction between immune inflammation and the hypothalamic-pituitary-adrenal (HPA) axis, the hyperglycemia state promotes chronic inflammation in the system, releases inflammatory factors (such as IL-6 and TNF-α),[12] stimulates the HPA axis to cause cortisol levels to rise, reduces insulin sensitivity, inhibits nerve and synaptic plasticity, and leads to emotional changes.[13] In addition, inflammatory factors inhibit serotonin (5-HT) synthesis, aggravating mood disorders.[14] (3) The regulatory effects of intestinal-brain axis (GBA) and intestinal-ophthalmic axis (GEA), and the imbalance of the bacterial population causes increased secretion of inflammatory factors, dysfunction of HPA axis and reduced synthesis of brain-derived neural factors (BNDF).[15] Psychological mechanisms are analyzed from multiple dimensions such as cognition, emotion and behavior, the main mechanism: (1) Cognitive mechanisms. DR patients may have negative cognition of their health due to visual impairment and self-care ability.[16] (2) Emotional mechanisms. DR patients are prone to negative emotions due to vision loss, a significant reduction in quality of life, long-term disease burden and treatment pressure. Anxiety is the most common psychological problem in DR patients, with a prevalence rate of more than 40%.[17] (3) Behavioral mechanism. Due to the loss of vision, patients may reduce social activities, resulting in a decrease in isolation and life satisfaction. This behavioral withdrawal will further increase the psychological burden and form a vicious cycle. (4) Social support, by providing emotional support, information support and practical help, thereby reducing patients' anxiety and depression, improving their psychological resilience and quality of life.[16] Therefore, the management of DR requires integrated consideration of physical and psychological factors, and psychological interventions and social support play an important role in improving the psychology of DR patients.

Psychological resilience is defined as a protective factor that makes individuals more resistant to adverse events, leading to positive developmental outcomes. In other words, psychological resilience refers to the ability to cope with difficulties, stress, and trauma while maintaining or restoring normal functions. The higher the resilience is, the lower the vulnerability and risk of illness.[18] Psychological resilience helps people achieve positive and healthy behaviours and outcomes in adversity.[19] It can reduce or prevent the negative impact of stress events, alleviate patients' negative emotions and anxiety, and has a protective effect. Individuals with high psychological resilience possess a positive mental state to cope with life stress and disease treatment, which can alleviate the worsening of disease and provide good rebound ability in the face of difficulties. Individuals with low psychological resilience are associated with high levels of psychological distress, poor quality of life, and uncontrolled blood sugar levels.[20] In recent years, with progress in research on the mental health status of chronic disease patients, the concept of psychological resilience has been widely applied as an important mediating variable affecting psychological stress in related research fields.[21] Research has shown that the recovery time for vision after DR surgery can range from several weeks to months or even longer. During this period, the inability to meet daily life needs due to impaired vision requires care from others, leading to a decreased sense of self and a feeling of burden.[22] Additionally, patients are prone to negative emotional responses such as anxiety, depression, fear, and loss of confidence.[23,24] This tendency not only threatens the physical and mental health of DR patients but also reduces their quality of life.[25,26]

Perceived stress refers to the confusion, threat, or challenge that various stimulating events in life psychologically pose to an individual, manifesting as psychological responses and representing a state of tension and loss of control for the individual.[27] Whether objectively existing stress affects an individual depends on the individual's perception and interpretation of the stress event, which is influenced by various subjective factors such as personal emotions, experiences, memories triggered by the situation, individual vulnerabilities, and coping skills.[28] DR patients perceive excessive stress, have poor psychological adjustment abilities, and experience significant psychological pressure, making it difficult for them to maintain a positive and optimistic attitude towards their condition. They often refuse necessary self-care and rarely take proactive steps to solve problems, leading to poor disease outcomes.[29] This behaviour may be related to the adaptation and perception fatigue caused by long-term chronic stress, which can easily lead patients to feel weary with regard to controlling their blood sugar and to question their self-management abilities and can result in negative self-evaluations.

