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Original Article

Stress-Related Biochemical Markers and Cardiovascular Autonomic Function in Psychologically Distressed Young Adults

Dr. B. Krishna Murthy[1], J Sreemannarayana[2], Ch. SowjanayaLatha[3], Sudhir Modala[4*], BV Sai Prasad[5], IGA Lakshmi Narayana Reddy[6]

[1]Associate Professor, Dept of Pathology, ACSR Medical College, Nellore
[2]Associate Professor, Dept of Biochemistry, CMR institute of medical sciences, Hyderabad
[3,4] Assistant professor, Dept of Physiology, Government Medical College, Ongole
[5]Professor & Head, Dept of Pathology, ACSR Medical college, Nellore
[6]Professor & Head, Dept of Psychiatry, Government Medical College, Ongole

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Corresponding Author:

Dr. Sudhir Modala
msudhir99@gmail.com
Assistant professor, Dept of Physiology, Government Medical College, Ongole.

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ABSTRACT

Background: Psychological distress is increasingly common among young adults and has been implicated in the early development of cardiovascular dysfunction. Stress-induced alterations in autonomic regulation and biochemical markers may represent early indicators of cardiovascular risk. **Objective:** To evaluate the association between psychological distress, cardiovascular autonomic function, and stress-related biochemical markers in young adults. **Methods:** This cross-sectional observational study included apparently healthy young adults aged 18–25 years. Psychological distress was assessed using a validated questionnaire. Cardiovascular autonomic function was evaluated using standard autonomic function tests. Stress-related biochemical markers, including serum Hs CRP andMalondialdehyde (MDA) ,Total Antioxidant Capacity (TAC), were analyzed. Statistical associations between psychological distress scores, autonomic parameters, and biochemical markers were examined. **Results:** Psychologically distressed individuals demonstrated reduced parasympathetic activity, increased sympathetic dominance. Elevated oxidative stressmarkers were significantly associated with autonomic dysfunction. **Conclusion:** Psychological distress in young adults is associated with measurable autonomic and biochemical alterations, indicating early cardiovascular dysregulation. Integrating biochemical markers with autonomic assessment may improve early identification of stress-related cardiovascular risk.

Keywords*: Psychological distress, autonomic nervous system, biochemical markers, , young adults.*

INTRODUCTION:

Psychological distress has become a significant public health concern among young adults due to increasing academic demands, social pressures, and lifestyle changes. Although often overlooked in early adulthood, persistent psychological distress has been linked to adverse cardiovascular outcomes later in life.

The autonomic nervous system (ANS) plays a vital role in cardiovascular regulation through coordinated sympathetic and parasympathetic activity. Alterations in autonomic balance, particularly reduced parasympathetic tone and enhanced sympathetic activity, are recognized as early markers of cardiovascular dysfunction. Reduced heart rate variability (HRV), a non-invasive indicator of autonomic control, has been consistently observed in individuals experiencing psychological distress.(1)

Emerging evidence suggests that psychological distress influences cardiovascular function even in young and apparently healthy populations. Objective markers of sympathetic overactivity and parasympathetic withdrawal have been reported in psychologically distressed young adults, independent of traditional cardiovascular risk factors.(2)

Psychological stress activates the hypothalamic–pituitary–adrenal axis, resulting in increased secretion of cortisol and catecholamines. Chronic activation of these neuroendocrine pathways contributes to sympathetic dominance, endothelial dysfunction, and metabolic disturbances. Large population-based studies have demonstrated a strong association between psychological distress and cardiovascular morbidity and mortality.(3)

In addition to neuroendocrine changes, psychological distress is associated with systemic inflammation and oxidative stress. Elevated inflammatory markers have been linked to impaired autonomic regulation and increased cardiovascular

risk. (4)Furthermore, cholinergic signaling pathways involved in parasympathetic regulation have been implicated in stress-related autonomic modulation.(5)
Despite growing evidence, studies integrating psychological distress, autonomic function, and biochemical markers in young adults remain limited.The aim of this study was to assess cardiovascular autonomic function and selected stress-related biochemical markers in psychologically distressed young adults and compare them with healthy controls.

MATERIALS & METHODS:

Study Design and Participants

After getting clearance from institute ethics committee. Written and informed consent was obtained from all the participants. This cross-sectional observational study included apparently healthy young adults aged 18–25 years.

Exclusion Criteria

Participants with known cardiovascular, endocrine, neurological, or psychiatric disorders and those on medications affecting autonomic function were excluded.

