Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/n5rvs088

STUDY OF PRESCRIPTION PATTERNS OF ANTIHYPERTENSIVE AGENTS IN TERTIARY CARE TEACHING HOSPITAL

Fadil Salmani[1*], Dr. Shaktibala Dutta[2], Dr. Jyotsna Sharma[3], Dr. Srihari Dutta[4]

[1*]PhD Scholar, Santhosh deemed to be University
[2]Professor & Head, Department of Pharmacology, SGRRIM&HS, Dehradun
[3]Professor & Head, Department of Pharmacology, G.S. Medical College, Hapur
[4]Heath Specialist (Immunization Supply chain & Primary Health care) United Nations Children Emergency Fund, MENA, Amman

***Corresponding Author:** Fadil Salmani
*PhD Scholar, Santhosh deemed to be University, salmanifadi123@gmail.com

Abstract

Background: Hypertension is a major public health concern requiring effective pharmacological management. This study aimed to evaluate the prescribing patterns of antihypertensive drugs and adherence to treatment guidelines in a tertiary care hospital. **Methods:** A cross-sectional observational study was conducted from June 2023 to June 2024 in the outpatient department of medicine at Santosh Medical College and Hospital, Ghaziabad. Ethical approval was obtained, and 1027 hypertensive patient prescriptions were analyzed based on predefined inclusion and exclusion criteria. Prescription data were assessed using WHO drug use indicators, and statistical analysis was performed using SPSS, with categorical variables analyzed via the chi-square test. **Results:** A total of 2978 drugs were prescribed, of which 1086 (36.5%) were antihypertensive agents, with an average of 1.67 antihypertensive drugs per prescription. Only 24.40% were prescribed by their generic name, and fixed-dose combinations (FDCs) were included in 41.70% of prescriptions. Injectable antihypertensive use was minimal (2.11%), while 68.82% of antihypertensive drugs were from the National List of Essential Medicines (NLEM 2020). Polypharmacy was observed in 91.70% of cases. The most commonly prescribed antihypertensive drug classes were Angiotensin Receptor Blockers (40.15%) and Calcium Channel Blockers (38.21%), with Telmisartan (37.48%) and Amlodipine (31.31%) being the most frequently prescribed individual drugs. Dual therapy was the most common treatment approach (45.28%), followed by monotherapy (39.73%). The chi-square test revealed no significant association between therapy type and drug class distribution ($p = 0.648$). **Conclusion:** The study highlights prescribing trends in hypertension management, emphasizing a preference for brand-name medications, a high prevalence of polypharmacy, and frequent use of combination therapy. Addressing gaps in generic prescribing and ensuring rational drug use can optimize hypertension treatment outcomes and reduce healthcare costs.

Keywords: Hypertension, Antihypertensive drugs, Prescribing patterns, Fixed-dose combinations, WHO drug use indicators, Polypharmacy, Rational drug use, Essential medicines, Drug utilization, Pharmacotherapy.

INTRODUCTION

Hypertension, or high blood pressure (BP), is one of the most prevalent non-communicable diseases (NCDs) globally, contributing significantly to the growing burden of cardiovascular diseases (CVDs).[1] It remains a leading cause of morbidity and mortality, often manifesting asymptomatically until complications arise, such as stroke, myocardial infarction, renal failure, or heart failure.[2] The World Health Organization (WHO) estimates that hypertension affects over 1.28 billion adults worldwide, with a disproportionately high prevalence in low- and middle-income countries, where healthcare access and awareness remain limited.[3] In India, the situation is particularly alarming, with a rising incidence across both urban and rural populations due to rapid urbanization, sedentary lifestyles, dietary shifts, and increasing life expectancy.[4] Alarmingly, national surveys indicate that nearly one-third of Indian adults are hypertensive, with many remaining undiagnosed or inadequately treated.[5]

Effective hypertension management necessitates a multifaceted approach, integrating lifestyle modifications such as dietary changes, increased physical activity, weight management, and smoking cessation.[6] However, pharmacotherapy remains the cornerstone of hypertension control, with most patients requiring at least two antihypertensive agents to achieve optimal BP regulation. The choice of antihypertensive drugs is guided by clinical evidence, comorbid conditions, and patient-specific factors. Over the years, evidence-based guidelines have evolved to refine therapeutic strategies and improve patient outcomes.[7,8]

The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7), published in 2003, played a pivotal role in shaping global hypertension treatment protocols[9]. It recommended angiotensin-converting enzyme inhibitors (ACEIs), angiotensin receptor blockers (ARBs), beta-blockers (BBs), calcium channel blockers (CCBs), or thiazide-type diuretics as first-line pharmacological options. Among these, thiazide diuretics were advocated as the preferred initial therapy for most patients without compelling indications for alternative drug classes. Furthermore, JNC 7 set rigorous BP targets, recommending a goal of <130/80 mmHg for individuals with diabetes or chronic kidney disease and <140/90 mmHg for the general hypertensive population. However, subsequent clinical evidence and large-scale trials led to the development of the Eighth Joint National Committee (JNC 8) guidelines in 2014, which introduced revised BP targets, particularly elevating the threshold to <150/90 mmHg for individuals aged ≥60 years, while maintaining <140/90 mmHg targets for younger adults and those with comorbidities. These evolving recommendations underscore the dynamic nature of hypertension management and the need for continual evaluation of prescribing patterns.[10]

Beyond clinical efficacy, a critical aspect of antihypertensive therapy involves rational drug use, a principle strongly emphasized by the World Health Organization (WHO). According to WHO, rational drug use entails prescribing medications that are appropriate for the patient's clinical condition, in the correct dosage, for an adequate duration, and at the lowest possible cost to both the individual and the healthcare system.[11,12] However, irrational prescribing remains a persistent issue worldwide, with WHO estimates suggesting that over 50% of all prescribed medications are inappropriate. This irrational use leads to increased risks of adverse drug reactions (ADRs), therapeutic failures, unnecessary polypharmacy, and antimicrobial resistance.[13] Additionally, WHO reports indicate that up to 5% of national healthcare expenditures could be conserved through rational prescribing, price regulation, and stringent pharmaceutical quality control measures.[14]