Anxiety refers to a state where a person experiences tension, unease, fear, panic, or discomfort. DR patients must bear not only the stress caused by their diabetes but also the dual pressure of declining vision, making them prone to negative emotions such as anxiety and depression. The implementation of effective nursing measures to improve the mental health of DR patients is one of the key medical issues currently attracting attention.[30] Previous studies have shown that anxiety symptoms are one of the independent predictors of DR, with a prevalence rate of 22.7% to 41.1% for anxiety symptoms concurrent with DR.[31] The severity of anxiety symptoms is positively correlated with the severity of DR.[32] Anxiety may be related to factors such as poor social support,[33] low psychological resilience,[34] low self-efficacy,[35] and high stress.[36] Anxiety symptoms not only lead to a greater disease burden for DR patients but also accelerate the progression of the disease, potentially increasing the risk of developing retinopathy among diabetes patients.

In the context of the transition from the biomedical model to the biopsychosocial model, the phenomenon of somatic diseases accompanied by psychological issues has already attracted widespread attention from the medical and psychological communities, as well as from the patients themselves. If DR disease is treated solely without emotional and psychological interventions, this treatment may lead to an exacerbation or a complication of the condition, thus affecting treatment outcomes and disease prognosis. Therefore, analysing the relationships among psychological resilience, perceived stress, and anxiety in DR patients, as well as their mechanisms and pathways of influence, has become a hot topic of clinical concern. Evaluating the psychological condition of DR patients helps in identifying existing psychological issues and in providing appropriate and targeted psychological interventions. Offering more psychological support and assistance can help patients correctly understand and face their illness, overcome negative emotions, and enhance their trust in medical staff. This, in turn, boosts their confidence and compliance with treatment, encouraging patients to actively and optimistically comply with their disease management, thereby improving their quality of life and clinical outcomes.

Methods
Ethical Statement
The study complies with the Declaration of Helsinki. This study was approved by the Ethics Committee of Changzhou Third People's Hospital (Ethics No. 02A-A20220022). All participants in this study provided informed consent.

Research Design
This study employed a cross-sectional design. The estimated minimum sample size was 89, based on a moderate f effect size of 0.15, a of 0.05, power of 0.95, and total number of predictors of 2 using G*Power (developed by Faul et al).[37] A total of 606 hospitalized patients from the ophthalmology department of Changzhou Third People's Hospital between January 2023 and June 2024 were selected as research subjects. The inclusion criteria were as follows: (1) being aged ≥ 18 years; (2) having been diagnosed with DR through fundus examination, fundus fluorescein angiography, and/or optical coherence tomography; (3) having a clear consciousness; (4) being able to communicate normally and answer questions independently. The exclusion criteria were as follows: (1) individuals with a history of drug or alcohol dependence or who previously used antidepressant or antianxiety medications; (2) patients with dementia, various mental illnesses, or those unwilling to cooperate; (3) individuals with other serious comorbid conditions.

Measures and Data Collection

This questionnaire survey was conducted in the ophthalmology ward of the hospital and was completed jointly by qualified quality control personnel and investigators. Eligible patients were invited to participate in the study. Members of the research team explained the purpose and process of the study, and the questionnaire was completed by the patients themselves. Patients who lacked the ability to complete the questionnaire independently could verbally express their responses, which were filled in by the investigators on their behalf. The questionnaires were collected on the spot and checked for errors or omissions, and patients were assisted in correcting or filling in missing information. A total of 630 questionnaires were distributed in this study, with 606 valid questionnaires returned, resulting in a valid response rate of 96.19%.

General Information Survey Questionnaire

The researchers designed general data survey questionnaires. The main content included gender, age, marital status, education level, employment status, income situation, medical expenses, duration of diabetes, types of retinopathy, etc.