Psychological Distress Assessment

Psychological distress was assessed using a validated self-reported scale such as the Perceived Stress Scale (PSS) .Participants were categorized based on established cutoff values.

Cardiovascular Autonomic Function Tests

Autonomic function testing was conducted in a controlled laboratory environment. Resting heart rate and blood pressure were recorded. Autonomic tests included: Deep breathing test (E:I ratio),Isometric handgrip test (DBP)&Cold pressor test (SBP and DBP).

Biochemical Analysis

Serum was separated and stored in refrigerator to estimate the inflammatory markers and oxidative stress markers. Estimation of Stress-related biomarkers included High-Sensitivity C-Reactive Protein (hs-CRP) and **Malondialdehyde (MDA)Total Antioxidant Capacity (TAC)**werecarriedoutbycommerciallyavailablekits.

Statistical Analysis

Data were analyzed using statistical software. Continuous variables were expressed as mean ± standard deviation. Group comparisons and correlation analyses were performed, with $p < 0.05$ considered statistically significant.

RESULTS:

A total of 100 young adults participated in the study, comprising 50 healthy controls and 50 psychologically distressed individuals. All participants completed psychological assessment, cardiovascular autonomic function testing, and biochemical evaluation**.**Psychological distress was assessed using a validated self-reported questionnaire. Based on established cutoff values, participants were categorized into control (low psychological distress) and psychologically distressed groups.

Table 1. Comparison of Autonomic Parameters Between Groups

Parameter	Controls (n = 50) Mean ± SD	Psychological Distress (n = 50) Mean ± SD	p-value
Resting Heart Rate (bpm)	72 ± 6	80 ± 7	<0.001
SBP (mmHg)	114 ± 8	122 ± 9	<0.01
DBP (mmHg)	74 ± 6	82 ± 7	<0.01
E:I Ratio	1.35 ± 0.10	1.15 ± 0.08	<0.001
DBP – Handgrip (mmHg)	12 ± 3	20 ± 4	<0.001
SBP – Cold Pressor (mmHg)	18 ± 4	28 ± 5	<0.001

Table no -1 shows that psychologically distressed participants demonstrated significant alterations in cardiovascular autonomic function compared to controls. Resting heart rate, systolic blood pressure, and diastolic blood pressure were significantly higher in the distressed group ($p < 0.01$). Heart rate variability analysis revealed reduced parasympathetic activity and increased sympathetic dominance among psychologically distressed participants.

Autonomic reactivity tests showed exaggerated sympathetic responses in psychologically distressed individuals. The increase in diastolic blood pressure during the isometric handgrip test (DBP) and the blood pressure response during the

cold pressor test (SBP and DBP) were significantly greater in the distressed group ($p < 0.001$). The E:I ratio during the deep breathing test was significantly reduced, reflecting impaired parasympathetic reactivity.

Table -2 Comparison of Biochemical Parameters Between Groups

Parameter	Controls (n = 50) Mean ± SD	Psychological Distress (n = 50) Mean ± SD	p-value
hs-CRP (mg/L)	1.2 ± 0.4	3.8 ± 1.2	<0.001
MDA (nmol/mL)	2.1 ± 0.5	4.6 ± 0.9	<0.001
TAC (mmol/L)	1.5 ± 0.3	0.9 ± 0.2	<0.001

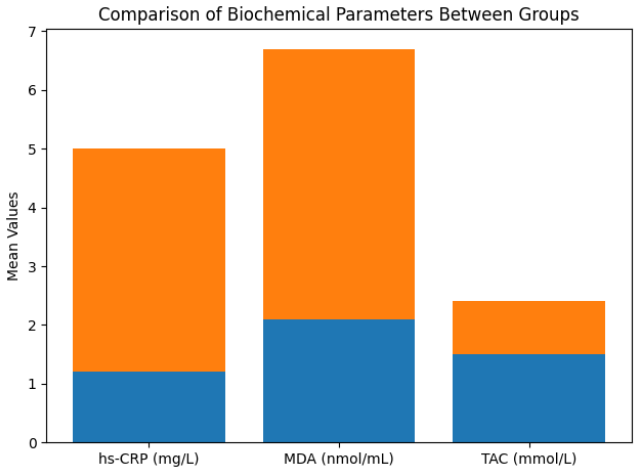
Table no -2 shows that Stress-related biochemical markers differed significantly between the two groups. Psychologically distressed participants exhibited elevated levels of hs-CRP and malondialdehyde (MDA), indicating increased inflammation and oxidative stress ($p < 0.001$). In contrast, total antioxidant capacity (TAC) was significantly lower in the distressed group compared to controls ($p < 0.001$).