A systematic analysis of prescription patterns, commonly categorized under drug utilization research (DUR), serves as a crucial tool in understanding medication usage trends, evaluating adherence to clinical guidelines, and identifying areas for optimization in prescribing practices.[15] Drug utilization research encompasses various aspects of medication use, including marketing, distribution, prescription patterns, and clinical impact. These studies provide valuable insights into physician prescribing behaviors, patient adherence, and healthcare system efficiency, ultimately guiding

policymakers and clinicians in improving medication use. [16,17]Despite extensive research on drug utilization across multiple healthcare domains, there remains a notable gap in the literature specifically examining antihypertensive prescribing patterns in India. Given the increasing prevalence of hypertension and the evolving therapeutic landscape, there is an urgent need to assess the current state of antihypertensive drug use in real-world clinical settings.[18,19]

This study seeks to bridge the existing knowledge gap by systematically evaluating antihypertensive drug utilization patterns in India, with a specific focus on assessing the prescription trends of various antihypertensive drug classes in clinical practice. It aims to evaluate the extent of adherence to evidence-based guidelines such as JNC 7, JNC 8, and WHO recommendations while identifying factors influencing prescribing behaviors, including patient demographics, comorbid conditions, and healthcare provider preferences. Additionally, the study will examine the prevalence of polypharmacy and its implications on patient safety and treatment efficacy, highlighting the need for more rational prescribing practices. By analyzing these aspects, the study aims to propose strategies to optimize antihypertensive therapy, ensuring a rational, cost-effective, and patient-centered approach to hypertension management. Addressing these objectives will provide a comprehensive understanding of current antihypertensive prescription practices, highlight areas for improvement, and contribute to the formulation of policies that enhance rational drug use in hypertension management. Given the rising burden of cardiovascular diseases in India, such research is imperative to guide clinicians and policymakers toward more effective, evidence-based therapeutic strategies, ultimately improving patient outcomes and reducing the economic burden on the healthcare system.

Methodology:

The study was a cross-sectional observational study conducted over two years (June 2023–June 2024) in the outpatient department of medicine at Santosh Medical College and Hospital, a 1000-bedded tertiary care hospital in Ghaziabad, Uttar Pradesh. It aimed to evaluate prescribing patterns of antihypertensive drugs and adherence to treatment guidelines. Ethical approval was obtained before initiation, and to minimize physician bias, prescribers were not informed about the research. The study included 1000 patient prescriptions, with participants selected based on predefined inclusion and exclusion criteria. Hypertensive patients aged 18 years and above, including those with comorbidities such as diabetes mellitus, ischemic heart disease, and congestive heart failure, were included, while patients with severe learning disabilities, organic brain syndromes, referrals from other departments, and those not receiving antihypertensive treatment were excluded.

Prescription data were collected using a structured data collection form and recorded in Microsoft Excel for analysis. Prescriptions were assessed based on WHO drug use indicators, including the average number of drugs per prescription, the percentage of antihypertensive drugs prescribed by generic name, the proportion of prescriptions containing fixed-dose combinations (FDCs), the percentage of injectable antihypertensive drugs prescribed, the percentage of antihypertensive drugs from the Essential Drug List (EDL), and the prevalence of polypharmacy. The study also examined WHO prescribing indicators, such as the percentage of drugs prescribed by generic versus brand name and the percentage of prescriptions with antibiotics.

Statistical analysis was conducted using SPSS. Descriptive statistics, including means, medians, standard deviations, frequencies, and percentages, summarized the data. Categorical variables were analyzed using the chi-square test, with a p-value of less than 0.05 considered statistically significant. Inferential statistical methods assessed correlations between prescribing behaviors and patient characteristics.

The study provided insights into drug utilization patterns in hypertension management, identified gaps in prescribing practices, and offered recommendations to optimize treatment regimens. By

analyzing prescription trends, it contributed to the literature on rational drug use, promoting evidence-based, cost-effective, and patient-centered approaches to hypertension management. The findings aimed to reduce the economic burden on the healthcare system and improve overall patient outcomes.

Results:

A total of 2978 drugs were prescribed, out of which 1086 (36.5%) were antihypertensive agents, with an average of 1.67 antihypertensive drugs per prescription. Notably, only 24.40% of antihypertensive drugs were prescribed by their generic name, indicating a preference for brand-name medications. Fixed-dose combinations (FDCs) were used in 41.70% of prescriptions, aligning with combination therapy recommendations for hypertension. Injectable antihypertensive use was minimal (2.11%), and 68.82% of antihypertensive agents were from the National List of Essential Medicines (NLEM 2020). However, polypharmacy was observed in 91.70% of prescriptions, suggesting a high prevalence of multiple drug regimens.

