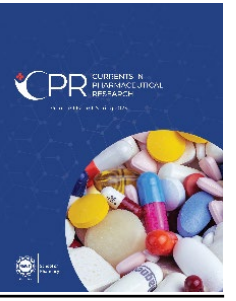
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JNC 8 Guideline Adherence and Systolic Blood Pressure Outcomes: Real-world Evidence from Sri Lanka

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ABSTRACT

Hypertension is a leading cause of cardiovascular morbidity globally, including Sri Lanka. Data on prescribing pattern adherence to Joint National Committee (JNC 8) guidelines in Sri Lankan primary care remains limited. The aim of this study was to evaluate antihypertensive prescribing patterns according to JNC 8 guidelines. Furthermore, the study also intended to assess Blood Pressure (BP) control among hypertensive patients at a primary care hospital in Kandy, Sri Lanka. A retrospective cross-sectional study was conducted among 411 hypertensive patients attending the primary care hospital, Ududumbara, Kandy, Sri Lanka, using prescription records abstracted over a one-month period (November 2025). Prescribing patterns were assessed against JNC 8 criteria using a structured data collection tool. JNC 8 guideline adherence was found to be high at 92%. Most patients (59.4%) received combination therapy. The most commonly prescribed drug classes were Angiotensin Receptor Blockers (ARBs) and diuretics. Systolic Blood Pressure (SBP) control was achieved in 82.7% of patients. Diabetes mellitus was identified as an independent predictor of poor BP control (OR = 0.504, 95% CI: 0.293–0.847, $p = 0.012$). This study revealed high adherence to JNC 8 prescribing guidelines. Additionally, the study also discovered that SBP control was achieved in most patients, though nearly one-fifth remained uncontrolled within the recommended targets in this rural Sri Lankan population. The association between diabetes and BP control highlights the need for intensified treatment strategies. As a retrospective cross-sectional analysis, these associations should not be interpreted as causal. Health systems should complement prescriber education with patient-centered interventions and expedited protocols for diabetic hypertensives.

Keywords: blood pressure control, hypertension, Joint National Committee guidelines, prescribing patterns, primary care, Sri Lanka

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1. INTRODUCTION

Hypertension is a progressive, chronic cardiovascular disease (CVD) that is defined by a continual rise in blood pressure in the arteries and is a major modifiable risk factor for premature morbidity and mortality worldwide [1]. It is closely related to several interconnected causes that increase the global burden of diseases. These include increasing age, obesity, a high intake of dietary sodium, lack of physical activity, genetic predisposition, and psycho-social stress [1–3]. According to latest world data, more than 1.3 billion adults aged 30-79 years were found to be living with hypertension with two-thirds of them living in low and middle-income countries. Hence, hypertension is the leading cause of nearly 9 million deaths annually [4, 5]. Sri Lanka has also shown quite a worrying trend. The national surveys have shown that the prevalence rate of hypertension in the population is on the rise to 35%. This highlights hypertension as a significant health problem among the population of this region [6]. High BP is one of the conditions that are directly connected to various prominent diseases [7]. These include ischemic heart disease, stroke, chronic kidney disease (CKD), and peripheral arterial disease, all of which cause high levels of disability and healthcare costs.

Drug-utilization studies, that were performed as per the World Health Organization (WHO) guidelines, give a systematic criterion in assessing medication use patterns, irrational prescribing, and to back the interventions in order to enhance therapeutic outcomes [8]. In this case, the pattern of prescription is defined as the choice, frequency, and combinations of the drugs that clinicians prescribe to treat a specific condition based on the guidelines, patient characteristics, and institution [9]. Evaluating these patterns is essential to ensure evidence-based care and optimize the quality of hypertension management. The 7th report of the Joint National Committee (JNC) on prevention, detection, evaluation, and treatment of high BP was issued by the National High Blood Pressure (BP) Education Program Coordinating Committee in 2003. The recommendations commended the use of Angiotensin Converting Enzyme Inhibitors (ACEIs), Angiotensin Receptor Blockers (ARBs), Beta Blockers (BBs), Calcium Channel Blockers (CCBs), or thiazide type of diuretics as initial agents. Most patients should take thiazide-type diuretics unless it can be clearly indicated otherwise. The use of two antihypertensive agents of other drug classes is also suggested to attain the JNC 7 target of below 140/90 mmHg

for the general population, with a stricter target of below 130/80 mmHg reserved for patients with diabetes or CKD. The 8th JNC was formed in 2014 [10]. These guidelines, as opposed to the JNC 7, have been established with the same preference to the drugs with an exception of BB as first line agent [11, 12]. Individuals older than 60 years have target BP of less than 150/90 mmHg. Hypertensive diabetic patients, hypertension in nondiabetic patients with chronic renal disease, and the general hypertension population with age less than 60 years, are adjusted to less than 140/90 mm Hg. Additionally, JNC 8 also firmly advises against ACEI plus ARB combination due to risk of hyperkalemia and AKI, solidifying the concerns which were present in JNC 7 [7, 13, 14]. These updates shifted the therapeutic decision-making towards more individualized treatment approaches and broadened acceptable first-line medication options, particularly for adult and elderly populations.

