

## Original Research Article

# HYPERTENSION CONTROL, MEDICATION ADHERENCE, AND LIFESTYLE PRACTICES AMONG PATIENTS WITH SYSTEMIC HYPERTENSION: A CROSS-SECTIONAL OBSERVATIONAL STUDY

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### ABSTRACT

**Background:** Hypertension control remains suboptimal worldwide, largely due to poor medication adherence and inadequate lifestyle modification.

**Materials and Methods:** A cross-sectional study was conducted among 588 hypertensive adults on treatment for  $\geq 6$  months at a rural Mission hospital in Kerala (September 2024–August 2025). Data on medication adherence and lifestyle practices were collected using a semi-structured questionnaire. Blood pressure (BP) was measured using a standardized protocol.

**Results:** Only 25% of patients achieved BP control. Good medication adherence was significantly higher in controlled patients (90.5% vs. 58.7%;  $p < 0.001$ ). Meat substitution was associated with better BP control ( $p = 0.023$ ). Interestingly, self-reported salt restriction and higher vegetable intake were more frequently observed among patients with uncontrolled hypertension than among those with controlled blood pressure ( $p < 0.05$ ). Physical activity was suboptimal across both groups. BP self-monitoring was universal among controlled patients (100% vs. 84.1%;  $p = 0.001$ ). Comorbidities, particularly diabetes (46.8%), were common.

**Conclusion:** BP control remains inadequate. Medication adherence is the strongest modifiable determinant, while inconsistencies in self-reported lifestyle practices highlight the need for objective reproducible measurements. Strengthening adherence-focused strategies is essential to improve outcomes.

**Keywords:** Hypertension, Blood pressure control, Medication adherence, Lifestyle practices.

## INTRODUCTION

Hypertension is a major modifiable risk factor for cardiovascular diseases (CVD), making it one of the significant contributors of premature death and morbidity.<sup>[1]</sup> It is often asymptomatic in its early stages, which contributes to delays in diagnosis. One of the main reasons for inadequate control of blood pressure is the inability to adhere to medications and lifestyle modifications. Only 8-9% of hypertensive patients had their blood pressure under control as per the 2019-21 India National Family Health Survey (NFHS-5).<sup>[2,3]</sup> Continued care and frequent monitoring are required for effective treatment and control. Hypertension is adequately controlled only

in less than one third of affected individuals even in developed countries.<sup>[4]</sup>

It is important to differentiate between adherence and compliance, with the latter being viewed by many, to have a negative connotation. Compliance is when the patient obeys the health-care provider's recommendation passively and is subservient to prescriber.<sup>[5]</sup> In contrast, according to World Health Organization (WHO), adherence is the extent to which a person's behaviour- adhering to prescribed medications, complying with dietary advice, and implementing recommended lifestyle changes, corresponds with agreed recommendations from a health-care provider.<sup>[6]</sup> Along the same lines, there is limited evidence in the literature to support the

arbitrary cutoff of 80% or more intake of prescribed medication as good adherence. In a perfect world where all patients take their medication regularly, the proportion of patients who consistently take medication would be 100%. But longitudinal database study of 21 clinical trials of 4783 participants with hypertension show that the persistence declines over time and by the end of one year, almost half of the patients stop taking their medication.<sup>[7]</sup> Early discontinuation of treatment and suboptimal daily execution of the prescribed regimen are the most common causes of poor adherence.

To comprehensively manage hypertension, we require both pharmacological treatment and lifestyle modification. Self-care has come to be recognised as an all-important determinant for achieving optimal BP control at the individual level. According to the World Health Organisation (WHO), self-care is defined as “the ability of individuals, families and communities to promote health, prevent disease, maintain health and to cope with illness and disability with or without the support of a healthcare provider”.<sup>[8]</sup> Further, hypertension guidelines advise self-care activities such as self-monitoring of BP, reduction of dietary sodium intake, increase in physical activity, limiting alcohol intake, adoption of a dietary approach to stop hypertension (DASH) diet plan, weight management and abstinence from tobacco as lifestyle modification strategies to achieve optimal BP control.<sup>[9]</sup> However, research in the areas of self-care practices and BP control are limited. Hence, we aimed to assess hypertension self-care practices and its impact on BP control among adult individuals with hypertension in a rural healthcare setting in Kerala.

