

Original Research Article

ASSOCIATION BETWEEN PSYCHOLOGICAL STRESS AND AUTONOMIC DYSFUNCTION IN PATIENTS WITH PARKINSON'S DISEASE: A CROSS-SECTIONAL STUDY

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Received : 31/07/2026
Received in revised form : 01/09/2026
Accepted : 14/09/2026

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DOI: 10.70034/ijmedph.2026.3.838

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 5446-5450

ABSTRACT

Background: Parkinson's disease (PD) is a progressive neurodegenerative disorder associated with several non-motor manifestations, including psychological stress and autonomic dysfunction. The interaction between psychological stress and autonomic regulation may contribute to the overall disease burden. The objective is to assess psychological stress and autonomic functions in patients with Parkinson's disease and determine the association between psychological stress and autonomic dysfunction.

Materials and Methods: A cross-sectional observational study was conducted among 38 patients diagnosed with Parkinson's disease. Psychological stress was assessed using the Perceived Stress Scale-10. Autonomic functions were evaluated using cardiovascular autonomic function tests and heart rate variability parameters, including SDNN, RMSSD, high-frequency power and LF/HF ratio. The association between psychological stress and autonomic parameters was analysed using appropriate statistical methods, with $p < 0.05$ considered statistically significant.

Results: The mean age of participants was 64.2 ± 7.1 years and the mean Perceived Stress Scale score was 19.1 ± 5.4 . Reduced autonomic modulation was observed, with mean SDNN and RMSSD values of 28.7 ± 9.6 ms and 21.4 ± 8.1 ms, respectively. Perceived stress showed significant negative correlations with SDNN ($r = -0.42$, $p = 0.009$), RMSSD ($r = -0.46$, $p = 0.004$) and high-frequency power ($r = -0.39$, $p = 0.016$). A positive association was observed with LF/HF ratio ($r = 0.35$, $p = 0.030$).

Conclusion: Psychological stress was associated with altered autonomic regulation in patients with Parkinson's disease. Assessment of both psychological and autonomic functions may help in recognising the non-motor burden of the disease.

Keywords: Parkinson's disease; psychological stress; autonomic dysfunction; heart rate variability; perceived stress; parasympathetic activity.

INTRODUCTION

Parkinson's disease (PD) is a progressive neurodegenerative disorder traditionally recognised by its characteristic motor manifestations, including bradykinesia, rigidity, resting tremor and postural instability. However, PD is increasingly understood as a multisystem disorder in which non-motor manifestations contribute substantially to disability and quality of life. Psychological disturbances and

autonomic dysfunction are important non-motor components of PD and may occur even in the early stages of the disease.^[1,2] Psychological stress is particularly relevant in patients with PD because the chronic and progressive nature of the disease, functional limitations, uncertainty regarding disease progression and dependence on others can impose considerable emotional burden. Stress may also aggravate motor and non-motor symptoms, creating a potentially self-perpetuating relationship between

psychological distress and disease-related disability. A large survey involving 5000 patients with PD reported higher perceived stress among patients compared with healthy individuals, with greater stress being associated with rumination and poorer quality of life.^[3] An integrated review has also suggested that psychological stress may influence symptom severity through neuroendocrine, inflammatory and other biological mechanisms.^[4] Furthermore, psychological stress and alterations in the hypothalamic-pituitary-adrenal axis have been demonstrated even in patients with newly diagnosed PD.^[5] Anxiety and depression are common psychological manifestations in PD and are frequently under-recognised. Studies have reported substantial proportions of patients experiencing anxiety and depressive symptoms, which may occur independently of motor impairment and adversely affect quality of life.^[6] The close relationship between psychological distress and autonomic symptoms is of particular interest because autonomic dysfunction itself may produce symptoms such as palpitations, dizziness, sweating abnormalities and orthostatic intolerance that can be perceived as anxiety or emotional distress.^[7] Therefore, assessment of psychological stress in PD should ideally be considered along with objective evaluation of autonomic function. Autonomic dysfunction is a frequent non-motor manifestation of PD and may involve cardiovascular, gastrointestinal, urinary, sexual and thermoregulatory systems. Cardiovascular autonomic dysfunction is particularly important because it may manifest as orthostatic hypotension, abnormal blood pressure regulation and impaired heart-rate responses.^[8] Autonomic abnormalities may occur early in PD, sometimes preceding prominent motor manifestations. Studies using cardiovascular reflex tests have demonstrated impaired parasympathetic and sympathetic regulation even among patients with relatively early disease.^[9] The presence of autonomic dysfunction may also increase morbidity and adversely affect daily activities and quality of life. Heart rate variability (HRV) provides a non-invasive method for assessing autonomic modulation of cardiac activity. Reduced HRV, particularly parameters reflecting vagal activity such as the root mean square of successive differences (RMSSD) and high-frequency power, has been reported in patients with PD. A systematic review and meta-analysis involving 47 studies and 2772 participants found evidence of reduced parasympathetic cardiac modulation in PD, with greater impairment suggested in more advanced disease.^[10] Thus, HRV, together with conventional cardiovascular autonomic function tests, can provide objective information regarding autonomic regulation. Psychological stress and autonomic function are physiologically interconnected through central autonomic networks, the hypothalamic-pituitary-adrenal axis and sympathetic-parasympathetic interactions. Mental stress can alter cardiovascular autonomic activity, while autonomic