Table 1: Analysis of prescription based on WHO drug use indicator

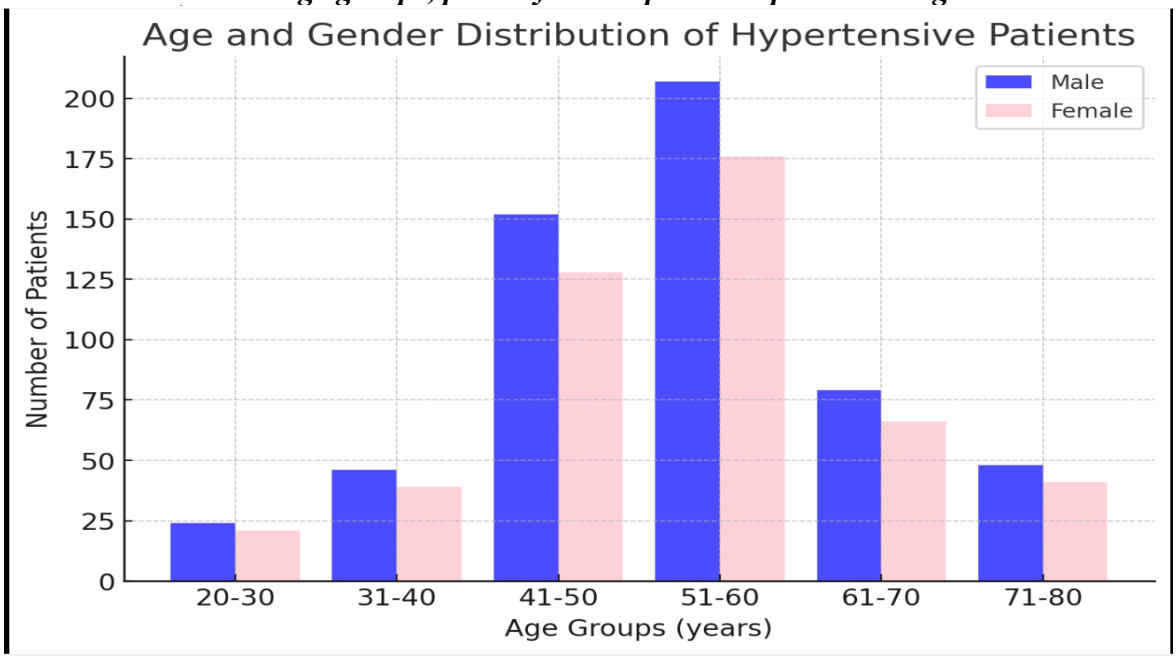
Drug use indicator	Result of analysis
Total no prescription	1027
Total no drugs	2978
Total no antihypertensive drugs	1086
Average no of the antihypertensive drugs per prescription	1.67%
Percentage of the antihypertensive agents	36.5%
Percentage of the antihypertensive agents prescribed by generic name	24.40%
Percentage of injectable drugs prescribed	2.11%
Percentage of prescription containing FDC (Antihypertensive agents)	41.70%
Percentage of the antihypertensive agents prescribed by essential drug list (NLEM 2020)	68.82%
Percentage of Polypharmacy	91.70%

To analyze the correlation between age and gender distribution among the hypertensive patients in the study (n=1027), we first examine the proportion of males (54.14%) and females (45.85%) across different age groups. The highest prevalence of hypertension is observed in the 51–60 years age group (37.29%), followed by 41–50 years (27.26%). These two middle-aged groups together account for 64.55% of the total hypertensive population, highlighting the increasing risk of hypertension with advancing age.

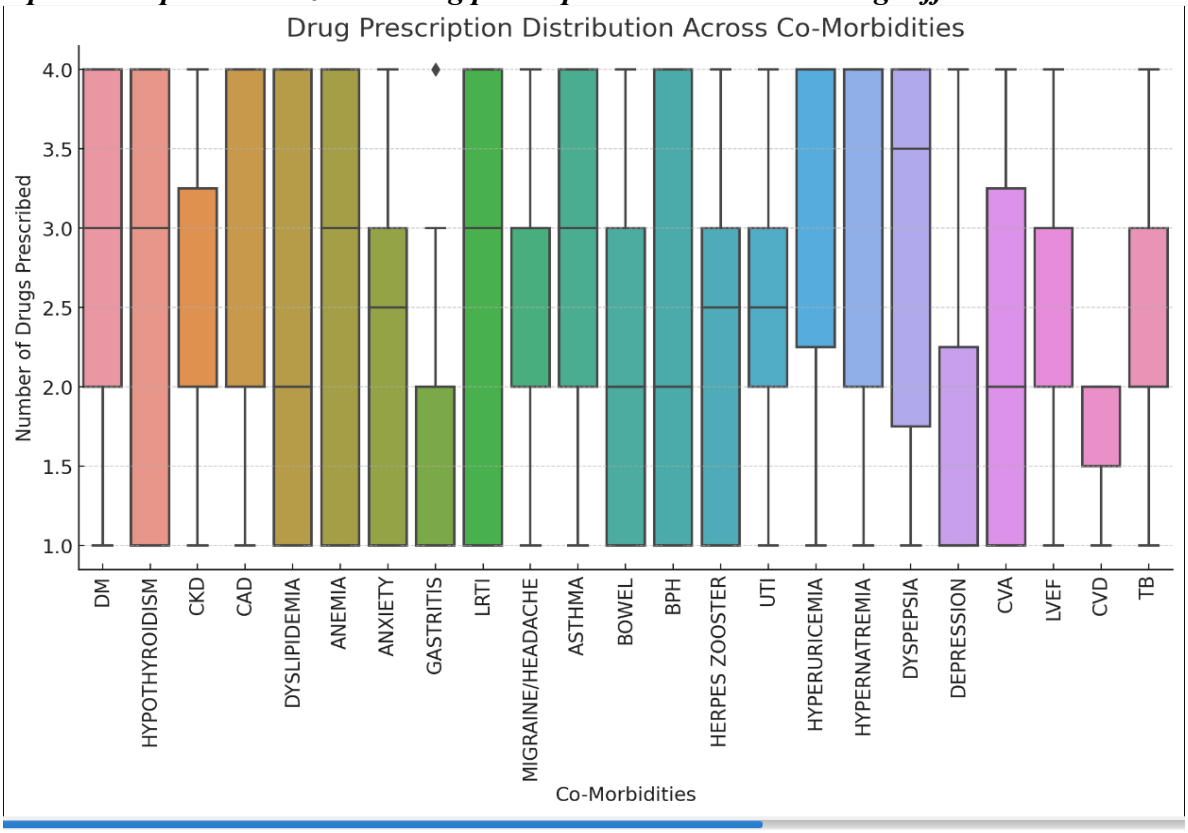
The prevalence then declines in the 61–70 years (14.12%) and 71–80 years (8.67%) age groups, possibly due to mortality or better hypertension management in elderly populations.When comparing gender distribution across age groups, a higher number of males are observed in all age categories, indicating a slightly greater burden of hypertension in men. This trend aligns with global data suggesting that men have a higher prevalence of hypertension in early and middle adulthood, possibly due to lifestyle factors, genetic predisposition, and lower healthcare-seeking behavior.

However, the gender gap narrows in older age groups as postmenopausal women experience an increased risk of hypertension due to hormonal changes, leading to nearly equal prevalence in later years.The following bar chart visually represents the distribution of hypertension cases by age and gender, illustrating the predominance of middle-aged males in the study population.

Graph1- The bar chart illustrates the distribution of hypertensive patients across different age groups, categorized by gender. It highlights that the highest number of cases are in the 51-60 years and 41-50 years age groups, with males outnumbering females in all categories. The trend suggests that hypertension prevalence is higher in middle-aged men, while the gender gap narrows in older age groups, possibly due to postmenopausal changes in women.