While several contemporary hypertension guidelines exist, such as the ACC/AHA 2017 (which introduced stricter 130/80 mmHg targets and requires cardiovascular risk calculators), ISH 2020 (a global harmonized guideline), WHO HEARTS technical package 2021 (recently adopted nationally in Sri Lanka), and ESH 2023 (the latest European update), this study specifically evaluated compliance with JNC 8 for five reasons specific to our setting. Firstly, JNC 8 was widely taught in medical curricula, making it the de facto reference for practicing physicians, especially considering its benefit of prescriber discretion. Secondly, it requires only age, BP values, and diabetes or CKD status which are variables reliably available in retrospective chart audits and medical records, unlike risk calculators (ASCVD risk estimator) and laboratory thresholds needed for ACC/AHA or HEARTS. Thirdly, its higher targets (<140/90 or <150/90 mmHg) represent a minimum acceptable standard, allowing to establish a baseline before the national HEARTS transition. Fourthly, no prior study has assessed JNC 8 compliance in any Sri Lankan healthcare setting. Lastly fifth, the current study's findings would directly identify implementation challenges and may inform the WHO-HEARTS rollout in targeted training and systemic interventions.

Given this context, the evaluation of current prescribing practices becomes imperative. Despite the high prevalence of hypertension as one of the primary public health issues in Sri Lanka, there is insufficient evidence on compliance of physicians in the local healthcare settings with the JNC 8

recommendations when prescribing antihypertensives. Learning the existing trends in prescribing is a key to define gaps. Additionally, it also enhances the clinical decisions to attain the best BP control methods. The primary aim of this research included the evaluation of antihypertensive prescribing patterns to the patients according to JNC 8 guidelines. The study also evaluated the extent of BP management among the patients undergoing treatment in a primary care hospital in Sri Lanka. The findings of this cross-sectional study would be useful in streamlining antihypertensive prescribing guidelines in Sri Lanka, as a precursor to future research and practice in the favor of JNC 8 guideline implementation in pursuit of improved curative effects.

2. MATERIALS AND METHODOLOGY

2.1. Study Design and Settings

This retrospective cross-sectional, non-interventional research was conducted in the medical outpatient clinic of the primary care hospital in Ududumbara, Kandy, Sri Lanka. Primarily, hypertensive patients are known to attend the general medical clinic of primary care hospital, Kandy.

2.2. Sample Size

The sample size was calculated as 343 by open epi sample size calculator with a confidence interval of 95% and margin of error of 5%. To account for potential incomplete or missing prescription records common in retrospective chart reviews, the calculated sample was inflated by 20%, yielding a target sample of 411 patients.

2.3. Inclusion Criteria

The study included male and female hypertensive patients of above 30 years old attending the general medical clinics in Ududumbara primary care hospital. As data was abstracted retrospectively from existing Hospital Management Information System (HMIS) prescription records, individual patient consent for this specific record review was not obtained from patients directly. People with intellectual disability, aged under 30 and pregnant women were excluded.

2.4. Study Techniques

Patients meeting the inclusion criteria were identified using a combination of convenience sampling (all eligible hypertensive patients

attending the outpatient clinics of the primary care hospital, Ududumbara, Kandy during the data-collection period were considered) and purposive sampling (patients were included specifically because their prescription records allowed evaluation of JNC 8 guideline adherence and BP control, the study's primary variables of interest). The data was produced by HMIS from printed prescriptions. Data was collected using a structured and pre-designed data collection tool and it covered the following sections:

The demographic data included patient identification, age, gender, and place of residence (urban/rural) to evaluate the demographic determinants of the prescribing patterns and therapeutic outcomes. Clinical data included the date of hypertension onset, duration, and comorbidity. These variables were gathered because JNC 8 recommendations differ depending on age and comorbidities. The BP measurements were extracted from routine records as a single BP reading, (taken using a standard mercury sphygmomanometer after 5 minutes of rest) provided by the hospital upon data collection request and without re-measurement during data collection, to test BP control against the standards provided by JNC 8. Primary outcome was Systolic Blood Pressure (SBP) control per JNC 8: <150 mmHg if ≥60 years, <140 mmHg if <60 years. Primary exposure was JNC 8 guideline adherence (yes/no). Antihypertensive treatment information included information of the date of administration, type of regimen (monotherapy, dual therapy or triple therapy), drug name, class, dose, and frequency. This helped in evaluating the patterns of prescribing and rational use of drugs. JNC 8 concordance was defined operationally as follows: a prescription was classified as concordant (adherent) if (i) the first-line agent belonged to a JNC 8-recommended class (thiazide-type diuretics, CCB, ACEI, or ARB); (ii) ACEI and ARB were not co-prescribed together; and (iii) therapy was intensified in a guideline-consistent manner when BP remained uncontrolled. JNC 8 concordance was measured according to the appropriateness of the first-line drug choice, whether ACE Inhibitors or ARBs were used while patients had CKD and how patients could have their treatment intensified when they had uncontrolled hypertension. CKD is typically defined based on clinical documentation of a diagnosis in the patient's medical record. However, no systematic screening (e.g., eGFR or urinary ACR measurement) was performed in this cohort. Prescriptions were classified into concordant and non-concordant and then the rationales were recorded. This was used to make comparisons between prescribing habits and clinical outcomes.

Data collection was conducted over a period of one month (November 2025). Data collection comprised patients who attended the clinic on consecutive fixed clinic days (every Tuesday and Thursday) in the said period. Complete data was available for all 411 participants for age, gender, BP, and drug prescriptions. The identity of the patients was kept confidential during data collection. The information obtained in a given period was entered in the Microsoft Excel 2019 and relevant statistical tests were conducted to analyze the information.

