DOI: 10.7860/JCDR/2026/80998.22826

Original Article

Internal Medicine Section

Association between Patients Presenting with Hypertensive Emergency in MICU and Target End-organ Damage across Different Genders and Age Groups: A Cross-sectional Study

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ABSTRACT

Introduction: Hypertensive emergencies represent life-threatening conditions characterised by acute elevations in blood pressure with evidence of target organ damage. They remain a significant contributor to cardiovascular, neurological, and renal morbidity and mortality, often leading to hospitalisation. Early detection of end-organ involvement is therefore crucial to prevent irreversible damage and improve clinical outcomes.

Aim: To study the association between patients presenting with hypertensive emergency in the Medical Intensive Care Unit (MICU) and target end-organ damage across different genders and age groups.

Materials and Methods: The present cross-sectional study was conducted among adult patients aged 18-80 years presenting with blood pressure ≥180/120 mmHg at R. D. Gardi Medical College and Charitable Hospital, Ujjain, Madhya Pradesh, India, over a period of six months, from June 2024 to November 2024. Demographic data, medical history, and other clinical information, including Electrocardiography (ECG), Two Dimensional (2D) echocardiography, chest X-ray, funduscopic examination, ultrasonography of the abdomen, and neuroimaging studies, were collected. Data were analysed using SPSS software (Statistical Package for the Social Sciences (SPSS) Inc., Chicago, IL), version 29.0.10, with a p-value <0.05 considered statistically significant.

Results: Among the 96 patients, 58 (60%) were male and 38 (40%) were female. The mean {±Standard Deviation (SD)} age was 58.66±12.62 years (range: 18-80 years). A past history of hypertension was present in 58 (60.4%) patients, with a mean duration of 6.51±4.34 years (range: 1-20 years). The most common forms of acute target organ damage were Cerebrovascular Accident (CVA) with retinopathy in 24 patients (25%), followed by Myocardial Infarction (MI) with retinopathy in 15 (15.6%), retinopathy alone in 13 (13.5%), retinopathy with pulmonary oedema and acute heart failure in 11 (11.5%), and MI alone in 10 patients (10.4%).

Conclusion: Hypertensive emergencies were more frequent among middle-aged and elderly males, most of whom had a prior history of hypertension. CVAs and retinopathy were the leading complications, followed by MI either alone or in combination with retinopathy. Strengthening early detection and ensuring strict blood pressure control are essential to reduce the burden of target organ damage in these patients.

Keywords: Cardiovascular diseases, Cerebrovascular disorders, Hypertension, Medical intensive care unit Risk Factors, Retinopathy

INTRODUCTION

Hypertension is one of the most prevalent non-communicable diseases and a major public health concern worldwide. It is associated with several risk factors and complications, including heart failure, coronary heart disease, peripheral vascular disease, stroke, and Chronic Kidney Disease (CKD) [1]. Globally, an estimated one billion individuals are affected by hypertension, and approximately 7.1 million deaths each year are attributable to hypertension and its complications [2]. In India, the Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) study reported a prevalence of 35.5%, underscoring its significance as a national health issue [3].

A hypertensive crisis is a life-threatening condition characterised by an abrupt rise in arterial blood pressure (systolic>180 mmHg and/or diastolic>120 mmHg), which can result in acute target organ damage [4]. Hypertensive crises are classified into two categories: hypertensive emergencies, in which there is evidence of end-organ damage (e.g., hypertensive encephalopathy, acute left ventricular failure, aortic dissection, subarachnoid haemorrhage, or ischemic stroke), and hypertensive urgencies, where there is no apparent end-organ damage [5]. A particularly severe form of hypertensive emergency is malignant hypertension, characterised by markedly elevated blood pressure accompanied by retinal changes such as haemorrhages, exudates, or papilloedema, and often associated with acute renal, cardiac, or cerebral dysfunction [6].

Although hypertensive emergencies can cause significant morbidity and potentially fatal complications, they are relatively rare, affecting only 1-3% of hypertensive patients during their lifetime [6]. For example, Dhadke SV et al., reported an incidence of 1.22% in an Intensive Care Unit (ICU) in India [7]. Despite their low prevalence, hospitalisations for hypertensive emergencies have been increasing since 2000, likely due to improved awareness, recognition, and diagnostic practices. Nevertheless, mortality remains comparatively low, with in-hospital mortality around 2.5% and one and ten-year survival rates exceeding 90% and 70%, respectively [6].