dysfunction may contribute to physical sensations that increase psychological distress. Interestingly, experimental assessment of sympathetic skin responses before and after mental stress in PD demonstrated that autonomic responses may be influenced by disease characteristics, although a single sympathetic test was insufficient to identify subclinical autonomic dysfunction.^[11] Despite the recognised importance of both psychological stress and autonomic dysfunction in PD, these domains are often assessed separately in routine clinical practice. Simultaneous assessment may provide a better understanding of the interaction between psychological and autonomic components of the disease. Therefore, the present study is proposed to assess psychological stress and autonomic functions in patients with Parkinson's disease, and to explore the relationship between psychological stress and autonomic dysfunction. Such an approach may contribute to a more comprehensive understanding of non-motor manifestations of PD and may help in developing appropriate holistic strategies for patient management

Aim and objectives: To assess psychological stress and autonomic functions in patients with Parkinson's disease using a validated stress scale, cardiovascular autonomic function tests and heart rate variability, and to determine the relationship between psychological stress and autonomic dysfunction, thereby evaluating the interplay between psychological and autonomic manifestations in Parkinson's disease.

MATERIALS AND METHODS

Study design: Cross-sectional observational study.

Study participants: total of 38 participants with Parkinson's disease were recruited for the study from the neurology outpatient department of the study centre. Participants were selected according to predefined inclusion and exclusion criteria. Written informed consent was obtained from all participants before enrolment.

Inclusion criteria

Participants who had a clinical diagnosis of Parkinson's disease and were able to understand and follow the study procedures were included.

Exclusion criteria

Patients with major psychiatric illness, severe cognitive impairment, significant cardiovascular disease, uncontrolled hypertension or diabetes, neurological disorders other than Parkinson's disease, and those receiving medications known to substantially influence autonomic function were excluded. Participants with acute illness or inability to cooperate with the autonomic function tests were also excluded.

Methodology: A detailed history was obtained from each participant, including age, sex, duration of Parkinson's disease, medication history and relevant medical conditions. Clinical details were recorded

using a structured proforma. The severity of Parkinson's disease was assessed using an appropriate validated clinical assessment scale, where applicable. Psychological stress was assessed using the Perceived Stress Scale (PSS-10). The questionnaire consisted of 10 items designed to assess the extent to which individuals perceived their experiences during the preceding period as stressful, unpredictable or difficult to manage. Each item was scored according to the standard scoring procedure, and the total score was calculated. Higher scores indicated a greater perceived level of psychological stress. Autonomic function was evaluated under standardised laboratory conditions. Participants were advised to avoid strenuous physical activity, caffeine and smoking before assessment. The tests were performed after an adequate period of rest, preferably in a quiet room with a comfortable ambient temperature. Baseline heart rate and blood pressure were recorded after the participant had remained supine for a sufficient period. Cardiovascular autonomic function was assessed using standard non-invasive autonomic function tests. Parasympathetic function was evaluated by measuring the heart-rate response to deep breathing and the response to standing from the supine position. Sympathetic function was assessed using the blood-pressure response to sustained handgrip and the orthostatic blood-pressure response. Appropriate intervals were provided between tests to minimise carry-over effects and participant fatigue. Heart rate variability (HRV) was also assessed as a non-invasive measure of cardiac autonomic modulation. Beat-to-beat cardiac intervals were recorded under resting conditions, and HRV parameters were derived from the recorded electrocardiographic signal. Time-domain parameters such as the standard deviation of normal-to-normal intervals and root mean square of successive differences were considered. Frequency-domain measures, where available, included low-frequency and high-frequency components and their

ratio. All measurements were performed using standardised procedures and the same equipment throughout the study. Participants were instructed to remain relaxed and minimise movement and talking during recordings.

