

Antihypertensive Treatment Patterns and Factors Associated with Blood Pressure Control Across Türkiye: A Multicenter Cross-Sectional Study

ABSTRACT

Background: This study aimed to evaluate office blood pressure control, antihypertensive treatment patterns, and factors associated with uncontrolled office blood pressure among adults attending family health centers across Türkiye.

Methods: This multicenter cross-sectional study was conducted across the 7 geographical regions of Türkiye from February to December 2025. Adults aged ≥ 18 years with previous hypertension, antihypertensive treatment, and/or elevated office blood pressure at the study visit were included. Controlled office blood pressure was defined as $<140/90$ mm Hg for the primary analysis; achievement of $<130/80$ mmHg was assessed descriptively. Antihypertensive agents, drug classes, clinical characteristics, and laboratory parameters were recorded. Multiple binary logistic regression analysis identified factors independently associated with uncontrolled office blood pressure.

Results: Among 1483 participants, median age was 63.0 years and 60.2% were female. Of 1456 participants with classifiable blood pressure, 902 (62.0%) had office blood pressure $<140/90$ mm Hg. At the lower threshold, 438 of 1458 participants (30.0%) had office blood pressure $<130/80$ mm Hg. Two-drug therapy was most common (38.7%), followed by monotherapy (27.1%) and 3-drug therapy (18.5%). Older age and higher body mass index were associated with greater odds of uncontrolled office blood pressure, whereas female sex was associated with lower odds; geographical region and antihypertensive treatment category were also independently associated with office blood pressure control.

Conclusion: Office blood pressure was $<140/90$ mm Hg in nearly two-thirds of participants, whereas 30.0% met the descriptive $<130/80$ mm Hg threshold. Combination therapy predominated, and office blood pressure control was associated with demographic, clinical, regional, and treatment-related factors.

Keywords: Antihypertensive therapy, blood pressure control, cross-sectional study, hypertension, primary care, Türkiye, uncontrolled office blood pressure

INTRODUCTION

Hypertension is a major public health problem and remains one of the leading modifiable risk factors for cardiovascular disease, stroke, chronic kidney disease, and premature mortality worldwide.^{1,2} The World Health Organization identifies hypertension as a principal contributor to the global disease burden and emphasizes that effective blood pressure detection, treatment, and control are essential components of cardiovascular prevention.³⁻⁵ International recommendations therefore continue to prioritize early diagnosis, accurate measurement, long-term follow-up, and appropriate pharmacological management in routine adult care.^{6,7}

Because blood pressure reduction is directly associated with lower cardiovascular risk, timely diagnosis, standardized measurement, risk stratification, and treatment intensification are central to effective management.^{6,8,9} Randomized evidence, including the Systolic Blood Pressure Intervention Trial (SPRINT) trial, demonstrated that more intensive systolic blood pressure (SBP) control can reduce

ORIGINAL ARTICLE

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major cardiovascular events and all-cause mortality in selected high-risk patients, and contemporary European guidelines emphasize structured management pathways to improve control in clinical practice.¹⁰⁻¹²

In Türkiye, hypertension has remained a major health problem over time.¹³ The nationally representative PatenT study reported an age- and sex-adjusted hypertension prevalence of 31.8% in 2003, while PatenT 2 found a similar prevalence of 30.3% in 2012; although awareness, treatment, and control improved, overall control among hypertensive adults remained 28.7%.^{14,15} In primary health care settings, the Turkish Survey on High Blood Pressure in Primary Care (TURKSAHA) study also showed that blood pressure control rates were suboptimal among treated hypertensive patients.¹⁶

Although mentioned studies established the epidemiologic importance of hypertension in Türkiye, contemporary multicenter real-world data providing a comprehensive picture of blood pressure control, office blood pressure categories, antihypertensive treatment patterns, antihypertensive drug-class patterns, and clinical correlates of uncontrolled office blood pressure in community-based primary care populations remain limited. Addressing this gap is important for understanding current management patterns in primary health care and for identifying patient groups at higher risk of inadequate control. Therefore, this multicenter cross-sectional study aimed to evaluate office blood pressure control, office blood pressure categories, antihypertensive treatment patterns, and factors associated with uncontrolled office blood pressure among adults attending community-based primary care settings across the 7 geographical regions of Türkiye.

METHODS

Study Design and Setting

This multicenter cross-sectional study was conducted in family health centers across the 7 geographical regions of Türkiye. The study was designed to evaluate office blood pressure control, antihypertensive treatment patterns, and clinical characteristics among adults with previously diagnosed hypertension, receiving antihypertensive treatment, or presenting with elevated office blood pressure in routine primary care. Data collection was carried out from February to December 2025. Participants were recruited consecutively from participating family health centers during the study period. The study aimed to achieve broad geographical coverage across Türkiye; however, participants were recruited consecutively from participating centers rather than through probability-based national sampling, and regional sample sizes reflected center participation rather than population-proportionate sampling.

Sample Size

The minimum sample size was calculated using the single-population proportion formula for prevalence studies. Assuming a conservative prevalence of 50%, a 95% CI level, and a margin of error of 3%, the minimum required sample size was 1068 participants. Because the study was conducted in multiple primary care centers across different geographical regions, a design effect of 1.2 was applied, yielding an adjusted minimum sample size of 1282 participants. To account for possible missing data and incomplete records, an additional 10% was added, resulting in a final target sample size of 1410 participants. The final study sample of 1483 participants exceeded this requirement.