Table No-3. Psychological Distress Scores using Perceived Stress Scale – PSSin Study Participants

Parameter	Controls (n = 50) Mean ± SD	Psychological Distress (n = 50) Mean ± SD	p-value
PSS Score	**11.2 ± 3.4**	**26.8 ± 5.6**	**<0.001**

Table no -3 shows that psychologically distressed group demonstrated significantly higher psychological distress scores compared to controls ($p < 0.001$). All participants in the control group scored within the normal/low-stress range, while participants in the distressed group predominantly fell into the moderate to severe stress categories.

Graph no 1shows that **Comparison of biochemical parameters between controls and psychologically distressed young adults.** Values are expressed as mean. Psychologically distressed individuals show elevated hs-CRP and MDA levels with reduced TAC, indicating increased inflammation and oxidative stress.



DISCUSSION:

The present study investigated the association between psychological distress, cardiovascular autonomic function, and stress-related biochemical markers in young adults. The key findings demonstrate that psychologically distressed individuals exhibit altered cardiovascular autonomic responses and significant biochemical imbalances indicative of inflammation and oxidative stress.

Psychologically distressed participants showed significantly higher resting heart rate and blood pressure compared to controls. Elevated resting heart rate and blood pressure are recognized markers of increased sympathetic tone and heightened cardiovascular strain. These findings are consistent with earlier studies reporting that psychological distress is associated with increased cardiovascular activation even in young and otherwise healthy individuals.(6)

Autonomic reactivity tests further revealed exaggerated cardiovascular responses in psychologically distressed young adults. The significantly higher diastolic blood pressure response during the isometric handgrip test and the increased systolic and diastolic blood pressure responses during the cold pressor test indicate heightened sympathetic reactivity to stressors. Such exaggerated responses suggest reduced autonomic adaptability and impaired stress buffering capacity. Similar findings have been reported in studies demonstrating enhanced sympathetic responsiveness in individuals experiencing chronic psychological stress(2).

The deep breathing test results showed a significantly reduced E:I ratio in the psychologically distressed group, reflecting impaired parasympathetic reactivity. Reduced parasympathetic responsiveness has been associated with diminished cardiovascular recovery following stress and may contribute to long-term cardiovascular risk.(7)

In addition to autonomic alterations, significant differences were observed in stress-related biochemical markers. Psychologically distressed individuals exhibited markedly elevated levels of hs-CRP, indicating low-grade systemic inflammation. Chronic inflammation has been proposed as a key biological mechanism linking psychological distress with cardiovascular disease, mediated through endothelial dysfunction and autonomic imbalance(4).

Levels of malondialdehyde, a marker of lipid peroxidation, were significantly higher in the psychologically distressed group, reflecting increased oxidative stress. Oxidative stress has been shown to impair autonomic regulation and vascular function, thereby amplifying cardiovascular risk(3).

Conversely, total antioxidant capacity was significantly reduced in psychologically distressed participants, suggesting compromised antioxidant defense mechanisms. Reduced antioxidant capacity may exacerbate oxidative damage and further disrupt autonomic cardiovascular control. Similar reductions in antioxidant defenses have been reported in stress-related conditions, highlighting the vulnerability of young adults to stress-induced biochemical dysregulation.(8)

Overall, the findings of this study support the concept that psychological distress in young adults is associated with both autonomic dysfunction and biochemical alterations. These changes may act synergistically to increase cardiovascular vulnerability at an early stage of life, emphasizing the importance of early screening and preventive interventions.

CONCLUSION:

The present study demonstrates that psychological distress in young adults is associated with significant alterations in cardiovascular autonomic function and stress-related biochemical markers. Psychologically distressed individuals exhibited increased resting cardiovascular parameters, exaggerated autonomic responses to stress, elevated inflammatory and oxidative stress markers, and reduced antioxidant capacity.

These findings suggest that psychological distress is not merely a mental health concern but is accompanied by measurable physiological and biochemical changes that may predispose young adults to future cardiovascular disease. Early identification of psychological distress and incorporation of stress management strategies may play a crucial role in preventing long-term cardiovascular complications.

Declaration:

Conflicts of interests: The authors declare no conflicts of interest.

Author contribution: All authors have contributed in the manuscript.

Author funding: Nill

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