This study evaluates the extent of blood pressure control and the patterns of medication adherence among individuals with systemic hypertension in a rural region of South Kerala. It also attempts to determine the lifestyle changes adopted by the hypertensive population and their limitations in controlling hypertension.

## MATERIALS AND METHODS

A cross-sectional observational study was conducted at MTMM Mission Hospital, a rural health unit in Bharanicavu, Sasthamcotta, Kollam, over a 12-month period from September 2024 to August 2025. All adults above the age of 18 who were on treatment for Hypertension for more than 6 months were included in the study. Pregnant ladies, patients who were on indigenous medications, and patients who discontinued treatment due to medical reasons were excluded from the study.

**Data Collection:** A semi-structured questionnaire was used to collect data by interviewing each participant. The collected data included demographic characteristics, duration of hypertension, antihypertensive medications used and

lifestyle modifications adopted by the participants. Blood pressure was recorded in mm of Hg thrice for a person, 1-2 minutes interval on the right arm, and the average value was taken. Digital sphygmomanometer (Biolight S12 Multipara Monitor) was used to measure blood pressure.

**Definition:** Uncontrolled Hypertension defined as systolic BP >130mm of Hg and/or diastolic BP >80mm of Hg. (ACC/AHA 2017)<sup>[10]</sup>

### Statistical Analysis

Data collected were entered in Microsoft Excel and analysed using Statistical Package for the Social Sciences (SPSS) version 25. Continuous variables such as age and duration of hypertension were expressed as mean  $\pm$  standard deviation, while categorical variables such as sex, medication adherence, comorbidities, lifestyle practices, and blood pressure control status were presented as frequencies and percentages. The prevalence of blood pressure control, medication adherence, and lifestyle practices were calculated using descriptive statistics. Inferential statistics were applied to assess associations between independent variables and blood pressure control status. The Chi-square test was used to determine associations between categorical variables (such as sex, adherence levels, lifestyle factors, smoking, alcohol use, and monitoring practices) and blood pressure control. Independent sample t-test was applied to compare the means of continuous variables between controlled and uncontrolled blood pressure groups. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

Of the 588 hypertensive patients, 252 patients (42.9%) were male. An average age of the subjects was 63.11 $\pm$ 13.28. Among the patients, majority (336, 57.1%) were diagnosed to have hypertension during a screening examination, 126 (21.3%) patients presented with a hypertensive emergency (Acute coronary syndrome or Pulmonary edema or Stroke). 70 (11.9%) patients were diagnosed due to persistently elevated blood pressure and 56 patients were detected to have hypertension during a pre-operative evaluation. Duration of hypertension was found to be <5 years in 271 patients (46.1%), 5-10 years in 199 patients (33.8%), 10-15 years in 85 patients (14.5%) and >15 years in 33 patients (5.6%). With respect to antihypertensive therapy, 346 patients (58.8%) were on RAAS inhibitors, 461 (78.4%) on calcium channel blockers, 148 (25.2%) on beta-blockers, 80 (13.6%) on alpha-2 agonists, and 97 (16.5%) on diuretics. Out of the 588 hypertensive patients, 275 patients (46.8%) had Diabetes Mellitus, 157 patients (26.7%) had coronary artery disease, 70 patients (11.9%) had history of a stroke, 198 patients (33.7%) had dyslipidemia, 38 patients (6.5%) had chronic kidney

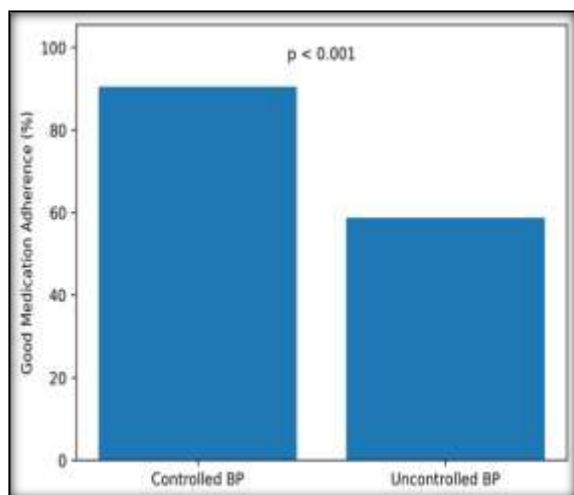
disease, and 72 patients (12.2%) had hypothyroidism.