2.5. Ethical Approval

Ethical approval was obtained from the District Medical Officer, of the Divisional Hospital, Ududumbara, Kandy, Sri Lanka (Ref No.: CPC/DH/UD/2/26) and the Ethical Review Committee of University of Central Punjab (UCP), Lahore, Pakistan (Ref No. UCP/FOPS/TDF/App#006/2025).

2.6. Statistical Analysis of Data

SPSS version 27 was used to enter and analyze the data. Tables and figures were used to provide descriptive statistics with proportions in terms of percentages. Bivariate chi-square tests were used to assess unadjusted associations only. For instance, between antihypertensive pharmacotherapy (monotherapy and combination therapy) and BP control with statistical significance set at $p < 0.05$. These bivariate tests did not control for confounding. Confounders were controlled solely through the multivariable Logistic Regression (LR) models described below. A similar bivariate approach was used in a Sri Lankan tertiary hospital prescribing study, [15] which likewise reported p-values for associations with antihypertensive prescribing and blood pressure control.

Variables were selected for inclusion in the multivariable LR model based on clinical relevance (i.e., factors previously reported to influence BP control) and statistical significance at the $p < 0.20$ level in bivariate analysis. The following variables were entered into the initial model: gender, age, place of residence, diabetes mellitus, ischemic heart disease, dyslipidemia, bronchial asthma, stroke, heart attack, prescriber type, and NSAID usage.

LR was used to determine the predictors of single versus combined antihypertensive therapy. Backward stepwise elimination was performed using the likelihood ratio test, with a removal criterion of $p > 0.10$. Multicollinearity was assessed using Variance Inflation Factor (VIF) and

tolerance statistics; all VIF values were < 2.0, indicating no significant multicollinearity. Model fit was evaluated using the Hosmer-Lemeshow goodness-of-fit test. Parameters were presented as regression coefficients (*B*), standard errors, Wald statistics, and *p*-values. The independent predictors were determined based on statistical significance.

3. RESULTS

Table 1. Distribution of Patient Characteristics

	Frequency	Percentage	Male (%)	Female (%)
Patients	411	100	25.5	74.5
Age				
31-40	7	1.7	0	1.7
41-50	37	9.0	1.2	7.8
51-60	103	25.1	4.9	20.2
61-70	143	34.8	9.7	25.1
71-80	93	22.6	7.1	15.6
81-90	23	5.6	2.2	3.4
91-100	5	1.2	0.5	0.7
Residence				
Urban	0	0	0	0
Rural	411	100	25.5	74.5
Comorbidities	305	74.2	20.7	53.5
Diabetes mellitus	132	32.1	7.1	25.1
Chronic Kidney Disease	0	0	0	0
Ischemic Heart Disease	21	5.1	1.5	3.6
Heart Failure	0	0	0	0
Dyslipidemia	241	58.6	14.4	44.3
Bronchial Asthma	34	8.3	4.6	3.6
Stroke	20	4.9	2.4	2.4
Heart Attack	22	5.4	1.7	3.6
None	106	25.8	4.8	21

Note. Percentages for individual comorbidities in this table do not sum to the overall comorbidity total (74.2%) because many patients had more than one comorbid condition.

A sample size of 411 patients with hypertension was used. The sample

mean age was 64.43 ± 11.47 years, with the highest number of patients being (34.8%) in the range of 61-70 years, and the second highest proportion (25.1%) in the range of 51-60 years. The proportion of female subjects was 74.5% of the cohort, and all of them (100% of the participants) resided in rural areas. Comorbidities were identified in 305 patients (74.2%), dyslipidemia (58.6%) and diabetes mellitus (32.1%) most often. Table 1 displays the rest of the socioeconomic and clinical features of the study population.

Table 2. Antihypertensive Treatment Patterns in Hypertension Alone Versus Hypertension with Comorbidities

	Therapy Recommended	Percentage
Hypertension	Calcium Channel Blockers	27.5
	Diuretics	49.9
	Beta blockers	7.1
	Angiotensin Receptor Blockers	73.2
	Alpha blockers	6.1
	ACEIs +Beta blockers	3.6
	Diuretics + Calcium Channel Blockers	1.4
	Beta blockers + Calcium Channel Blockers	1.2
	Diuretics + Diuretics	4.4
Comorbidities	Diuretics + Calcium Channel Blockers	12.9
	Beta blockers+ Calcium Channel Blockers	1
	Diuretics + Calcium Channel Blockers + Beta blockers	0.2
	Diuretics + Diuretics + Beta blockers	0.2
	ARBs + Calcium Channel Blockers + Diuretics	10.2
	ACEI + ARBs + Beta blockers + Diuretics	0.2

Note. Percentages within each stratum (Hypertension alone; Hypertension with comorbidities) reflect the proportion of patients on each individual regimen and do not sum to 100%. This is because regimen categories are not mutually exhaustive and some low-frequency regimens are omitted from this summary table.