10-Item Connor-Davidson Resilience Scale

Simplified version of the Connor-Davidson Resilience Scale (10-item Connor-Davidson Resilience Scale, CD-RISCI -10): This scale is a simplified version extracted by Campbell-Stills et al[38] from the 25 items of the Connor-Davidson Resilience Scale developed by Connor and Davidson, forming the CD-RISCI.[39] It has high internal consistency, with a Cronbach's α of 0.85, and it is used to measure the psychological resilience level of respondents. The CD-RISCI translation by Wang et al[40] has been revised into a simplified Chinese version, which includes a total of 10 items. Using a 4-point scoring method, with a total score ranging from 0 to 40, the higher the score is, the better the psychological resilience of the respondent. The internal consistency of the scale is a Cronbach's α of 0.91, indicating good reliability, and the scale has been widely used in surveys of psychological resilience among adults in China.

Perceived Stress Scale Short-Form (PSS-10)

The PSS-10 scale was proposed by American scholars Cohen et al to assess the level of stress perceived by individuals.[41] It is divided into two aspects: crisis awareness and response control capability. Crisis awareness includes Items 1, 2, 3, 6, 9, and 10, and response control capability includes Items 4, 5, 7, and 8. It uses a 5-point Likert scale, with scores ranging from 0 to 4, corresponding to "never" to "always." The total score ranges from 0 to 40, with higher scores indicating greater stress. Based on the scores, 0–13 points indicate low stress levels, 14–18 points indicate low to moderate stress levels, 19–25 points indicate moderate to high stress levels, and 26–40 points indicate high stress levels. The Cronbach's α of this scale is 0.78.

7-Item Generalized Anxiety Disorder Scale (GAD-7)

This scale was developed by Spizer et al.[42] The scale consists of 7 items and adopts a 4-level classification, ranging from 0 (not at all) to 3 (almost every day). The total score ranges from 0 to 21 points. The higher the score is, the higher the anxiety level. Scores of 5, 10 and 15 correspond to the boundary values representing "mild", "moderate" and "severe" anxiety levels, respectively. The Cronbach's α of this scale was reported to be 0.92.[43] The Cronbach's α coefficient of the Chinese version of the GAD-7 in the hospital patient population was 0.898,[44] and the GAD-7 can be used to screen not only GAD but also panic disorder, social anxiety disorder and post-traumatic stress disorder.[45]

Statistical Analysis

The data were analyzed with SPSS 26.0 software. Measurements were expressed as mean ± standard deviation (SD) and counts were expressed as frequencies or percentages. Spearman correlation analysis was used to evaluate the relationship between variables. Mediation analysis using Model 4 in PROCESS v4.1. The software Bootstrap method (with 5000 resamples) was used to examine the mediating role of perceived stress in psychological resilience and anxiety.

Results

A total of 606 DR patients were included, with 85.31% being 45 years or older, 57.3% being female, and 54.13% having an education level of elementary school or below. A total of 74.92% of the patients were married, 55.94% were unemployed, 57.92% had an income between 2000 and 5000 RMB, 76.57% were self-paying, 63.03% had a diabetes duration of more than 5 years, 51.65% had generally controlled blood sugar levels, and 78.38% had proliferative DR.

The average score of the CD-RISC-10 is 27.51±8.32, the average score of the PSS-10 is 15.97±6.54, and the average score of the GAD-7 is 5.78±4.08 (Table 1).

Table 1 Characteristics of the Participants (n=606)

Variable	Mean (SD)	N (%)
Age (years)		
<45		89 (14.69)
45–60		194 (32.01)
>60		323 (53.30)
Gender		
Male		259 (42.7)
Female		347 (57.3)
Education		
Primary school and below		328 (54.13)
Junior secondary school		137 (22.61)
High school/technical secondary school		98 (16.17)
College and above		43 (7.09)
Marital status		
Married		454 (74.92)
Unmarried/divorced/widowed		152 (25.08)
Employment status		
Employed		267 (44.05)
Unemployed		339 (55.94)
Monthly income (RMB)		
<2000		157 (25.91)
2000–5000		351 (57.92)
>5000		98 (16.17)
Medical expenses		
Medical insurance		142 (23.43)
Out of pocket		464 (76.57)
Duration of diabetes (years)		
<3year		63(10.40)
3–5year		161(26.57)
>5year		382(63.03)
Blood glucose control		
Good		96 (15.84)
General		313 (51.65)
Bad		197 (32.51)
Types of retinopathy		
Non-proliferative type		131(21.62)
Type of proliferation		475(78.38)
CD-RISC-10 score	27.51±8.32	
PSS-10 score	15.97±6.54	
GAD-7 score	5.78±4.08	