Blood pressure control was achieved in 147 patients (25%) out of the total study population (n= 588), while 441 (75%) remained uncontrolled. Among those with controlled blood pressure, 61 (41.4%)

were male and 86 (58.6%) were female. Medication adherence was notably higher in the group with good BP control, with 133 patients (90.5%) showing good adherence; in contrast, only 259 (58.7%) with uncontrolled BP had good adherence.

**Table 1: Baseline Demographic and Clinical Characteristics of Study Population (n=588).**

Variable	Category	n (%)
Age(Y)	63.11 ± 13.28	
Gender	M/F; (%)	252/336; (42.9%/57.1%)
Method of diagnosis	Hypertensive emergency – MI	42 (7.1%)
	Hypertensive emergency – PE	42 (7.1%)
	Hypertensive emergency – Stroke	42 (7.1%)
	Persistent hypertension	70 (11.9%)
	Pre-operative evaluation	56 (9.5%)
	Routine checkup	336 (57.1%)
Duration of hypertension	<5 years	271 (46.1%)
	5–10 years	199 (33.8%)
	10–15 years	85 (14.5%)
	>15 years	33 (5.6%)
Medication Class	RAS inhibitors (RASi)	346 (58.8%)
	Calcium channel blockers (CCB)	461 (78.4%)
	Beta-blockers (BB)	148 (25.2%)
	Alpha 2 agonists (A2A)	80 (13.6%)
	Diuretics	97 (16.5%)
Comorbidity	Diabetes mellitus	275 (46.8%)
	Coronary artery disease	157 (26.7%)
	Cerebrovascular accident	70 (11.9%)
	Dyslipidemia	198 (33.7%)
	Chronic kidney disease	38 (6.5%)
	Hypothyroidism	72 (12.2%)



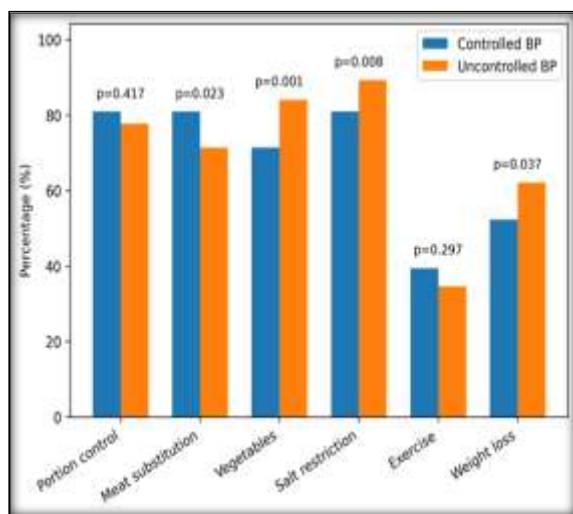
**Figure 1 Comparison of Medication adherence between controlled and uncontrolled hypertensives**

Portion control—limiting meal sizes to reduce caloric intake—was practiced by a similar proportion in both groups: 119 patients (80.9%) with controlled BP and 343 (77.7%) with uncontrolled BP, with no statistical difference ( $p=0.417$ ). Meat substitution, such as replacing red meat with leaner proteins like fish or plant-based options, was more prevalent among those with controlled BP (119; 80.9%) than uncontrolled (315; 71.4%;  $p=0.023$ ). Only 71.4% of participants with controlled BP (n = 105) reported vegetable inclusion, whereas this practice was significantly