Data analysis: The collected data were entered into a structured database and analysed statistically. Continuous variables were expressed as mean and standard deviation or median and interquartile range, depending on data distribution. Categorical variables were expressed as frequencies and percentages. Appropriate statistical tests were used to compare variables and determine the association between psychological stress scores and autonomic function parameters. A p-value <0.05 was considered statistically significant.

RESULTS

Results are presented in table 1 to table 3. Among the 38 participants, the mean age was approximately 64 years, with a higher proportion of males. The mean duration of Parkinson's disease was approximately 5 years. The mean PSS-10 score suggested a moderate level of perceived psychological stress. HRV parameters, particularly SDNN, RMSSD and high-frequency power, indicated reduced cardiac autonomic modulation in the study population. Psychological stress showed a moderate negative correlation with SDNN and RMSSD, suggesting that higher perceived stress was associated with reduced overall and parasympathetic cardiac modulation. High-frequency power also demonstrated a significant negative association with stress scores. In contrast, the LF/HF ratio showed a modest positive correlation with psychological stress, suggesting a relative shift towards sympathetic predominance. These findings indicated an association between psychological stress and altered autonomic regulation among patients with Parkinson's disease.

Table 1: Demographic and clinical characteristics of study participants (n = 38)

Parameter	Mean $\pm$ SD / n (%)
Age (years)	64.2 $\pm$ 7.1
Male participants	25 (65.8%)
Female participants	13 (34.2%)
Duration of Parkinson's disease (years)	5.3 $\pm$ 2.8
Resting heart rate (beats/min)	74.6 $\pm$ 8.2
Systolic blood pressure (mmHg)	132.4 $\pm$ 15.1
Diastolic blood pressure (mmHg)	78.6 $\pm$ 8.7
Perceived Stress Scale score	19.1 $\pm$ 5.4

Table 2: Psychological stress and autonomic function parameters among participants (n = 38)

Parameter	Mean $\pm$ SD
PSS-10 score	19.1 $\pm$ 5.4
SDNN (ms)	28.7 $\pm$ 9.6
RMSSD (ms)	21.4 $\pm$ 8.1
Low-frequency power (ms ²)	285.6 $\pm$ 126.4
High-frequency power (ms ²)	154.8 $\pm$ 82.7
LF/HF ratio	1.96 $\pm$ 0.84
Deep breathing E:I ratio	1.12 $\pm$ 0.09
30:15 ratio	1.06 $\pm$ 0.07
Fall in systolic BP on standing (mmHg)	15.8 $\pm$ 7.4
Rise in diastolic BP during handgrip (mmHg)	12.6 $\pm$ 5.8

Table 3: Association between psychological stress and autonomic function parameters

Autonomic parameter	Correlation with PSS-10 (r)	p-value
SDNN	−0.42	0.009
RMSSD	−0.46	0.004
High-frequency power	−0.39	0.016
LF/HF ratio	0.35	0.030
Deep breathing E:I ratio	−0.29	0.075
30:15 ratio	−0.32	0.049
Systolic BP fall on standing	0.37	0.022
Diastolic BP rise during handgrip	−0.27	0.099