Abbreviation: SD, standard deviation.

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Table 2 Correlations Among Perceived Stress, Psychological Resilience and Anxiety (n=606)

Variables	1	2	3	4	5
1 Psychological resilience	1				
2 Crisis awareness	−0.587**	1			
3 Response Control Capability	−0.453**	0.191**	1		
4 Perceived stress	−0.681**	0.816**	0.695**	1	
5 Anxiety	−0.569**	0.724**	0.221**	0.638**	1

Note: ** $P<0.01$.

Table 3 Examination of the Mediating Effect of Perceived Stress on the Relationship Between Psychological Resilience and Anxiety (n=606)

Model	Model 1		Model 2		Model 3	
Variable	Anxiety		Perceived Stress		Anxiety	
Notation	β	t	β	t	β	t
Psychological resilience	−0.588	−17.861**	−0.653	−21.199**	−0.269	−6.953**
Perceived stress					0.488	12.613**
R^2	0.346		0.427		0.482	
Adjusted R^2	0.345		0.426		0.480	
F	319.005**		449.402**		280.786**	

Note: ** $P<0.01$.

Spearman correlation analysis revealed that perceived stress was positively correlated with psychological resilience ($r=−0.681$, $P<0.01$), whereas anxiety was negatively correlated with perceived stress and psychological resilience ($r=−0.569$, 0.638, $P<0.01$) (Table 2).

In the mediating effect test, in Model 1, the psychological resilience score had a significant effect on the anxiety score ($\beta=−0.588$, $t=−17.861$, $p<0.01$), indicating that the total effect was valid. In Model 2, the psychological resilience score had a significant effect on the perceived stress score ($\beta=−0.653$, $t=−21.199$, $p<0.01$). In Model 3, the psychological resilience score had a significant effect on the anxiety score ($\beta=−0.269$, $t=−6.953$, $p<0.01$), and the perceived stress score also significantly affected the anxiety score ($\beta=0.488$, $t=12.613$, $p<0.01$). Therefore, the mediating role of perceived stress in the model is established and is part of the mediating effect (Table 3 and Figure 1).

The 95% confidence interval (CI) was calculated by bootstrapping for testing with 5000 resamples. The value of the indirect effect is −0.177, with a 95% confidence interval of (−0.219, −0.139). Since both the upper and lower limits do not include 0, the indirect effect is established. These findings indicate that psychological resilience can not only directly
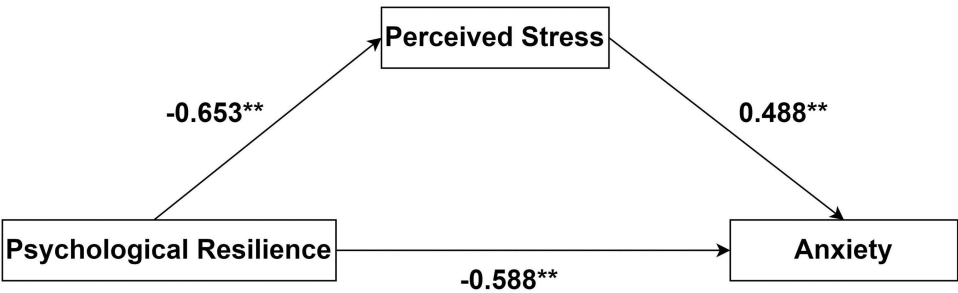

Figure 1 Model of the mediating effect of perceived stress on the relationship between psychological resilience and anxiety.
Note: **$p < 0.01$.