The most common precipitating factors for hypertensive crises include poor adherence to treatment, inappropriate therapy, renal disease, endocrine disorders, pregnancy, and substance abuse, notably cocaine and methamphetamine [8]. Among these precipitants, non-adherence to antihypertensive therapy is the most common in Indian settings. A tertiary-care ICU study reported that 26% of patients with hypertensive emergency had discontinued their medications [9], and a meta-analysis of Indian cohorts estimated non-adherence in approximately 48% of hypertensive patients [10]. Renal causes (approximately 25%), particularly renovascular and parenchymal disease, are also frequent [11],

while reports of malignant hypertension suggest that around 35% are attributable to secondary aetiologies [12]. Endocrine disorders, pregnancy, and substance abuse contribute less commonly. These figures, though largely derived from single-centre studies, highlight non-adherence and renal pathology as dominant triggers of hypertensive crises in India.

Reducing the morbidity and mortality associated with hypertension requires early diagnosis, adoption of lifestyle modifications, and effective antihypertensive therapy [13]. Importantly, early detection of hypertensive end-organ damage can prevent or reverse disease progression if treatment is initiated at a reversible stage. The diagnosis of target organ damage is therefore of decisive importance in hypertensive emergencies [14]. The present study aimed to evaluate the relationship between patients presenting with hypertensive emergency in the MICU and target end-organ damage across different genders and age groups.

The primary objective was to assess the association between hypertensive emergencies and target end-organ damage among patients admitted to the MICU. The secondary objective was to evaluate differences in the pattern and severity of end-organ damage across gender and age groups.

MATERIALS AND METHODS

The present cross-sectional study was conducted in the Outpatient Department of General Medicine at R.D. Gardi Medical College and Charitable Hospital, Ujjain, Madhya Pradesh, India, over a period of six months, from June 2024 to November 2024. Ethical approval was obtained from the Institutional Ethics Committee, R.D. Gardi Medical College, Ujjain (Reference No. IEC-RDGMC/25/2022), and written informed consent was obtained from all participants prior to enrolment.

Sample size calculation: The minimum sample size was estimated to be 96 patients based on a difference in proportions, with a 95% confidence level, 80% power, a proportion in the control group (p_0) of 65%, and a proportion in the case group (p_1) of 30% [15].

Inclusion and Exclusion criteria: The inclusion criteria comprised adults aged 18-80 years presenting with a blood pressure ≥180/120 mmHg. The exclusion criteria included patients who did not provide consent, pregnant women, patients aged >80 years, known cases of CKD, and patients with coronary artery disease, valvular heart disease, malignancy, autoimmune disorders, or connective tissue disorders.

Study Procedure

A total of 100 patients were screened for the study, of whom four were excluded due to CKD, advanced age, or non-consent, resulting in 96 patients included in the final analysis. The rationale for excluding patients with CKD was to avoid confounding, as pre-existing CKD is itself a significant determinant of renal end-organ damage in hypertensive emergencies and could bias the assessment of acute hypertensive effects.

A structured proforma was used to collect demographic data, medical history, clinical examination findings, and laboratory investigation results. Clinical investigations included ECG, two-dimensional echocardiography, chest X-ray, funduscopic examination, ultrasonography of the abdomen, and neuroimaging studies.

Hypertensive retinopathy was graded according to the Keith-Wagener-Barker classification (Grades 1-4) [16]. Echocardiographic findings, including left ventricular dysfunction and regional wall motion abnormalities, were assessed in accordance with the American Society of Echocardiography guidelines [17]. Abdominal ultrasonography was performed to evaluate organ changes such as mild hepatomegaly (liver span>15 cm) and mild prostatomegaly (prostate volume>30 mL) [18,19]. These grading systems enabled a standardised assessment of hypertensive end-organ damage and correlation with demographic and clinical variables.

The primary outcome was to assess the association between hypertensive emergencies and target end-organ damage among patients admitted to the MICU. The secondary outcome was to evaluate differences in the pattern and severity of end-organ damage across gender and age groups.