Graph 2- box plot visualizes the drug prescription distribution among different co-morbidities



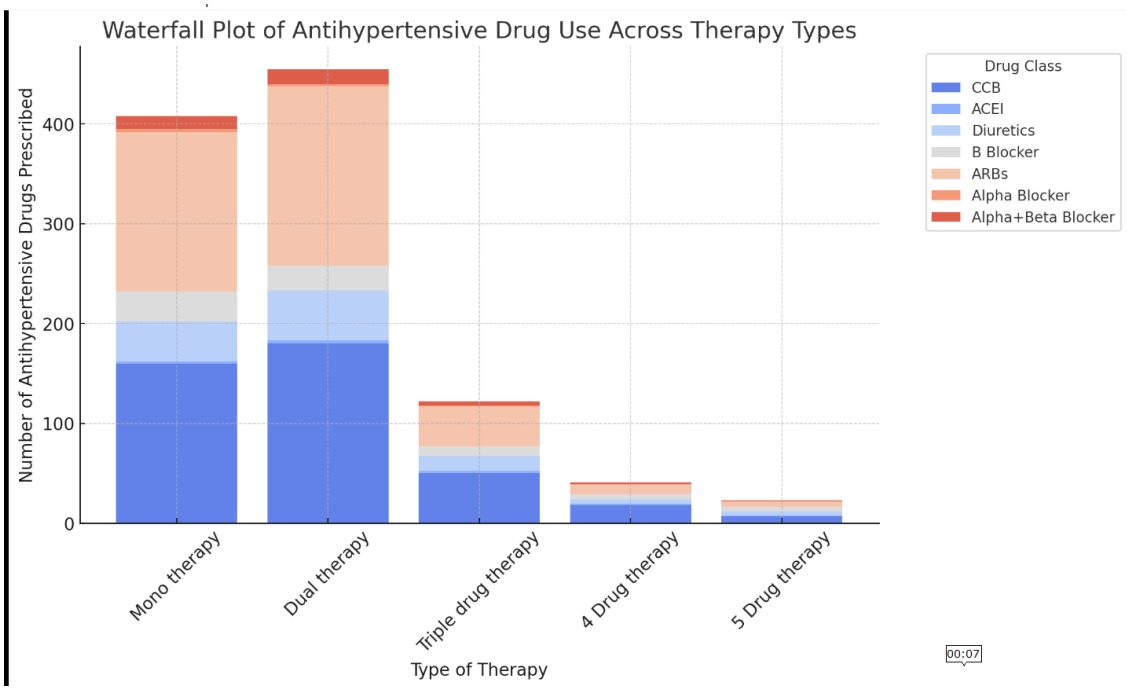
Among the 1027 patients analyzed, Diabetes Mellitus (36.35%) was the most prevalent co-morbidity, followed by Coronary Artery Disease (14.16%) and Hypothyroidism (10.67%), with other conditions like Dyslipidemia (9.44%), Chronic Kidney Disease (5.66%), and Anemia (2.64%) occurring less frequently. Despite variations in disease prevalence, ANOVA analysis showed no

statistically significant difference in the number of drugs prescribed across different co-morbidities ($p = 0.374$), suggesting a consistent prescribing pattern regardless of condition. A total of 2978 drugs were prescribed across 1027 prescriptions, with antihypertensive agents accounting for 36.5% (1086 drugs). The average number of antihypertensive drugs per prescription was 1.67, with 24.40% prescribed by generic name, 2.11% as injectables, and 41.70% as part of fixed-dose combinations. Additionally, 68.82% of antihypertensive agents were from the essential drug list (NLEM 2020). Polypharmacy was observed in 91.70% of cases, indicating that most patients required multiple medications, likely due to the presence of multiple co-morbid conditions.

Among the 1027 enrolled patients, the majority received dual therapy (45.28%), followed by monotherapy (39.73%), while smaller proportions required triple (11.88%), four-drug (2.14%), or five-drug therapy (0.97%). The preference for dual therapy suggests a strategic approach to balancing efficacy and side effects, while the lower prevalence of multi-drug regimens may indicate successful blood pressure control with fewer agents or concerns over polypharmacy. Among the 1086 prescribed antihypertensive drugs, Angiotensin Receptor Blockers (ARBs) (40.15%) and Calcium Channel Blockers (CCBs) (38.21%) were the most frequently used, reflecting their first-line recommendation in hypertension guidelines, while Diuretics (10.50%), Beta Blockers (6.81%), ACE Inhibitors (0.83%), and Alpha Blockers (0.55%) were used less frequently. The chi-square test showed no statistically significant association between therapy type and drug class distribution ($\chi^2 = 20.84$, $p = 0.648$), indicating that prescription patterns were relatively consistent across different therapy regimens. The data suggest that monotherapy primarily consists of ARBs or CCBs due to their effectiveness, while dual therapy often combines ARBs/CCBs with diuretics or beta-blockers for better control. Triple and quadruple therapy commonly includes diuretics, beta-blockers, and alpha-blockers, mainly in patients with resistant hypertension or co-existing conditions like heart failure, highlighting a tailored approach to hypertension management.

- ARBs and CCBs are the most commonly used across all therapy types.
- Diuretics and Beta Blockers become more prevalent as therapy intensifies (triple/quadruple therapy).
- Alpha Blockers and Alpha+Beta Blockers are rarely prescribed, indicating their limited role in routine hypertension management.