Table 4 Bootstrap Test Results

	Effect	BootSE	BootLLCI	BootULCI	Proportion of the Effect
Total effect	−0.327	0.018	−0.363	−0.291	
Direct effect	−0.150	0.022	−0.192	−0.108	45.87%
Indirect effect	−0.177	0.020	−0.219	−0.139	54.13%

Abbreviations: SE, standard error; CI, 95% confidence interval; LLCI, the lower limit confidence interval; ULCI, the upper limit confidence interval.

predict anxiety but also predict anxiety through the mediating effect of perceived stress. The direct effect 95% CI is (−0.192, −0.108), and the size of the mediating effect is 54.13% (Table 4).

Discussion

This study examines the relationship between psychological resilience and anxiety and further reveals the underlying mechanisms by establishing a mediation model. Our research indicates that psychological resilience is significantly related to anxiety. Additionally, perceived stress partially mediated the impact of psychological resilience on anxiety, with the mediating effect reaching as high as 54.13%.

The survey revealed that the perceived stress levels of DR patients were low to moderate (15.97±6.54), with these results being lower than those of previous research (42.83±10.41).[46] The reason for this difference may be the use of different measurement tools. As a subjective psychological response of an individual to environmental stimuli, perceived stress can reflect the individual's emotional state. Various stimuli in life that threaten the psyche can create perceived stress in an individual, leading to a state of tension and loss of control. As one of the severe complications of diabetes, DR can cause irreversible vision damage and progressive vision decline, leading to significant psychological trauma in patients. This trauma results in strong psychological stress and the maintenance of high levels of perceived stress. Therefore, exploring the key factors affecting the perceived stress of DR patients and taking targeted psychological intervention measures are particularly important for reducing patients' perceived stress and improving their negative emotional states.

The results of this study revealed that the psychological resilience of DR patients was at an intermediate level, and the results were similar to those of Wang Yan lei et al.[47] DR is a progressive disease related to retinal circulation, causing severe damage to patients' vision, visual quality, and retinal vascular structure as the condition progresses, potentially leading to complete blindness. Although surgical methods such as vitrectomy and fundus laser photocoagulation have achieved definite efficacy in the clinical treatment of DR, the recovery time for vision and visual function after surgery is relatively long. Patients need to manage disease progression through prolonged lifelong management, which can easily lead to increased psychological stress due to poor recovery of vision and visual function, the occurrence of complications, and the burden of financial costs.

The overall mental health of DR patients is not optimistic. The survey results revealed that the incidence rate of anxiety in DR patients was 53.63%, similar to the findings of Yu Hua et al (47.42%).[48] Qiu et al reported that the incidence of anxiety in DR patients was 32%.[49] The differences in incidence rates may be due to variations in sample size and regional populations. Moreover, in contrast to the findings of some previous studies, a study by Rees et al that used the Hospital Anxiety and Depression Scale (HADS) revealed no correlation between DR and anxiety, attributing the presence of anxiety alongside DR to a history of anxiety, comorbid conditions, or young age.[24] The reason for these differences may be the different countries of origin of the samples and the measurement tools used. Excessive anxiety not only harms the physical and mental health of DR patients but also causes endocrine disorders in patients, including increased secretion of stress hormones such as glucagon and growth hormone, accelerated glucose metabolism, and increased insulin resistance. These disorders lead to further elevated blood sugar levels, worsening of the condition, reduced quality of life, and even suicidal behaviour.[50,51] In addition, anxiety can cause patients to lack firm beliefs and sufficient confidence to control their blood sugar levels through consistent exercise, dietary changes, and regular medication, further accelerating disease progression.[24]