STATISTICAL ANALYSIS

Statistical analysis was performed using SPSS software (version 29.0.10; SPSS Inc., Chicago, IL). Descriptive statistics, including mean±SD for continuous variables and frequency and percentage for categorical variables, were used. The independent-sample t-test was employed to compare continuous variables such as age, duration of hypertension, haemoglobin, white blood cell count, platelet count, cardiac markers, renal function tests, and electrolytes according to gender and past history of hypertension. Categorical variables were analysed using the likelihood ratio test. One-way Analysis of Variance (ANOVA) was applied to compare the duration of hypertension across different types of end-organ damage. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 96 patients with hypertensive emergencies were included in the present study, of whom 58 (60.4%) were male and 38 (40%) were female, indicating a male predominance. The mean (±SD) age of the study population was 58.66±12.62 years (range: 18-80 years), and the mean (±SD) duration of hypertension was 6.51±4.34 years. More than half of the participants, 58 (60.4%), had a past history of hypertension [Table/Fig-1].

Variables		n (%)
Age groups (Years)	<30	2 (2.1)
	30-40	5 (5.2)
	41-50	17 (17.7)
	51-60	34 (35.4)
	61-70	21 (21.9)
	71-80	17 (17.7)
Gender	Male	58 (60.4)
	Female	38 (39.6)
Past history of hypertension	Yes	58 (60.4)
	No	38 (39.6)

[Table/Fig-1]: Demographic characteristics of study subjects.

The most common presenting symptom was headache, reported by 41 patients (42.7%), followed by nausea or vomiting in 31 (32.3%), chest pain or discomfort in 30 (31.3%), perspiration in 26 (27.1%), and dizziness in 20 (20.8%). Less frequent symptoms included shortness of breath, palpitations, visual disturbances, and loss of consciousness [Table/Fig-2].

Symptoms	n (%)
Headache	41 (42.7)
Perspiration	26 (27.1)
Chest pain/Discomfort	30 (31.3)
Heart palpitations	12 (12.5)
Shortness of breath	15 (15.6)
Nausea/Vomiting	31 (32.3)
Loss of consciousness	10 (10.4)
Right/left side body weakness	16 (16.7)
Dizziness	20 (20.8)
Vision problem	5 (5.2)
Other symptoms	12 (12.5)

[Table/Fig-2]: Distribution of symptoms among study subjects.

Clinical parameters are summarised in [Table/Fig-3]. The mean haemoglobin level was 11.12 g/dL, the mean serum creatinine level was 2.03 mg/dL, and the mean troponin level was 6955.18 ng/mL.

Parameters	Mean (±SD)
Haemoglobin (g/dL)	11.12 (2.44)
Total WBC count (cells/cu.mm)	11605.04 (3496.74)
Platelets (cells/µL)	220125 (94940.9)
Urea (mg/dL)	60.63 (48.87)
Creatinine (mg/dL)	2.03 (2.62)
Sodium (mEq/L)	134.10 (13.62)
Potassium (mEq/L)	4.91 (4.92)
Troponin level (ng/mL)	6955.18 (20364.89)
CKMB (U/L)	60.34 (136.50)

[Table/Fig-3]: Distribution of clinical investigations among study subjects.
CKMB: Creatine kinase-myocardial band test

On further investigation, ECG findings were normal in 37 patients (38.5%), while 29 (30.2%) showed Left Ventricular Hypertrophy (LVH) and 27 (28.1%) had ST-T wave changes. Two-dimensional echocardiography revealed normal findings in 46 patients (47.9%), whereas 20 (20.8%) demonstrated regional wall motion abnormalities and 14 (14.6%) had left ventricular dysfunction. Chest X-ray showed cardiomegaly in 19 patients (19.8%) and pulmonary oedema in 8 (8.3%).

Funduscopic examination revealed Grade 2 hypertensive retinopathy in 28 patients (29.2%) and Grade 3 retinopathy in 26 (27.1%), while 8 patients (8.3%) presented with Grade 4 retinopathy. Neuroimaging demonstrated acute infarcts in 28 patients (29.2%), with smaller proportions showing intraparenchymal or subarachnoid haemorrhage [Table/Fig-4].