The most commonly prescribed of the recommended antihypertensive therapies were ARBs (73.2%) followed by diuretics (49.9%). The combination of diuretics and CCBs was leading in patients with comorbid conditions (12.9%), followed by the combination of ARBs, CCBs, and diuretics (10.2%). Adherence to the JNC 8 guideline was significant at 92%; the non-adherence rate was only 8% of all prescriptions. Prescriptions combining an ACEI with an ARB, as well as statins prescribed as monotherapy, were considered non-adherent to JNC 8. In the stratified (i.e., below age-specific target) group of patients aged 60 and above (150 mmHg) and those younger than 60 years (140 mmHg), systolic BP control was attained in a total of 82.7% (Table 2, Table 3).

Table 3. Result of JNC 8 Guideline Adherence of the Study

	Adherent (*n*=378)	Non-adherent (*n*=33)
JNC 8 Guideline (First line: thiazide diuretics, CCBs, ACEIs or ARBs Second line: thiazide diuretics, CCBs, ACEIs or ARBs Not taking ACEIs and ARBs together)	378 (92%)	33 (8%)
	Good SBP Control	Poor SBP Control
Total sample SBP control (*n* = 411)	340 (82.7%)	71 (17.3%)
SBP <150 mmHg (above 60 years old, *n*=281)	224 (79.71%)	57 (20.29%)
SBP <140 mmHg (below 60 years old, *n*=130)	116 (89.2%)	14 (10.8%)

Note. *n* values for the adherent/non-adherent and total sample SBP control rows were computed by applying the stated percentages to the full cohort (*n*=411). The two age-stratified rows (SBP <150 mmHg for age ≥60; SBP <140 mmHg for age <60) report percentages within each age subgroup, not the total cohort, and are therefore not directly comparable to the 82.7% total-sample figure above, which applies each patient's own age-specific JNC 8 target.

Table 4 shows the distribution of individual antihypertensive

medications prescribed. ARBs were the most commonly used class, prescribed to 301 patients (73.2%), with losartan being the sole ARB used. Diuretics were the second most prescribed class (49.9%), among which hydrochlorothiazide (41.4%) was the most frequent, followed by furosemide (10.2%). BBs (7.1%), alpha blockers (6.1%), and vasodilators (2.4%) were less frequently used.

Table 4. Antihypertensive Medication used by Patients

Class of Medication	Frequency	Percentage
ACEIs	69	16.8
Enalapril	64	15.6
Captopril	5	1.2
ARBs	301	73.2
Losartan	301	73.2
CCBs	113	27.5
Nifedipine SR	44	10.7
Amlodipine	58	14.1
Diltiazem	12	2.9
Verapamil	1	0.2
Diuretics	205	49.9
Furosemide	42	10.2
Spironolactone	12	2.9
Hydrochlorothiazide	170	41.4
Alpha blockers	25	6.1
Prazosin	25	6.1
Beta blockers	29	7.1
Bisoprolol	21	5.1
Propranolol	3	0.7
Atenolol	2	0.5
Metoprolol	3	0.7
Vasodilators	10	2.4
ISMN	6	1.5
SL GTN	5	1.2
Nicorandil	1	0.2

Note. Class-level totals (e.g., diuretics, CCBs) represent the number of unique patients prescribed at least one medication from that class. A patient prescribed more than one drug within the same class is counted once in the

class total but appears in each corresponding individual-drug row below it. This is why the itemized rows can sum to more than the class total (e.g., diuretics: 42+12+170=224 vs. class total of 205; CCBs: 44+58+12+1=115 vs. class total of 113).

The analysis of antihypertensive prescription patterns is presented in Tables 5 and 6. Among the 411 patients, the majority were on monotherapy, with 33.5% on two-drug regimens, 18.8% on three-drug regimens, and 7.1% on four or more medications, while 36.5% received monotherapy (Table 5). Among patients on monotherapy (36.5%), ARBs were the most frequently prescribed class (28.2%), followed by ACEIs (4.1%). In the two-drug combinations (33.5%), the most common was ARB plus thiazide diuretic (17.5%), followed by ARB plus CCB (7.5%). Among three-drug regimens (18.8%), the predominant combination was ARB plus diuretic plus CCBs (9.24%) (Table 6).

Table 7 presents gender distributions of comorbid conditions. The most common comorbidity found was dyslipidemia, with a prevalence of 14.4% of men and 44.3% of women taking the condition. Statistical analysis using the chi-square test showed that there were no significant differences in males and females on any of the comorbidity disorders that were studied as indicated by the p values; diabetes mellitus (p=0.253), ischemic heart disease (p =0.744), dyslipidemia (p =0.555), bronchial asthma (p =0.11), stroke (p =0.10), and heart attack (p =0.488).

Table 5. Therapeutic Regimen

	Frequency	Percentage	Male%	Female%
Mono	150	36.5	9.5	27.0
2-Drugs	137	33.5	7.5	25.8
3-Drug	77	18.8	5.4	13.4
4-Drug or more than 4	29	7.1	2.2	4.9

Note. The four regimen-size categories above sum to 393 patients (150 + 137 + 77 + 29), rather than the full cohort of n = 411, resulting in a shortfall of 18 patients (4.4%), who were omitted from the regimen classification. This is because they were prescribed statins as standalone therapy, which are not considered primary antihypertensive medications.