Research has shown that psychological resilience is closely related to perceived stress and anxiety. DR patients with high psychological resilience perceive less stress than those with low psychological resilience. The incidence of anxiety is lower in DR patients with high psychological resilience than in those with low psychological resilience. This study revealed that psychological resilience is negatively correlated with perceived stress ($r=-0.681$, $P<0.01$), indicating that the higher an individual's psychological resilience is, the lower the individual's perceived stress level, and the higher the quality of life.[52] Research both in China and in other countries has shown that perceived stress affects patients' psychological resilience and that perceived stress is negatively correlated with psychological resilience. However, related studies have focused mainly on populations such as health care workers,[53] haemodialysis patients,[54] and elderly individuals.[55] Studies have shown that both lower perceived stress and higher mental resilience improve the mental health of breast cancer patients.[56] Wang Qi et al reported that perceived stress is a key factor affecting the mental resilience of lung cancer patients.[57] At the same time, Franks et al reported a significant negative correlation between perceived stress and mental resilience in patients with advanced chronic kidney disease.[58] If patients remain in a state of prolonged stress, then it will inevitably affect their quality of life. Therefore, health care professionals, in addition to treating patients' illness, should pay attention to their psychological state, engage in timely and effective communication, understand the sources of their stress, actively assess their perceived stress levels, and take targeted intervention measures to adjust and alleviate their stress.

The relationship between psychological resilience and anxiety is very close. This study revealed that psychological resilience is negatively correlated with anxiety ($r=-0.569$, $P<0.01$), indicating that an increase in psychological resilience can reduce the level of anxiety. This finding is consistent with the results of several previous studies, but the target populations of the studies were not the same.[59,60] Wang Yan lei et al reported that anxiety in hospitalized young diabetes patients was negatively correlated with mental resilience, that is, patients with lower mental resilience were more likely to have negative emotions.[61] Pate et al reported that anxiety is negatively correlated with mental resilience through structural equation model analyses of adult patients with type 1 and type 2 diabetes, and they found that mental resilience is a key factor in managing mental state and diabetes outcomes.[62] Sun et al suggested that by improving the mental resilience of HIV-infected people, anxiety and depression could be reduced.[63] The chronic nature of the disease and the potential for vision loss may lead DR patients to feel helpless and hopeless, resulting in negative perceptions of the disease that increase their psychological burden, reduce their psychological resilience, and consequently lead to heightened anxiety. Patients with lower psychological resilience may lack social support. They might reduce their social activities due to vision problems, leading to increased feelings of loneliness. A lack of social support can make patients feel more helpless when facing anxiety, further reducing their psychological resilience. Therefore, psychological interventions for patients with diabetic retinopathy should focus on enhancing their psychological resilience and coping skills to help them better manage anxiety and improve their quality of life.

The results of this study show that perceived stress is positively correlated with anxiety ($r=0.638$, $P<0.01$). The higher the level of perceived stress is, the more negative emotions such as anxiety the individual experiences. This finding is consistent with the findings of Wiegner et al, who reported that perceived stress is usually accompanied by an increase in anxiety and depressive symptoms.[64] Both Ferszt et al[65] and Yin Lin et al[66] confirmed that there is a significant positive correlation between perceived stress and symptoms of depression and anxiety and that it can positively predict symptoms of depression and anxiety. Various stressful events in life can indeed have a profound impact on our mental state, often making us feel tense and out of control. Patients with diabetic retinopathy often experience a range of negative emotions, including fear, depression, and anxiety, when facing the gradual loss of their vision. Not only do these emotions affect these patients' daily lives, but they can also lead to negative impacts on their disease management. Therefore, studying the important factors that affect the psychological stress of patients with diabetic retinopathy is particularly important. By identifying these factors, health care professionals can develop more targeted psychological interventions. Reducing patients' psychological stress not only helps improve their emotional state but also promotes their overall health. Mental health is closely related to physical health, and a good mental state can enhance patients' self-management abilities and improve their ability to cope with the disease. This can not only help them reduce their psychological burden but also improve their quality of life.