Investigation	n (%)
ECG	
Normal	37 (38.5)
ST/T changes	27 (28.1)
Left Ventricular Hypertrophy (LVH)	29 (30.2)
ST/T changes with LVH	3 (3.1)
2D Echocardiography	
Normal	46 (47.9)
Left ventricular dysfunction (LVD)	14 (14.6)
Regional wall motion abnormality	20 (20.8)
Left ventricular hypertrophy (LVH)	16 (16.7)
USG W/A	
Grade 1 Fatty Liver	6 (6.3)
Grade 2 Fatty Liver	1 (1)
Renal Cyst	4 (4.2)
Mild Hepatomegaly	3 (3.1)
Mild Prostomegaly	1 (1)
Normal	81 (84.4)
Chest X-ray	
Cardiomegaly	19 (19.8)
Pulmonary oedema	8 (8.3)
Bronchopneumonia	3 (3.1)
Normal	66 (68.8)
Fundus	
Grade 1 Hypertensive retinopathy	9 (9.4)
Grade 2 Hypertensive retinopathy	28 (29.2)
Grade 3 Hypertensive retinopathy	26 (27.1)
Grade 4 Hypertensive retinopathy	8 (8.3)
Normal	25 (26)
Neuroimaging	
Acute infarct	28 (29.2)
Intraparenchymal Haemorrhage	3 (3.1)
Sub-Arachnoid Haemorrhage	8 (8.3)
Normal	57 (59.4)

[Table/Fig-4]: Imaging Investigations and observations of study subjects.

The most common acute target organ damage among patients was CVA with retinopathy in 24 patients (25%), followed by MI with retinopathy in 15 (15.6%), retinopathy alone in 13 (13.5%), retinopathy with pulmonary oedema and acute heart failure in 11 (11.5%), and MI alone in 10 patients (10.4%) [Table/Fig-5].

End organ damage	n (%)
Myocardial Infarction (MI)	10 (10.4)
MI + Retinopathy	15 (15.6)
Cerebrovascular Accident (CVA)	8 (8.3)
CVA + Retinopathy	24 (25)
Sub-Arachnoid haemorrhage + Retinopathy	5 (5.2)
Acute Heart Failure + Retinopathy	8 (8.3)
Retinopathy	13 (13.5)
Retinopathy + Pulmonary Oedema + Acute Heart Failure	11 (11.5)
Retinopathy + Hypertensive Encephalopathy	2 (2.1)

[Table/Fig-5]: Distribution of study subjects according to end-organ damage.

When analysed by age group, CVA with retinopathy was most frequent among patients aged 71-80 years (41.2%) and 41-50 years (29.4%), whereas MI with retinopathy predominated in the 51-60 years age group (26.5%). Retinopathy with pulmonary oedema and acute heart failure was observed only in patients aged <30 years [Table/Fig-6]. Comparison across age groups revealed no statistically significant difference (p>0.05).

End organ damage	Age groups						Likelihood ratio	p-value
	<30	30-40	41-50	51-60	61-70	71-80		
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)		
Myocardial Infarction (MI)	0 (0)	1 (20)	1 (5.9)	2 (5.9)	4 (19)	2 (11.8)	48.61	0.165
MI + Retinopathy	0 (0)	1 (20)	3 (17.6)	9 (26.5)	2 (9.5)	0 (0)		
Cerebrovascular accident (CVA)	0 (0)	0 (0)	3 (17.6)	1 (2.9)	1 (4.8)	3 (17.6)		
CVA + Retinopathy	0 (0)	1 (20)	5 (29.4)	6 (17.6)	5 (23.8)	7 (41.2)		
Sub-Arachnoid haemorrhage + Retinopathy	0 (0)	0 (0)	0 (0)	3 (8.8)	2 (9.5)	0 (0)		
Acute Heart Failure + Retinopathy	0 (0)	0 (0)	1 (5.9)	4 (11.8)	2 (9.5)	1 (5.9)		
Retinopathy	0 (0)	0 (0)	1 (5.9)	7 (20.6)	4 (19)	1 (5.9)		
Retinopathy + Pulmonary Oedema + Acute Heart Failure	2 (100)	1 (20)	3 (17.6)	2 (5.9)	1 (4.8)	2 (11.8)		
Retinopathy + Hypertensive Encephalopathy	0 (0)	1 (20)	0 (0)	0 (0)	0 (0)	1 (5.9)		

[Table/Fig-6]: Comparison of end-organ damage according to age groups (Likelihood ratio test)

When analysed by gender, CVA with retinopathy occurred in 22.4% of males and 28.9% of females, whereas MI with retinopathy was more frequent among males (19%) than females (10.5%). However,

the distribution of target organ damage did not differ significantly between genders (p>0.05) [Table/Fig-7].