Table 6. Antihypertensive Medication used by Patients in Mono and Combination Therapy (*n*=411)

Medication	Frequency	Percentage
Monotherapy	150	36.5
ACEIs	17	4.1
ARBs	116	28.2
Diuretics	8	1.9
CCBs	8	1.9
Betablockers	1	0.2
Two Medication Regimens	137	33.5
ARBs + ACEIs	3	0.7
ARBs + CCBs	15	3.6
ARBs + Thiazide Diuretics	69	16.8
ACEIs + Thiazide Diuretics	10	2.4
CCBs + Thiazide Diuretics	5	1.2
CCBs + Diuretics (Except thiazide diuretics)	1	0.2
Diuretics + Diuretics	3	0.7
ACEIs + Diuretics (Except thiazide diuretics)	3	0.7
ACEIs + Vasodilators	1	0.2
ACEIs + Beta blockers	5	1.2
ARBs + Diuretics (Except thiazide diuretics)	10	2.4
ARBs + Beta blockers	3	0.7
Three Medications Regimen	77	18.8
ACEIs + ARBs + Diuretics	4	0.97
ACEIs + CCBs + Diuretics	4	0.97
ACEIs + CCBs + Beta blockers	2	0.48
ARBs + CCBs + Diuretics	38	9.24
ARBs + Diuretics + Alpha blockers	4	0.97
ARBs + Diuretics + Beta blockers	3	0.73

Table 8 outlines the comorbid pharmacotherapies that were used by the trial cohort. The most common adjunctive medication were statins, prescribed to 269 participants (65.5% of the total population). Additionally, it is noteworthy that statins have been used as a standalone therapy for hypertension in 18 patients, which was considered as a deviation from JNC 8 guidelines. Antidiabetic agents (29.7%) and nonsteroidal anti-inflammatory drugs (29.4%) followed.

Table 7. Comorbid Conditions among Participants according to the Gender (*n*=411)

Comorbidity	Male *n* (%)	Female *n* (%)	Total *n* (%) *p*-value
Diabetes Mellitus	29 (7.06)	103 (25.06)	132 (32.12) - 0.25
Chronic Kidney Disease	0	0	-
Ischemic Heart Disease	6 (1.46)	15 (3.65)	21 (5.11) - 0.74
Heart Failure	0	0	-
Dyslipidemia	59 (14.36)	182 (44.28)	241 (58.64) - 0.55
Bronchial Asthma	19 (4.62)	15 (3.65)	34 (8.27) - 0.11
Stroke	10 (2.43)	10 (2.43)	20 (4.87) - 0.10
Heart Attack	7 (1.70)	15 (3.65)	22 (5.35) - 0.49

Table 8. Additional Medications used by Patients

Class of Medication	Frequency	Percentage
Statins	269 (18 - standalone drug)	65.5
NSAIDs	121	29.4
Antihistamines	13	3.2
Antidiabetics	122	29.7
SABA	32	7.8
Corticosteroids	26	6.3
Methylxanthines	9	2.2
Antiepileptic	2	0.5
Antipsychotics	3	0.7
Antidepressants	8	1.9
PPIs	4	1
Thyroid Agent	5	1.2
Antiplatelet Agent	1	0.2
Anticonvulsant	1	0.2
PDE5I	1	0.2
SMR	1	0.2

Class of Medication	Frequency	Percentage
Dopamine Antagonist	1	0.2
Antimuscarinic	1	0.2
AAS	1	0.2
Miscellaneous	65	15.8

Table 9. Factors Associated with the Type of Medication Therapy

Variable	Mono (%)	Combined (%)	*p*-value
Gender			
Male	39 (38.61%)	62 (61.39%)	- 0.940
Female	111 (38.01%)	181 (61.99%)	
Residence			
Rural	150 (36.5%)	243 (59.12%)	- 0.601
Urban	-	-	
Age			
31-40	3 (42.86%)	4 (57.74%)	- 0.138
41-50	13 (36.11%)	23 (63.89%)	
51-60	42 (43.75%)	54 (56.25%)	
61-70	56 (41.48%)	79 (58.52%)	
71-80	26 (28.57%)	65 (71.43%)	
81-90	6 (26.09%)	17 (73.91%)	
91-100	4 (80%)	1 (20%)	
Diabetes Mellitus			
Yes	58 (47.15%)	65 (52.85%)	- 0.013
No	92 (34.07%)	178 (65.93%)	
Chronic Kidney Disease			
Yes	-	-	-
No	150 (38.17%)	243 (61.83%)	
Ischemic Heart Disease			
Yes	8 (38.09%)	13 (61.91%)	- 0.381
No	142 (38.17%)	230 (61.83%)	
Heart Failure			
Yes	-	-	-
No	150 (38.17%)	243 (61.83%)	
Dyslipidemia			
Yes	81 (35.53%)	147 (64.47%)	- 0.212
No	69 (41.82%)	96 (58.18%)	

Variable	Mono (%)	Combined (%)	*p*-value
Bronchial Asthma			
Yes	12 (35.29%)	22 (64.71%)	- 0.191
No	138 (38.44%)	221 (61.56%)	
Stroke			
Yes	9 (52.94%)	8 (47.06%)	- 0.072
No	141 (37.5%)	235 (62.5%)	
Heart Attack			
Yes	7 (31.82%)	15 (68.18%)	- 0.296
No	143 (38.54%)	228 (61.46%)	
Prescriber Type			
Consultant	150 (38.17%)	243 (61.83%)	-
MO	0	0	

Multivariate analysis was carried out to determine the variables affecting the decision on whether to use monotherapy or combination therapy (Table 9). Only diabetes mellitus had a statistically significant association ($p = 0.013$): Patients without diabetes were more likely to be on combined (65.93%) than on monotherapy (34.07%), and a higher proportion of diabetic patients received combined therapy (52.85% vs. 47.15% mono). All other variables including gender, residence, age, CKD, ischemic heart disease, heart failure, dyslipidemia, bronchial asthma, stroke, heart attack, and prescriber type, showed no significant differences between the two regimen types.