The modelling results of this study show that perceived stress plays a partial mediating role in the relationship between psychological resilience and anxiety. This finding indicates that psychological resilience not only directly affects anxiety but also indirectly influences anxiety through perceived stress. Therefore, for DR patients, although both psychological resilience and perceived stress affect anxiety, the impact of perceived stress on anxiety is more severe. Anxiety can affect the hypothalamus–pituitary–target gland axis, reducing insulin sensitivity or increasing hyperglycaemic hormones such as cortisol, decreasing the body's utilization of glucose, promoting gluconeogenesis, leading to persistent high blood sugar levels, and further worsening the condition of DM patients. Additionally, DM patients suffer from long-term illness and undergo prolonged treatment with insulin and hypoglycaemic drugs. The burden of high medical costs can exacerbate their psychological stress, leading to negative emotions such as depression and anxiety and creating a vicious cycle.[67] The sense of loss of control in the dimension of perceived stress is positively correlated with anxiety and has a significant impact, suggesting that the sense of loss of control over life events may lead to anxiety, tension, and feelings of depression and inferiority. Prolonged suffering from anxiety, tension, and negative depression may affect a patient's ability to control events, further increasing the sense of loss of control. Moreover, tension is positively correlated with anxiety. Tension affects anxiety by influencing an individual's cognitive appraisal and emotional regulation.[68] This phenomenon suggests that attention should be directed towards the perceived stress levels of DR patients. When treating DR patients, health care professionals should pay attention not only to their physical condition but also to their psychological state to provide appropriate psychological support and intervention measures.

Limitations

This study employs a single-centre convenience sampling method, which may introduce selection bias. Although this study provides evidence of the mediating role of perceived stress in the relationship between psychological resilience and anxiety, there are certain limitations. First, owing to the cross-sectional design of this study, causal relationships cannot be established. Second, the relatively small sample size included in this study may limit the generalizability of the findings. Future research can adopt a longitudinal design to better understand the dynamic relationships among perceived stress, psychological resilience, and anxiety and to validate the findings above in larger samples.

Conclusion

Diabetes is a chronic disease that affects multiple organs throughout the body, making comprehensive understanding and integrated management extremely important. DR and its psychological state severely affect the quality of life of diabetes patients. We need comprehensive and accurate epidemiological research, as well as concentrated health efforts, to expand DR screening and reduce the risk of blindness. The present research preliminarily indicates correlations between DR and anxiety, psychological resilience, and perceived stress, providing a new perspective for clinical psychological interventions. However, research on the potential psychological pathogenesis and related risk factors for DR is urgently needed. Research has shown that social support can effectively alleviate negative emotions such as anxiety and depression in patients with DR, and help them cope with stress by providing psychological and material support. Future research needs to further explore how social support can improve patients' mental health by moderating stress or enhancing psychological resilience. In addition, positive coping strategies can help patients better manage stress and reduce the occurrence of anxiety and depression. In the future, we can deeply explore the impact of different application strategies on patients' psychological states and how to cultivate patients' positive coping abilities through psychological intervention.

To sum up, it is crucial to pay attention to psychological assessment and intervention in DR patients. Medical staff need to regularly evaluate, dynamically monitor and promptly discover patients' psychological problems, and actively provide psychological counseling, cognitive behavioral therapy (CBT), music therapy and other interventions to help patients relieve negative emotions. Strengthen family and peer support, popularize DR knowledge to patients and their families, and train patients' self-management skills. Through multidisciplinary collaboration between the medical, psychological and nursing teams, regular consultations are conducted, and treatment plans are jointly formulated and timely adjusted. Pay full attention to the mental health of DR patients, combine the psychological evaluation, intervention and clinical work of DR patients, so as to improve the treatment effect and quality of life, and more in line with the requirements of the biological-psychological-social medical model.

Data Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author upon reasonable request.

Ethical Statement

This study was approved by the Changzhou Third People's Hospital ethics committee (Ethics No: 02A-A20220022). Informed consent was obtained from all participants in the study.

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Disclosure

The authors report no conflicts of interest in this work.

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