End organ damage	Gender		Likelihood ratio	p-value
	Male, n (%)	Female, n (%)		
Myocardial Infarction (MI)	5 (8.6)	5 (13.2)	3.07	0.930
MI + Retinopathy	11 (19)	4 (10.5)		
Cerebrovascular Accident (CVA)	6 (10.3)	2 (5.3)		
CVA + Retinopathy	13 (22.4)	11 (28.9)		
Sub-Arachnoid haemorrhage + Retinopathy	3 (5.2)	2 (5.3)		
Acute Heart Failure + Retinopathy	5 (8.6)	3 (7.9)		
Retinopathy	7 (12.1)	6 (15.8)		
Retinopathy + Pulmonary Oedema + Acute Heart Failure	7 (12.1)	4 (10.5)		
Retinopathy + Hypertensive Encephalopathy	1 (1.7)	1 (2.6)		

[Table/Fig-7]: Comparison of end-organ damage according to gender (Likelihood ratio test).

The duration of hypertension did not show any statistically significant association with the type of end-organ damage (p>0.05). The mean duration of hypertension ranged from 3.9 years in patients with acute heart failure with retinopathy to 8.4 years in those with retinopathy associated with pulmonary oedema and acute heart failure [Table/Fig-8].

End organ damage	Duration of hypertension Mean (±SD)	"F"	p-value
Myocardial Infarction (MI)	5.71 (3.64)	0.90	0.523
MI + Retinopathy	8.13 (3.91)		
Cerebrovascular accident (CVA)	6 (1.73)		
CVA + Retinopathy	7.25 (4.93)		
Sub-Arachnoid haemorrhage + Retinopathy	7.67 (2.52)		
Acute Heart Failure + Retinopathy	3.86 (4.22)		
Retinopathy	6.26 (4.47)		
Retinopathy + Pulmonary Oedema + Acute Heart Failure	8.40 (6.07)		
Retinopathy + Hypertensive Encephalopathy	2.50 (0.71)		

[Table/Fig-8]: Comparison of the duration of hypertension according to end-organ damage.
("F" = One-way ANOVA)

Overall, these findings highlight cerebrovascular and retinal involvement as the most common forms of target organ damage in patients presenting with hypertensive emergencies, with no significant variation across gender, age, or duration of hypertension.

DISCUSSION

In the present study, LVH with retinopathy were the most frequent form of target organ damage (25%), followed by MI with retinopathy (15.6%) and retinopathy alone (13.5%). These findings underscore the predominance of neurological and retinal involvement in hypertensive emergencies. Similar findings have been reported in studies from East and Southeast Asia, where stroke is consistently identified as the most common target organ damage in hypertensive emergencies.

In Indonesia, 57.6% of patients with hypertensive emergencies experienced stroke as the primary organ involvement. In Thailand, the prevalence of stroke among hypertensive emergency patients was 49.8%, while Korean nationwide registry data reported stroke in 43% of cases [20]. Collectively, these studies highlight a regional pattern in which cerebrovascular complications predominate among patients presenting with hypertensive emergencies. These differences may reflect variations in demographic characteristics, lifestyle factors, and access to healthcare across populations.

The prevalence of hypertensive emergencies has been shown to vary geographically, ranging from 0.1-1.5% in Asia to 0.6-3.2% in the United States [21,22]. Such disparities may be attributable to differences in population demographics, co-morbidity burden, healthcare systems, and diagnostic practices. Given the limited availability of Indian data, the present study contributes valuable evidence by characterising the profile of hypertensive emergencies in a MICU setting.