Graph 3- waterfall plot visually represents the distribution of antihypertensive drug classes across different therapy types. It highlights that:

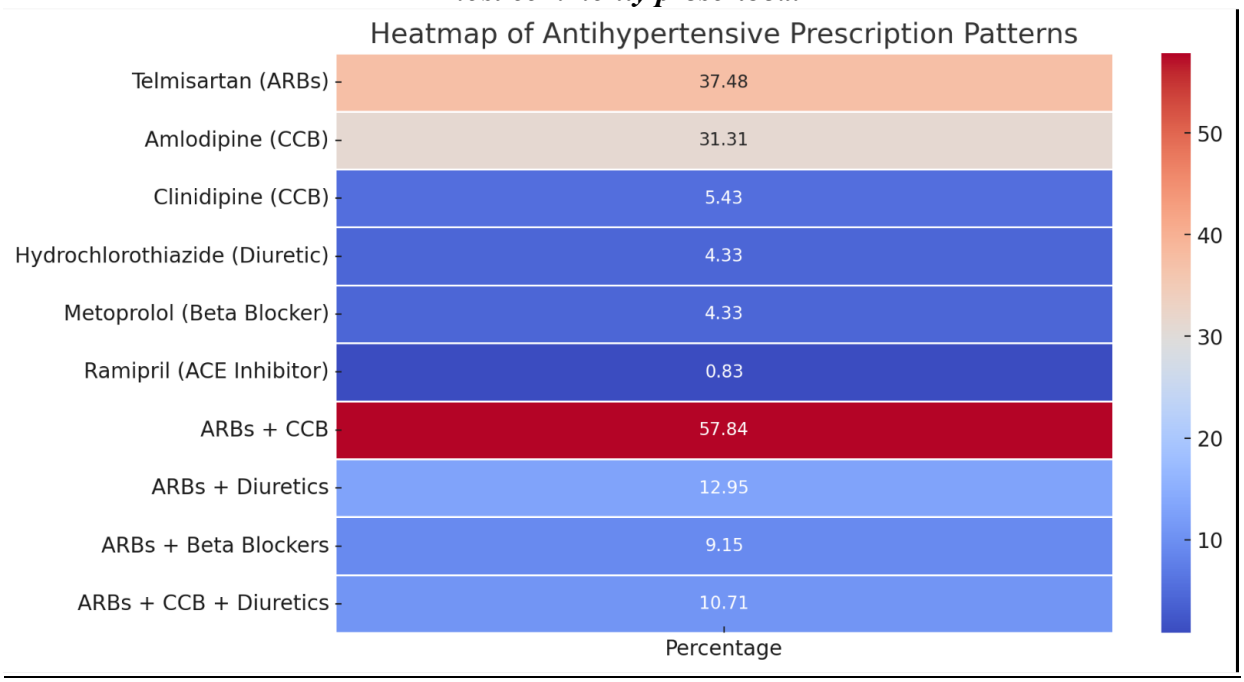


Among the 1086 antihypertensive drugs prescribed, Angiotensin Receptor Blockers (ARBs) were the most frequently used class, with Telmisartan (37.48%) being the most prescribed drug, followed by Amlodipine (31.31%) from the Calcium Channel Blocker (CCB) class. Other notable prescriptions included Clinidipine (5.43%), Hydrochlorothiazide (4.33%), and Metoprolol (4.33%). ACE inhibitors were the least commonly prescribed, with Ramipril (0.83%) being the only representative. The combination therapy patterns reflected this preference, with ARBs+CCB being the most commonly used fixed-dose combination (57.84%), followed by ARBs+Diuretics (12.95%) and ARBs+Beta Blockers (9.15%). Triple combinations like ARBs+CCB+Diuretics (10.71%) were less frequent, indicating that while dual therapy remains dominant, triple-drug regimens are selectively used in cases requiring tighter blood pressure control. The limited use of ACE inhibitors and Alpha Blockers suggests a preference for ARBs and CCBs in current hypertension management, likely due to their better tolerability and efficacy.

Among the 1027 patients analyzed, blood pressure (BP) distribution at the time of OPD visit showed that 4.19% had normal BP, while 23.17% were in the prehypertension range. Hypertension Stage 1 was observed in 26.39% of patients, whereas 43.04% were classified under Stage 2 hypertension. Notably, 3.21% of patients presented with severe hypertension (>200/>100 mmHg), indicating a significant proportion of uncontrolled hypertension cases.

Regarding drug interactions, several antihypertensive combinations demonstrated potential risks. Telmisartan with spironolactone was identified as a major interaction due to the life-threatening risk of hyperkalemia, necessitating close monitoring of serum potassium levels, especially in patients with renal dysfunction. Moderate interactions included metoprolol with amlodipine, which may cause hypotension and bradycardia, requiring careful cardiac function monitoring. Ramipril with diclofenac showed a risk of hyperkalemia and renal failure, suggesting cautious patient evaluation. Additionally, minor interactions such as atenolol or metoprolol with aspirin resulted in reduced drug efficacy, requiring BP monitoring. These findings emphasize the need for careful prescription practices to mitigate adverse effects associated with polypharmacy in hypertensive patients.

Graph 4: the heatmap representing the prescription patterns of antihypertensive drugs and their combinations. The color intensity reflects the frequency of use, with ARBs and CCBs being the most commonly prescribed.



Discussion:

Hypertension is a major public health concern and a leading risk factor for cardiovascular diseases, stroke, and kidney failure worldwide.[20] According to the Global Burden of Disease Study,

hypertension contributes significantly to morbidity and mortality, particularly in low- and middle-income countries like India, where its prevalence has been steadily increasing[21]. The rising burden of hypertension is driven by lifestyle factors, genetic predisposition, urbanization, and an aging population.[22]

Effective hypertension management requires long-term pharmacological therapy alongside lifestyle modifications. International guidelines, such as those from the American College of Cardiology (ACC)/American Heart Association (AHA) and the European Society of Hypertension (ESH), emphasize the importance of individualized treatment strategies to achieve optimal blood pressure control [23]. In India, the Indian Hypertension Guidelines (2022) advocate for the use of Angiotensin Receptor Blockers (ARBs), Calcium Channel Blockers (CCBs), and diuretics as first-line therapies, with combination therapy recommended in patients with moderate to severe hypertension[24].

Despite the availability of evidence-based treatment strategies, hypertension control rates remain suboptimal due to factors such as poor medication adherence, lack of awareness, healthcare accessibility issues, and inappropriate prescribing practices. Additionally, polypharmacy—a common practice in hypertensive patients with comorbid conditions—raises concerns about adverse drug interactions and medication safety[25].

This study aims to analyze antihypertensive prescription patterns in India, evaluate adherence to clinical guidelines, and assess the impact of polypharmacy on patient safety. Understanding these prescribing trends is crucial for optimizing hypertension management and minimizing treatment-related complications.