DISCUSSION

The present study assessed psychological stress and autonomic functions among 38 patients with Parkinson's disease (PD). The findings suggested that psychological stress was moderately elevated and that autonomic regulation was altered, as reflected by reduced heart rate variability (HRV) parameters and changes in cardiovascular autonomic responses. An important finding was the inverse relationship between perceived stress and indices such as SDNN, RMSSD and high-frequency power. These observations support the concept that psychological and autonomic disturbances are closely interrelated components of PD rather than independent manifestations. In the present study, the mean Perceived Stress Scale score was approximately 19, indicating a moderate degree of perceived psychological stress. This observation is consistent with previous evidence showing that individuals with PD experience greater perceived stress than healthy individuals. In a large survey involving 5000 patients with PD, higher stress was associated with increased rumination, poorer quality of life and worsening of both motor and non-motor symptoms.^[12] Psychological stress may therefore represent an important determinant of overall disease burden, particularly because the unpredictable nature of motor fluctuations, progressive disability and dependence on medications can contribute to persistent emotional strain.^[13] The biological basis for increased psychological stress in PD is complex. Activation of the hypothalamic-pituitary-adrenal axis, alterations in cortisol secretion and inflammatory responses have been proposed as possible mechanisms linking psychological stress with disease manifestations.^[14] In a study of patients with newly diagnosed PD, approximately 55% demonstrated mild to severe psychological stress, while abnormalities related to the hypothalamic-pituitary-adrenal axis were also identified.^[15] These findings indicate that psychological stress may be present relatively early in the disease and cannot be attributed solely to long-standing disability. The present study also demonstrated evidence of impaired cardiac autonomic modulation. The reduced SDNN and RMSSD values suggested diminished overall and parasympathetic modulation of cardiac activity. This finding is in agreement with a systematic review and meta-analysis involving 47 studies and 2772 participants, which reported significantly reduced RMSSD and high-frequency HRV in patients with

PD.^[16] Another meta-analysis also reported reduced HRV in PD and suggested the presence of sympathovagal imbalance involving both sympathetic and parasympathetic components.^[17] Therefore, the reduced HRV observed in the present study may reflect the involvement of central and peripheral autonomic pathways in PD. The negative correlation between PSS scores and RMSSD in the present study was particularly noteworthy. RMSSD predominantly reflects short-term vagal modulation, and its reduction with increasing psychological stress may indicate diminished parasympathetic adaptability. Psychological stress is normally accompanied by coordinated autonomic adjustments; however, neurodegeneration involving autonomic regulatory networks in PD may limit this adaptive capacity. Consequently, patients experiencing greater psychological stress may exhibit more pronounced autonomic imbalance. This interpretation should, however, be considered cautiously because the present study was cross-sectional and could not establish a causal relationship. The modest positive association observed between psychological stress and the LF/HF ratio further suggested a relative shift in sympathovagal balance with increasing stress. However, interpretation of LF/HF as a direct measure of sympathetic activity remains controversial. Therefore, the present findings should be interpreted as altered cardiac autonomic modulation rather than definitive evidence of isolated sympathetic overactivity. Methodological differences between HRV studies, including recording duration, respiratory control, medication status and disease duration, may also contribute to variations in reported results.^[16,17] Autonomic dysfunction in PD is not restricted to cardiac regulation. Cardiovascular, gastrointestinal, urinary and thermoregulatory abnormalities are frequently reported and may occur even during the early stages of the disease. A longitudinal study found autonomic symptoms in 71% of patients with early PD compared with 30.4% of healthy controls, with autonomic dysfunction increasing during follow-up.^[18] This supports the importance of evaluating autonomic function even when patients do not report prominent autonomic complaints. The relationship between autonomic dysfunction and psychological symptoms is particularly relevant to the present findings. Previous research has shown that autonomic symptoms are associated with anxiety and depression in PD, and some physical symptoms of anxiety may overlap with manifestations of autonomic failure.^[19] More

recently, longitudinal evidence from newly diagnosed patients demonstrated that greater autonomic burden was associated with subsequent increases in anxiety and depression over five years.^[20,21] Thus, the association between psychological stress and autonomic dysfunction observed in the present study may reflect a bidirectional interaction between emotional and physiological regulation. Overall, the findings indicate that assessment of PD should extend beyond motor manifestations to include psychological stress and autonomic function. The simultaneous assessment of perceived stress and objective autonomic measures such as HRV may help identify patients with greater non-motor burden. However, the present study was limited by its relatively small sample size of 38 participants and cross-sectional design. Larger longitudinal studies with healthy controls and adjustment for disease severity, medication, sleep and comorbidities are required to establish the temporal and causal relationship between psychological stress and autonomic dysfunction in PD.

CONCLUSION

Patients with Parkinson's disease demonstrated appreciable psychological stress and impaired autonomic regulation. Higher psychological stress was associated with reduced heart rate variability, particularly parasympathetic indices, suggesting an interaction between psychological and autonomic dysfunction. Assessment of both domains may therefore provide a more comprehensive understanding of non-motor manifestations in Parkinson's disease.

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