more common among those with uncontrolled BP (84.1%, n = 371;  $p=0.001$ ). Similarly, salt restriction, a cornerstone of DASH (Dietary Approaches to Stop Hypertension) therapy, was practiced by 119 (80.9%) with controlled BP versus a higher 394 (89.3%) with uncontrolled BP ( $p=0.008$ ). Physical exercise was attempted by 58 (39.4%) with controlled BP and 153 (34.6%) with uncontrolled BP ( $p=0.297$ ), indicating room for improvement across both groups. Intentional weight loss efforts, through diet and exercise, were slightly higher in the group with uncontrolled BP (274; 62.1% vs. 77; 52.3% in controlled;  $p=0.037$ ). Smoking status showed no difference (37; 25.2% were active smokers in the group with controlled BP vs. 117; 26.6% in the group with uncontrolled BP;  $p=0.745$ ) but cessation attempts were universal among the patients with controlled BP (37/37; 100%) compared to 91/117 (77.7%) in the group with uncontrolled BP ( $p=0.001$ ). Alcohol consumption was comparable (45; 30.7% consumers in the group with controlled BP vs. 137; 31.1% in patients with uncontrolled;  $p=0.918$ ), with similar cessation rates (33/45; 73.3% vs. 93/137; 67.8%;  $p=0.491$ , not significant). BP monitoring was universal among those with controlled BP (100%, n = 147), whereas it was practiced by 84.1% of participants with uncontrolled BP (n = 371;  $p = 0.001$ ).

**Table 2: Comparison of Clinical, Adherence and Lifestyle Factors between Patients with Controlled and Uncontrolled Hypertension**

Variable	Controlled	Uncontrolled	P-Value
Age (Y)	64.84	62.54	0.068
Gender (M/F)	61(41.4%)/86(58.6%)	191(43.3%)/250(56.7%)	0.7
Good adherence (Yes/No)	133(90.5%);14(9.5%)	259(58.7%);182(41.3%)	<0.001
Duration (Y)	7.78	7	0.112
Portion control (Attempted/Never)	119(80.9%);28(19.1%)	343(77.7%);98(22.3%)	0.417
Meat substitution (Attempted/Never)	119(80.9%);28(19.1%)	315(71.4%);126(28.6%)	0.023
Inclusion of vegetables/fruits (Attempted/Never)	105(71.4%);42(28.6%)	371(84.1%);70(15.9%)	0.001
Salt restriction (Attempted/Never)	119(80.9%);28(19.1%)	394(89.3%);47(10.7%)	0.008
Exercise (Attempted/Never)	58(39.4%);89(60.6%)	153(34.6%);288(65.4%)	0.297
Intentional weight loss (Attempted/Never)	77(52.3%);70(47.6%)	274(62.1%);167(37.9%)	0.037
Smoking status (Never/Active)	110(74.8%);37(25.2%)	324(73.4%);117(26.6%)	0.745
Smoking cessation (Attempted/Never)	37(100%);0(0%)	91(77.7%);26(22.2%)	0.001
Alcohol use (Never/Consumer)	102(69.3%);45(30.7%)	304(68.9%);137(31.1%)	0.918
Alcohol cessation (Attempted/Never)	33(73.3%);12(26.6%)	93(67.8%);44(32.1%)	0.491
BP monitoring (Attempted/Never)	147(100%);0(0%)	371(84.1%);70(15.9%)	0.001



**Figure 2 Comparison of Lifestyle practices between controlled and uncontrolled Hypertensives**

## DISCUSSION

This study of 588 hypertensive patients reveals a female predominance (57.1%) and mean age of  $63.11 \pm 13.28$  years, consistent with global trends where postmenopausal women face elevated cardiovascular risk due to estrogen decline.<sup>[11,12]</sup> Common presentations included screening (57.1%) and emergencies (21.3%), reflecting late detection in resource-limited settings. National program for prevention and control of Non communicable diseases (NP-NCD) is India's primary government screening programme for non-communicable diseases. In Kerala, it integrates with statewide Amrutham Arogyam program. One of the primary constraints on this program is the sheer size of the target population, resulting in a markedly higher volume of individuals who must be screened. The program's limited capacity to screen the full population contributes to late detection, as hypertension is often first identified when patients present with hypertensive emergencies, reflecting missed opportunities for earlier intervention. Most of them have target organ damage at the time of

diagnosis. Thus, a more robust screening is required for early detection and prevention of complications. Other factors that contribute to hypertensive emergencies are refusal to adhere to medications when asymptomatic and lack of regular follow-up.