Table 10. Factors Associated with SBP Control

Variable	SBP Control: Yes	SBP Control: No	Statistical Analysis
Gender			
Male	92 (87.62)	13 (12.38)	$\chi^2 = 1.771$;
Female	251 (82.03)	55 (17.97)	$p = 0.183$
Residence:			
Rural	343 (83.46)	68 (16.54)	$\chi^2 = 0.293$;
Urban	-	-	$p = 0.589$
Age:			
31-40	5 (71.43)	2 (28.57)	
41-50	29 (78.38)	8 (21.62)	$\chi^2 = 6.365$;
51-60	82 (79.61)	21 (20.39)	$p = 0.384$
61-70	122 (85.32)	21 (16.68)	
71-80	78 (83.87)	15 (16.13)	

Variable	SBP Control: Yes	SBP Control: No	Statistical Analysis
81-90	22 (95.65)	1 (4.35)	
91-100	5 (100)	0	
Diabetes Mellitus:			$\chi^2 = 6.783$; $p = 0.009$ S.E 0.271 B -0.697 Wald 6.624 p (Wald) 0.01 Exp (B) 0.498 95% CI (OR) – 0.293–0.847
Yes	101 (76.52)	31 (23.48)	
No	242 (86.74)	37 (13.26)	
Chronic Kidney Disease:			
Yes	0	0	-
No	343 (83.46)	68 (16.54)	
Ischemic Heart Disease:			$\chi^2 = 0.790$; $p = 0.374$
Yes	19 (90.48)	2 (9.52)	
No	324 (83.46)	66 (16.92)	
Heart Failure:			
Yes	0	0	-
No	343 (83.08)	68 (16.54)	
Dyslipidemia:			$\chi^2 = 0.710$; $p = 0.399$
Yes	198 (82.16)	43 (17.84)	
No	145 (85.29)	25 (14.71)	
Bronchial Asthma:			$\chi^2 = 0.033$; $p = 0.857$
Yes	28 (82.35)	6 (17.65)	
No	315 (83.55)	62 (16.45)	
Stroke:			$\chi^2 = 0.652$; $p = 0.419$
Yes	18 (90)	2 (10)	
No	325 (83.12)	66 (16.88)	
Heart Attack:			$\chi^2 = 0.142$; $p = 0.706$
Yes	19 (86.36)	3 (13.64)	
No	324 (83.29)	65 (16.71)	
Prescriber Type:			
Consultant	343 (83.46)	68 (16.54)	-
MO	0	0	
NSAIDs:			$\chi^2 = 0.333$ $p = 0.564$
Yes	99 (81.82)	22 (18.18)	
No	244 (84.14)	46 (15.86)	

Note. Multivariable model's p-value was relabeled from "p value (LR)" to

"*p* value (Wald)" to match Wald statistic actually reported, and the 95% CI for the odds ratio (0.293–0.847) was added, calculated from B and SE using the Wald method (exp(B ± 1.96×SE)).

To identify the determinants of BP control, backward stepwise LR was performed with SBP as the outcome variable (Table 10). Statistically significant variables included diabetes mellitus as the variable that was associated with SBP control in bivariate analysis ($\chi^2 = 6.783$, $p = 0.009$), with 76.515% of diabetics achieving control compared to 86.738% of non-diabetics. Diabetes mellitus remained significant as an independent predictor of poor SBP control in the backward stepwise model of LR ($B = -0.697$, $SE = 0.271$, Wald = 6.624, OR = 0.504, 95% CI: 0.293–0.847). Therefore, diabetic patients had 50% lower chances to achieve SBP control compared to non-diabetic patients. No other covariates showed a statistically significant association with SBP control.

4. DISCUSSION

This retrospective study evaluated antihypertensive prescribing patterns and BP control among 411 patients attending a primary care hospital in Sri Lanka. The key findings revealed a notable prevalence of combination therapy (59.4%) and a remarkable adherence rate of 92% to the JNC 8 guideline recommendations. When applying the target of <150 mmHg specifically to patients aged above 60 years, 54.5% achieved control; similarly, using the target of <140 mmHg for patients below 60 years, 28.2% achieved control. These two figures report control within each age subgroup separately; when JNC 8's age-specific targets were applied to the entire cohort, overall SBP control was achieved in 82.7% of patients (table 3), leaving nearly 1/5th uncontrolled despite JNC 8 adherent prescribing. The most commonly prescribed medication classes were ARBs (73.2%) and diuretics (49.9%). Statins were given as standalone treatment to 18 patients, despite not being a standard antihypertensive. Moreover, the ACEI+ARB's combination was prescribed in two drug and three drug regimens for 7 patients in the total sample, both of which contributed to the JNC 8 non-adherence (8%). Multivariate analysis identified diabetes mellitus as a significant independent predictor of poor SBP control, with diabetic patients having 50% lower odds of achieving target BP compared to non-diabetics (OR = 0.504, 95% CI: 0.29–0.86).