The present study provides a comprehensive analysis of antihypertensive prescription patterns and their association with patient demographics, particularly age and gender, in a cohort of 1,027 hypertensive patients in India.Our findings indicate that hypertension prevalence increases with age, peaking in the 51–60 years age group (37.29%), followed by the 41–50 years group (27.26%). This trend aligns with existing literature,[26] which reports a higher prevalence of hypertension among older adults. For instance, a study found that individuals aged 60 and above had a hypertension prevalence of 48.4%. Gender-wise, males constituted 54.14% of the hypertensive population, while females accounted for 45.85%. This male predominance is consistent with previous research indicating a higher prevalence of hypertension in men up to the age of 50, after which women exhibit higher rates.[27] The increased risk in postmenopausal women is often attributed to hormonal changes influencing blood pressure regulation.Diabetes Mellitus (36.35%) emerged as the most prevalent comorbidity, followed by Coronary Artery Disease (14.16%) and Hypothyroidism (10.67%). Despite these comorbid conditions, our ANOVA analysis revealed no statistically significant difference in the number of drugs prescribed across different comorbidities ($p = 0.374$), suggesting a consistent prescribing pattern irrespective of the specific comorbidity.In terms of antihypertensive therapy, dual therapy was most common (45.28%), followed by monotherapy (39.73%), and triple therapy (11.88%). This preference for combination therapy is corroborated by studies highlighting the efficacy of dual therapy in achieving better blood pressure control.[28]Angiotensin Receptor Blockers (ARBs) (40.15%) and Calcium Channel Blockers (CCBs) (38.21%) were the most frequently prescribed antihypertensive classes. This prescribing pattern is consistent with other studies reporting a high utilization of ARBs and CCBs in hypertensive patients[28]. The preference for these classes may be due to their favorable side effect profiles and efficacy in blood pressure management.A significant proportion of patients presented with uncontrolled hypertension, with 43.04% in Stage 2 and 3.21% with severe hypertension (>200/>100 mmHg). This finding underscores the need for effective management strategies and patient adherence to therapy.Among the 1,027 patients analyzed, dual therapy was the most commonly prescribed regimen (45.28%), with ARBs and CCBs being the most frequently utilized drug classes. Polypharmacy was prevalent in 91.70% of cases, raising concerns regarding medication safety. Notably, combinations such as Telmisartan and Spironolactone posed significant risks of hyperkalemia, especially in patients with renal dysfunction. These findings underscore the necessity for rational prescribing practices to enhance treatment efficacy and patient safety.

The observed prescription trends align with previous research highlighting a preference for ARBs and CCBs as first-line agents in hypertension management. A study conducted in a tertiary care hospital in Western India similarly reported ARBs as the most commonly prescribed antihypertensive agents, either alone or in combination[29].Another study demonstrated that CCBs, particularly Amlodipine, were frequently utilized due to their efficacy in reducing blood pressure with minimal metabolic side effects[30].Furthermore, the high prevalence of polypharmacy observed in this study is consistent with global trends, as multiple drug regimens have been linked to higher risks of adverse drug reactions, drug-drug interactions, and reduced medication adherence[31]. Notably, the combination of Telmisartan and Spironolactone has been associated with life-threatening hyperkalemia, necessitating strict monitoring of serum potassium levels, particularly in patients with compromised renal function[32].The findings from this study highlight the importance of adherence to evidence-based guidelines and routine medication reviews to mitigate the risks associated with polypharmacy. Implementing strategies such as medication reconciliation, therapeutic drug monitoring, and patient education can enhance treatment adherence and optimize long-term blood pressure control.While combination therapy remains a cornerstone of hypertension management, a tailored approach that considers individual patient profiles, renal function, and potential drug interactions is essential. Future research should focus on longitudinal studies assessing clinical outcomes associated with different antihypertensive regimens to further refine personalized treatment strategies.

Conclusion

This study provides valuable insights into the prescribing patterns of antihypertensive drugs in a tertiary care hospital. The findings indicate a high prevalence of polypharmacy, frequent use of combination therapy, and a preference for brand-name medications over generic prescribing. Angiotensin Receptor Blockers (ARBs) and Calcium Channel Blockers (CCBs) emerged as the most commonly prescribed drug classes, with Telmisartan and Amlodipine being the preferred agents. Despite adherence to essential medicine guidelines in most cases, the underutilization of generic names and the high rate of polypharmacy highlight areas for improvement. Ensuring rational drug prescribing, promoting the use of generic medications, and adhering to evidence-based guidelines can enhance the cost-effectiveness and overall quality of hypertension management. Further studies are warranted to evaluate long-term treatment outcomes and adherence patterns among hypertensive patients.

Reference

1. Mills KT, Stefanescu A, He J. The global epidemiology of hypertension. Nat Rev Nephrol. 2020 Apr;16(4):223-237. doi: 10.1038/s41581-019-0244-2. Epub 2020 Feb 5. PMID: 32024986; PMCID: PMC7998524.
2. Bromfield S, Muntner P. High blood pressure: the leading global burden of disease risk factor and the need for worldwide prevention programs. Curr Hypertens Rep. 2013 Jun;15(3):134-6. doi: 10.1007/s11906-013-0340-9. PMID: 23536128; PMCID: PMC3699411.
3. NCD Risk Factor Collaboration (NCD-RisC). Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. Lancet. 2021 Sep 11;398(10304):957-980. doi: 10.1016/S0140-6736(21)01330-1. Epub 2021 Aug 24. Erratum in: Lancet. 2022 Feb 5;399(10324):520. doi: 10.1016/S0140-6736(22)00061-7. PMID: 34450083; PMCID: PMC8446938.
4. Sreeniwas Kumar A, Sinha N. Cardiovascular disease in India: A 360 degree overview. Med J Armed Forces India. 2020 Jan;76(1):1-3. doi: 10.1016/j.mjafi.2019.12.005. Epub 2020 Jan 13. PMID: 32020960; PMCID: PMC6994761.
5. Ramakrishnan S, Zachariah G, Gupta K, Shivkumar Rao J, Mohanan PP, Venugopal K, Sateesh S, Sethi R, Jain D, Bardolei N, Mani K, Kakar TS, Kidambi B, Bhushan S, Verma SK, Bhargava B, Roy A, Kothari SS, Gupta R, Bansal S, Sood S, Nath RK, Tyagi S, Gupta MD,