A large population of the patients (46.1%) had a short duration of hypertension (<5 years) and multiple comorbidities were prevalent – diabetes (46.8%), dyslipidemia (33.7%), and CAD (26.7%). Hypertension significantly increases the risk of myocardial infarction (MI) through mechanisms like endothelial dysfunction, accelerated atherosclerosis and left ventricular hypertrophy.<sup>[13,14]</sup> Patients with pre-existing hypertension often experience worse MI outcomes, including higher mortality, more extensive myocardial necrosis and increased complications like heart failure.<sup>[15,16]</sup> Chronic hypertension promotes coronary artery disease by causing mechanical stress on vessels, reducing capillary density, and impairing vasodilation, which compromises myocardial perfusion.<sup>[13,17]</sup> It shares risk factors with MI such as sympathetic hyperactivity and renin-angiotensin system activation, leading to plaque progression and rupture.<sup>[14,17]</sup> In hypertensive patients, MI pathology shows greater fibrosis, inflammation, and necrosis compared to normotensives.<sup>[16]</sup>

Medication patterns favoured CCBs (78.4%) and RAASi (58.8%), aligning with JNC-8 guidelines prioritizing these for most patients.<sup>[18]</sup> Medication adherence emerged as a critical determinant of prognosis, with adherent and non-adherent groups exhibiting distinctly different outcome trajectories (90.5% in controlled vs. 58.7% in uncontrolled;  $p < 0.001$ ). This finding reiterates the global non-adherence rates (40-50%), driven by side effects and cost.<sup>[19]</sup>

Lifestyle paradoxes emerged: portion control was equitable amongst the controlled and uncontrolled groups (80.9% vs. 77.7%;  $p = 0.417$ ) but meat substitution favoured control (80.9% vs. 71.4%;  $p = 0.023$ ). The guidelines of DASH diet advise us to restrict our red meat intake to help control hypertension. High red meat intake correlates with

raised Trimethylamine N-oxide (TMAO) levels that ultimately strain cardiovascular health.<sup>[20]</sup> Processed red meat is also a risk factor due to the inclusion of high sodium content. Reduced saturated fats help improve vascular compliance. Counterintuitively, uncontrolled patients reported more vegetables (84.1% vs. 71.4%;  $p=0.001$ ) and salt restriction (89.3% vs. 80.9%;  $p=0.008$ ), possibly from inaccurate self-reporting or recall bias, as validated by studies comparing surveys to objective measures of sodium intake like urinary sodium excretion.<sup>[21]</sup> Exercise remained suboptimal (39.4% vs. 34.6%;  $p=0.297$ ). Age and other comorbidities are possible limitations to duration and quality of exercises. Intentional weight loss was higher in uncontrolled BP (62.1% vs. 52.3%;  $p=0.037$ ), reflecting frustration-driven efforts neutralised by metabolic factors like hypothyroidism (12.2%). Smoking and alcohol usage were comparable amongst those with controlled and uncontrolled hypertension but patients with controlled BP were able to successfully discontinue smoking more frequently (100%) compared to patients with uncontrolled BP (77.7%) with a  $p=0.001$ . This can be attributed to motivation or counselling efficacy. Universal BP monitoring in the BP controlled group (100% vs. 84.1%;  $p=0.001$ ) demonstrates the role BP monitoring plays in real-time adjustments to medications and lifestyle practises.

## CONCLUSION

This study demonstrates that the current screening programme for detection of hypertension (NP-NCD) is inadequate to detect hypertension sufficiently early due to the hurdles like vast populations and inadequate number of healthcare workers. Hypertension control remains suboptimal, with a significant proportion of patients presenting late or with emergencies. Questionnaire based evaluation is not an ideal tool to detect the reasons for uncontrolled hypertension due to inaccurate self-reporting and recall bias. The limitations of the study are unverified self-reported data, single-centre bias and lack of objective measurements that are reproducible (e.g., urinary sodium, pill count). However, this study demonstrates that there is a huge room for improvement in rates of early detection of hypertension and its satisfactory control in patients.

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