In the present study, males constituted 60% of patients presenting with hypertensive emergencies, demonstrating a male predominance. This observation is consistent with previous studies reporting a higher incidence of hypertensive crises among males [23,24]. Although behavioural risk factors and healthcare utilisation patterns were not evaluated in the present study, earlier research suggests that biological sex differences, along with variations in health-seeking behaviour, may contribute to gender disparities in hypertension-related complications. Women are often more proactive in accessing healthcare services and reporting symptoms, which may offer some protection against severe hypertensive episodes [25].

The mean age of the study population was 58.66 years, consistent with prior reports indicating that hypertensive emergencies predominantly affect middle-aged and elderly individuals [25,26]. Findings from the Framingham Heart Study further support this observation, demonstrating that the risk of coronary artery disease increases with age in men and that age-related vascular stiffening contributes significantly to the higher prevalence of hypertension among older adults [26,27].

More than half of the patients in the present study had a prior history of hypertension, with a mean duration of 6.5 years. This finding is consistent with other studies in which non-compliance with antihypertensive therapy has been identified as a major risk factor for hypertensive emergencies [28]. The presenting symptoms in this cohort were predominantly headache, nausea or vomiting, chest pain, perspiration, and dizziness. These observations are comparable to those reported by Ahmed Hashmi SF et al., who identified neurological deficits, dyspnoea, and chest pain as common clinical manifestations [29]. These findings emphasise that, although symptom patterns may vary, patients with severe hypertension should always be evaluated for underlying target organ damage, even when symptoms appear nonspecific.

Regarding cardiac involvement, the present study demonstrated electrocardiographic evidence of LVH in 30.2% of patients and echocardiographic LVH in 16.7%. Prakash D et al., reported slightly different findings, with ECG detecting LVH in 20.7% and echocardiography in 29.3% of patients [30]. This variation suggests differences in sensitivity and diagnostic yield between these modalities, underscoring the importance of a multimodal approach to cardiac assessment.

Furthermore, 29.2% and 27.1% of patients in this cohort exhibited Grade 2 and Grade 3 hypertensive retinopathy, respectively. Similar findings have been reported in previous studies, which demonstrated that microvascular injury resulting from sustained elevations in blood pressure leads to retinal arteriolar narrowing and haemorrhages [30,31]. In addition, albuminuria was observed in 35.4% of patients in the present study, comparable to the 44.7% reported by Prakash D et al., [30], highlighting the role of renal microvascular injury in hypertensive end-organ damage.

Neuroimaging in the present study revealed acute infarcts as the most common cerebral finding, consistent with previous evidence

indicating that ischemic stroke is more prevalent than haemorrhagic stroke among patients with hypertensive emergencies [32,33]. Stroke has also been reported as the leading cause of hypertensive emergencies in Asian populations, affecting nearly 40% of patients presenting to emergency departments [32].

Limitation(s)

The present study was limited by its single-centre design and the exclusion of patients with CKD, which may restrict the generalisability of the findings. Additionally, the cross-sectional nature of the present study precluded follow-up assessment of long-term outcomes. Future research should include multicentre studies with larger sample sizes, incorporate patients with coexisting chronic illnesses such as CKD, and adopt longitudinal designs to evaluate both short- and long-term prognoses.

CONCLUSION(S)

The present study demonstrates that hypertensive emergencies are more common among middle-aged and elderly males, with cerebrovascular accidents and hypertensive retinopathy emerging as the most frequent forms of target organ damage. Although the duration of hypertension did not show a significant association with organ involvement, the high prevalence of neurological and retinal complications underscores the importance of early detection and strict blood pressure control. Strengthening patient adherence to antihypertensive therapy, routine monitoring for end-organ damage, and timely clinical interventions are essential to reduce the morbidity and mortality associated with hypertensive emergencies.

Acknowledgement

The authors would like to express their sincere appreciation to all colleagues who contributed to the successful completion of this study.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Jun 05, 2025
- Manual Googling: Oct 29, 2025
- iThenticate Software: Oct 31, 2025 (2%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Jun 04, 2025**
Date of Peer Review: **Sep 25, 2025**
Date of Acceptance: **Nov 03, 2025**
Date of Publishing: **Apr 01, 2026**