The high JNC 8 guideline adherence (92%) observed in this primary

care setting retrospectively justified our choice of JNC 8 as the evaluation framework. It demonstrated that this guideline is feasible to implement in a resource-limited primary care setting. Furthermore, it is also consistent with prescribing practices among clinicians in this Sri Lankan hospital being largely aligned with established international standards, [16] specifically regarding the use of first-line agents (thiazide diuretics, CCBs, ACEIs, ARBs) and the avoidance of ACEI-ARB combinations. However, the finding that nearly one-fifth of patients (17.3%) remained uncontrolled despite guideline-concordant prescribing revealed that adherence to prescribing guidelines alone may be insufficient to achieve universal BP control. A critical insight that might have been obscured if a stricter guideline, such as ACC/AHA 2017 had been chosen, where both adherence and control rates would likely have been substantially lower.

Combination therapy prescriptions were more extensively practiced with a percentage of 59.4%. These enhanced the therapeutic efficacy by targeting multiple physiological systems as well as portrayed clinician awareness of multifactorial BP pathophysiology and the need for multidrug regimens to attain optimal control [3]. The predominant use of ARBs, particularly Losartan, may reflect formulary availability, clinician preference, or perceived tolerability. However, this preference diverges from the JNC 8's initial recommendation for thiazide diuretics. The observation of statins being prescribed as monotherapy is a deviation from standard guidelines given that they are primarily lipid lowering agents. Thus, despite the BP-lowering effect being real, it is insufficient for statins to be used as a standalone treatment (monotherapy) for hypertension [17]. The strong association between diabetes and poor BP control is consistent with the complexity of managing hypertension in patients with comorbid conditions, where achieving target BP is more challenging and requires more intensive and individualized therapeutic strategies.

International studies demonstrate considerable variability in guideline adherence. A study from Yemen reported that while all physicians had heard of JNC 8, knowledge of specific recommendations varied, with only 64% aware of the elderly BP target and 58% aware of ACEI/ARB preference in CKD [11]. In Southern Nigeria, Nwosu and Okonjo (2024) reported that 62.89% of the subjects had controlled BP according to JNC-8 guidelines, with CCBs (72.16%) most commonly prescribed [9]. Conversely, Suthar and Dumra (2022) in India reported higher JNC-8

adherence (77.88%), with majority (65%) of patients on monotherapy [10]. Shankpal and colleagues (2025) found that combination therapy was given in 63.77% of patients with 82.63% prescriptions adhering to JNC 8 guidelines [5]. A comparable pattern was reported in a separate rural Indian teaching hospital, where JNC 8 adherence was markedly lower (54.5%), yet BP control was higher (70.3%) than in the current study. This reinforces that the relationship between guideline adherence and BP control is not uniform across South Asian primary and tertiary care settings and is shaped by additional local factors [18]. Patient-level studies reveal critical knowledge and adherence gaps [19]. Prabahar (2021) examined geriatric prescribing patterns and reported that 27.5% of prescriptions deviated from JNC 8 guidelines, with CCBs (88%) being the most commonly prescribed class [12].

Achieving optimal BP control remains challenging globally. Mahdavi and colleagues (2020) compared control rates under JNC 8 versus ACC/AHA 2017 criteria. It was reported that 39.1% of hypertensive individuals achieved JNC 8 targets compared to only 19.6% under stricter ACC/AHA criteria [14]. The BP control rate of 82.7% in the current study highlights that favorable outcomes are attainable in rural Sri Lankan primary care with consistent JNC 8 application. Nevertheless, the 17.3% who remained uncontrolled, particularly diabetics with 50% lower odds of target achievement, suggest that global guidelines, while implementable, require subgroup-specific intensification to achieve universal control, especially in this predominantly rural patient population of Sri Lanka, according to Ranasinghe [6]. This is an association rather than a causally established mechanism given the cross-sectional design. This becomes evident when examining the cross-cultural applicability of JNC 8. As shown in the results of an Arkansas State University study an intervention enhancing guideline concordance, led to a 25% increase in BP control [20]. This positive impact was portrayed in the American population, which could be a result of the JNC 8 guideline specification of classifying patient populations to blacks and non-blacks, as the guidelines were developed primarily from Western population data [21]. However, “non-black” is a broad and heterogeneous category and does not clearly stratify Asians, South Asians or more specifically our sample population, the rural Sri Lankans. Additionally, it may fail to account for the distinct cardiovascular risk profiles, medication response characteristics, and sociocultural determinants of health that exist among these populations [22, 23]. Another

contributing factor to relatively lower BP control (82.7%) compared to the JNC 8 compliance (92%), could be the lack of proper patient counseling, which ensures patient understanding and knowledge, and consequently affects patient adherence as appraised by Mohan et al in their 2022 study [24]. Pirasath and colleagues (2021) reported that 58.8% of Sri Lankan patients demonstrated good medication adherence, only 52.3% correctly identified target BP values [19]. Furthermore, in analyzing the impact of comorbidities, the finding that diabetes is a predictor of poor control is a well-documented phenomenon globally. This reaffirms the need for more aggressive management in this subgroup [7]. The lack of CKD patients in this cohort is also notable. This is because it contrasts with the broader Sri Lankan context where hypertension is a major cause of CKD as discussed in a 2011 study by Wijewickrama [25]. The zero prevalence of CKD in this sample is contributed by either under-diagnosis, complete lack of screening or a true absence, which could affect the generalizability of these findings to other populations. Finally, the high proportion of females (74.5%) may reflect healthcare-seeking behavior patterns but it does not explain the overall SBP control rates.