Girish MP, Kalra IPS, Wander GS, Gupta S, Mandal S, Senguttuvan NB, Subramanyam G, Roy D, Datta S, Ganguly K, Routray SN, Mishra SS, Singh BP, Bharti BB, Das MK, Kumar S, Goswami KC, Bahl VK, Chandra S, Banerjee A, Guha S, Deb PK, Chopra HK, Deedwania P, Seth A; CSI-Great India BP Campaign Investigators. Prevalence of hypertension among Indian adults: Results from the great India blood pressure survey. Indian Heart J. 2019 Jul-Aug;71(4):309-313. doi: 10.1016/j.ihj.2019.09.012. Epub 2019 Sep 18. PMID: 31779858; PMCID: PMC6890959.

6. Carey RM, Wright JT Jr, Taler SJ, Whelton PK. Guideline-Driven Management of Hypertension: An Evidence-Based Update. Circ Res. 2021 Apr 2;128(7):827-846. doi: 10.1161/CIRCRESAHA.121.318083. Epub 2021 Apr 1. PMID: 33793326; PMCID: PMC8034801.
7. Heidari B, Avenatti E, Nasir K. Pharmacotherapy for Essential Hypertension: A Brief Review. Methodist Debakey Cardiovasc J. 2022 Dec 6;18(5):5-16. doi: 10.14797/mdcvj.1175. PMID: 36561082; PMCID: PMC9733188.
8. Evbayekha EO, Okobi OE, Okobi T, Ibeson EC, Nwafor JN, Ozobokeme OE, Olawoye A, Ngoladi IA, Boms MG, Habib FA, Oyelade BO, Okoroafor CC, Chukwuma VN, Alex KB, Ohikhuai EE. The Evolution of Hypertension Guidelines Over the Last 20+ Years: A Comprehensive Review. Cureus. 2022 Nov 13;14(11):e31437. doi: 10.7759/cureus.31437. PMID: 36523741; PMCID: PMC9746526.
9. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr, Roccella EJ; National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; National High Blood Pressure Education Program Coordinating Committee. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA. 2003 May 21;289(19):2560-72. doi: 10.1001/jama.289.19.2560. Epub 2003 May 14. Erratum in: JAMA. 2003 Jul 9;290(2):197. PMID: 12748199.
10. James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, Lackland DT, LeFevre ML, MacKenzie TD, Ogedegbe O, Smith SC Jr, Svetkey LP, Taler SJ, Townsend RR, Wright JT Jr, Narva AS, Ortiz E. 2014 evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014 Feb 5;311(5):507-20. doi: 10.1001/jama.2013.284427. Erratum in: JAMA. 2014 May 7;311(17):1809. PMID: 24352797.
11. Al-Makki A, DiPette D, Whelton PK, Murad MH, Mustafa RA, Acharya S, Beheiry HM, Champagne B, Connell K, Cooney MT, Ezeigwe N, Gaziano TA, Gidio A, Lopez-Jaramillo P, Khan UI, Kumarapeli V, Moran AE, Silwimba MM, Rayner B, Sukonthasan A, Yu J, Saraffzadegan N, Reddy KS, Khan T. Hypertension Pharmacological Treatment in Adults: A World Health Organization Guideline Executive Summary. Hypertension. 2022 Jan;79(1):293-301. doi: 10.1161/HYPERTENSIONAHA.121.18192. Epub 2021 Nov 15. PMID: 34775787; PMCID: PMC8654104.
12. Paz MA, de-La-Sierra A, Sáez M, Barceló MA, Rodríguez JJ, Castro S, Lagarón C, Garrido JM, Vera P, Coll-de-Tuero G. Treatment efficacy of anti-hypertensive drugs in monotherapy or combination: ATOM systematic review and meta-analysis of randomized clinical trials according to PRISMA statement. Medicine (Baltimore). 2016 Jul;95(30):e4071. doi: 10.1097/MD.0000000000004071. PMID: 27472680; PMCID: PMC5265817.
13. Ofori-Asenso R, Agyeman AA. Irrational Use of Medicines-A Summary of Key Concepts. Pharmacy (Basel). 2016 Oct 28;4(4):35. doi: 10.3390/pharmacy4040035. PMID: 28970408; PMCID: PMC5419375.
14. Garg M, Vishwakarma P, Sharma M, Nehra R, Saxena KK. The impact of irrational practices: A wake up call. J Pharmacol Pharmacother. 2014 Oct;5(4):245-7. doi: 10.4103/0976-500X.142434. PMID: 25422564; PMCID: PMC4231553.

15. Joshi R, Medhi B, Prakash A, Chandy S, Ranjalkar J, Bright HR, Basker J, Govindraj L, Chugh PK, Tripathi CD, Badyal DK, Balakrishnan S, Jhaj R, Shukla AK, Atal S, Najmi A, Banerjee A, Kamat S, Tripathi RK, Shetty YC, Parmar U, Rege N, Dikshit H, Mishra H, Roy SS, Chatterjee S, Hazra A, Bhattacharya M, Das D, Trivedi N, Shah P, Chauhan J, Desai C, Gandhi AM, Patel PP, Shah S, Sheth S, Raveendran R, Mathaiyan J, Manikandan S, Jeevitha G, Gupta P, Sarangi SC, Yadav HN, Singh S, Kaushal S, Arora S, Gupta K, Jain S, Cherian JJ, Chatterjee NS, Kaul R, Kshirsagar NA. Assessment of prescribing pattern of drugs and completeness of prescriptions as per the World Health Organization prescribing indicators in various Indian tertiary care centers: A multicentric study by Rational Use of Medicines Centers-Indian Council of Medical Research network under National Virtual Centre Clinical Pharmacology activity. Indian J Pharmacol. 2022 Sep-Oct;54(5):321-328. doi: 10.4103/ijp.ijp_976_21. PMID: 36537400; PMCID: PMC9846909.
16. Gama, Helena. (2007). Drug utilization studies. Arq Med. 22.
17. Wettermark, Bjorn & Elseviers, Monique & Almarsdóttir, Anna Birna & Andersen, Morten & Benko, Ria & Bennie, Marion & Eriksson, Irene & Godman, Brian & Krska, Janet & Poluzzi, Elisabetta & Taxis, Katja & Vander Stichele, Robert & Vlahovic-Palcevski, Vera. (2016). Introduction to drug utilization research. 10.1002/9781118949740.ch1.
18. Neville H, Trenaman SC. Drug Utilization Research: Methods and Applications. Can J Hosp Pharm. 2017 Jul-Aug;70(4):325. Epub 2017 Aug 31. PMCID: PMC5587052.
19. Nitya S, Ramya G, Kiruthika S, Meenakshi R, Devi JN, Suganya G, Pravin S. Drug utilization pattern and factors associated with polypharmacy and excessive polypharmacy in geriatric medical out-patients at a rural health training centre in India. J Family Med Prim Care. 2021 Jul;10(7):2636-2641. doi: 10.4103/jfmpc.jfmpc_2417_20. Epub 2021 Jul 30. PMID: 34568148; PMCID: PMC8415691.
20. Fuchs FD, Whelton PK. High Blood Pressure and Cardiovascular Disease. Hypertension. 2020 Feb;75(2):285-292. doi: 10.1161/HYPERTENSIONAHA.119.14240. Epub 2019 Dec 23. PMID: 31865786; PMCID: PMC10243231.
21. Kario, K., Okura, A., Hoshide, S. et al. The WHO Global report 2023 on hypertension warning the emerging hypertension burden in globe and its treatment strategy. Hypertens Res 47, 1099–1102 (2024). https://doi.org/10.1038/s41440-024-01622-w
22. Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Di Angelantonio E, Prabhakaran D. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. J Hypertens. 2014 Jun;32(6):1170-7. doi: 10.1097/HJH.0000000000000146. PMID: 24621804; PMCID: PMC4011565.
23. Giezendanner S, Tschudi P, Leuppi J, Dieterle T, Zeller A. Effect of guideline revisions by the Swiss Society of Hypertension on blood pressure control in hypertensive patients from primary care. Swiss Med Wkly. 2020 Jun 29;150:w20279. doi: 10.4414/smw.2020.20279. PMID: 32657419.
24. Satheesh G, Dhurjati R, Balagopalan JP, Mohanan PP, Salam A. Comparison of Indian clinical practice guidelines for the management of hypertension with the World Health Organization, International Society of Hypertension, American, and European guidelines. Indian Heart J. 2024 Jan-Feb;76(1):6-9. doi: 10.1016/j.ihj.2023.12.009. Epub 2024 Jan 1. PMID: 38171390; PMCID: PMC10943557.
25. Mukete BN, Ferdinand KC. Polypharmacy in Older Adults With Hypertension: A Comprehensive Review. J Clin Hypertens (Greenwich). 2016 Jan;18(1):10-8. doi: 10.1111/jch.12624. Epub 2015 Jul 27. PMID: 26215211; PMCID: PMC8031793.
26. Mohammad R, Bansod DW. Hypertension in India: a gender-based study of prevalence and associated risk factors. BMC Public Health. 2024 Oct 1;24(1):2681. doi: 10.1186/s12889-024-20097-5. PMID: 39354462; PMCID: PMC11443669.
27. Mohanty P, Patnaik L, Nayak G, Dutta A. Gender difference in prevalence of hypertension among Indians across various age-groups: a report from multiple nationally representative

samples. BMC Public Health. 2022 Aug 10;22(1):1524. doi: 10.1186/s12889-022-13949-5. PMID: 35948916; PMCID: PMC9364494.
28. Alexander T, Hiremath JS, Swahney JPS, Chandra S, Jain P, Chandra P, Sinha N, Sashikanth T, Bachhu Y, Balachandran A, Jayagopal PB, Unni TG, Nair T, Kannan K, Prabhakar D, Chenniappan M, Mahajan AU, Karnik RD, Ponde CK, Advani P, Khan IA, Goyal BM, Vaidyanathan PR, Prajapati H, Verberk WJ. Identifying Drug Prescription in Newly Diagnosed Hypertension Patients in India. J Clin Hypertens (Greenwich). 2025 Jan;27(1):e14963. doi: 10.1111/jch.14963. PMID: 39822165; PMCID: PMC11771799.
29. Abdelkader NN, Awaisu A, Elewa H, El Hajj MS. Prescribing patterns of antihypertensive medications: A systematic review of literature between 2010 and 2020. Explor Res Clin Soc Pharm. 2023 Aug 5;11:100315. doi: 10.1016/j.rcsop.2023.100315. PMID: 37635839; PMCID: PMC10448163.
30. Jadhav U, Mohanan PP, Almeida AF, Abraham G, Khan MY, Gaurav K, Mane A, Vikas S, Jain M, Meel B. Effectiveness and Effect on Renal Parameters of Amlodipine vs. Other Dihydropyridine Calcium Channel Blockers in Patients with Essential Hypertension: Retrospective Observational Study Based on Real-World Evidence from Electronic Medical Records. Cardiol Ther. 2021 Dec;10(2):465-480. doi: 10.1007/s40119-021-00224-8. Epub 2021 Jun 11. PMID: 34115326; PMCID: PMC8555025.
31. Delara M, Murray L, Jafari B, Bahji A, Goodarzi Z, Kirkham J, Chowdhury M, Seitz DP. Prevalence and factors associated with polypharmacy: a systematic review and Meta-analysis. BMC Geriatr. 2022 Jul 19;22(1):601. doi: 10.1186/s12877-022-03279-x. Erratum in: BMC Geriatr. 2022 Sep 12;22(1):742. doi: 10.1186/s12877-022-03388-7. PMID: 35854209; PMCID: PMC9297624.
32. Takahashi T, Ono H, Ono Y, Ishimitsu T, Matsuoka H. Combination therapy with telmisartan and spironolactone alleviates L-NAME exacerbated nephrosclerosis with an increase in PPAR-gamma and decrease in TGF-beta(1). Int Heart J. 2007 Sep;48(5):637-47. doi: 10.1536/ihj.48.637. PMID: 17998773.