4.1. Study Implications

The findings of this study offer three key clinical implications for hypertension management in Sri Lankan primary care. First, health systems must complement prescriber guidelines with patient-level interventions, specifically, culturally adapted counseling programs to address Sri Lanka's low hypertension health literacy [6]. Second, diabetic hypertensives require accelerated treatment protocols, including automatic referral for combination therapy and shortened follow-up intervals, given their 50% lower odds of achieving BP targets [7]. Third, the fact that the JNC 8 guidelines were successfully implemented in this rural primary care environment suggests that international protocols can be implemented locally where they can be used in the creation of a national Sri Lankan hypertension treatment algorithm based on JNC 8 [10]. This is further supported by the achievement of 82.7% BP control under the relatively relaxed JNC 8 age-specific targets, and the subsequent adoption of the WHO HEARTS 2021 package, which has stricter targets, by the country. This demonstrates that favorable outcomes are attainable in rural Sri Lankan primary care when guidelines are applied as intended.

4.2. Strengths of the Study

One of the main notable strengths of this study is that it is among the first in Sri Lanka to specifically evaluate antihypertensive prescribing patterns against JNC 8 guidelines in a primary care setting, addressing a critical evidence gap identified in recent systematic reviews. A predetermined sample size (n=411) was used, which included 95% confidence intervals and a dropout rate of 20%, ensuring sufficient statistical power to perform multivariable analyses. The rigorous methodology used both the bivariate chi-square tests and multivariate backward stepwise LR to define independent predictors of therapy type and BP control with potential confounders, such as age and comorbidities controlled [13]. The structured data collection instrument recorded all demographic variables, clinical variables, and pharmacological variables, which allowed the evaluation of prescribing patterns in detail. On the contrary, the limitations also warrant acknowledgement. The retrospective cross-sectional design means prescribing patterns and BP outcomes were assessed from records at a single point in time. This prevents causal inferences regarding the relationship between prescribing patterns and long-term BP outcomes and limits conclusions to associations onl [11]. Convenience sampling may introduce selection bias, limiting generalizability to urban or tertiary care populations. The BP measurements being taken from a single reading and the absence of medication adherence data which is a critical determinant of BP control, means that the study cannot fully explain why BP targets remain unmet for 17.3% of the patients despite guideline-concordant prescribing. Since BP status was determined from a single recorded reading rather than the repeated measurements recommended for diagnosis and monitoring, some patients may have been misclassified as controlled or uncontrolled (e.g., through white-coat or masked hypertension effects), which could bias the reported control rate in either direction. Additionally, the study did not capture the "clinical inertia" phenomenon, where clinicians may not intensify therapy even when BP is uncontrolled [26]. The sample has a prevalence of zero CKD patients even though it is unlikely to be so in a hypertensive cohort, due to the lack of screening, which affects the credibility and restricts the generalizability of the results to individuals with impaired renal functions. Lastly, the clinic-based BP measurements do not necessarily indicate the 24-hour BP control as compared to the ambulatory monitoring [27].

4.3. Future Research Directions

Future research must integrate objective adherence indicators (count of pills, pharmacy refill records or electronic monitoring) and qualitative procedures to investigate clinician and patient attitudes which are barriers to treatment [19]. Intervention-based studies must be conducted to test scalable interventions in order to improve BP control. This includes nurse-led care models, tele pharmacy follow-up, community health worker-led counseling, and fixed-dose combination therapies to simplify regimens [28]. Considering Sri Lanka's current economic constraints, the cost-effectiveness of various treatment intensification policies should be conducted to inform resource distributio [29]. Finally, the validation of JNC 8 guidelines or the more recently followed WHO HEARTS for under stratified populations, such as the rural Sri Lankan populations, through retrospective cohort studies is recommended.

4.4. Conclusion

Bridging the gap between guideline adherence and BP control in rural Sri Lanka requires change of emphasis to patient-centered implementation strategies, rather than prescriber education alone. The health systems should focus on culturally modified counseling programs and expedited treatment regimens among diabetic hypertensives and ratify international standards among under-represented South Asian groups. As this study was retrospective and cross-sectional, these conclusions reflect associations rather than proven causal relationships and should be confirmed in prospective, South Asia-specific research. In the absence of context-specific adaptations, even the perfect prescribing patterns could result in suboptimal therapeutic outcomes.

Author Contribution

Zainab Razeen: conceptualization, data curation, formal analysis, writing – review & editing. **Fawas Hakeem:** Formal Analysis, Conceptualization, Project administration, Data curation, Writing – review, editing, Visualization. **Yumna Fouzer:** Investigation, Resources, Writing Original Draft, Writing review and editing. **Hasna Faris:** Writing - review & editing, methodology. **Ali Akhtar**: Supervision. **Hazmath Shakeenah**: Resources. **Waqas Akram:** Conceptualization, Data curation, Formal analysis, Investigation, Project administration, review & editing.

Conflict of Interest

The authors of the manuscript have no financial or non-financial conflict of interest in the subject matter or materials discussed in this manuscript.

Data Availability Statement

Data supporting the findings of this study will be made available by the corresponding author upon request.

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