The largest proportion of participants was recruited from the Marmara region (n = 471; 31.8%), followed by Central Anatolia (n = 262; 17.7%), the Mediterranean region (n = 252; 17.0%), and the Black Sea region (n = 211; 14.2%) (Figure 1).

HIGHLIGHTS

- Office blood pressure was <140/90 mmHg in 62.0% of participants, whereas 30.0% met the additional descriptive <130/80 mmHg threshold.
- Two-drug therapy was the most common antihypertensive treatment pattern.
- Older age and higher body mass index were associated with greater odds of uncontrolled office blood pressure.
- Geographical region and antihypertensive treatment category remained associated with office blood pressure control after multiple regression adjustment.

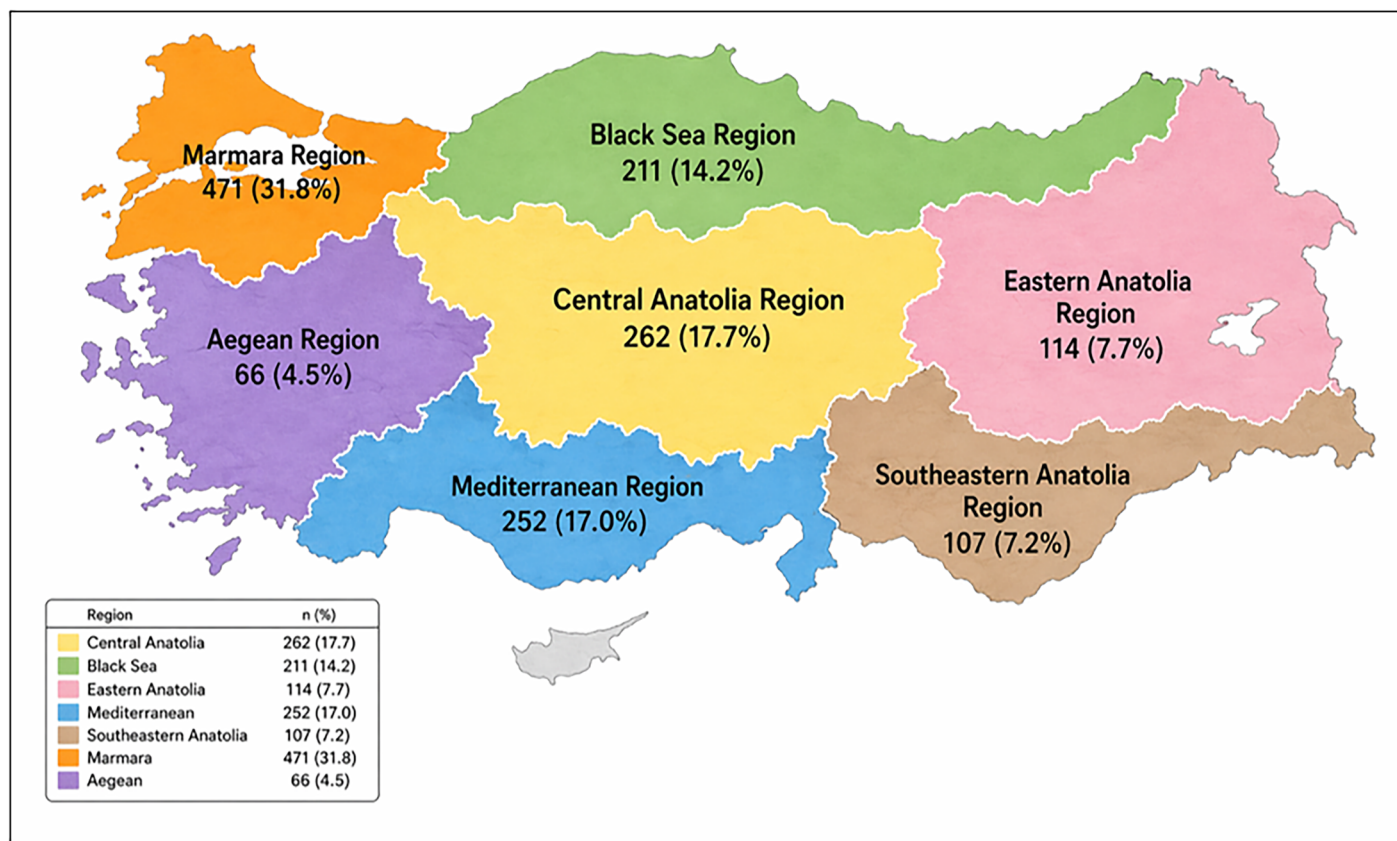


Figure 1. Regional distribution of study population in Türkiye.

Participants

The study population consisted of adults evaluated in family health centers who had a previous diagnosis of hypertension, were receiving antihypertensive treatment, and/or had elevated office blood pressure at the study visit. Untreated participants with elevated office blood pressure were included to characterize elevated blood pressure encountered in routine primary care. Because hypertension was not confirmed at separate visits or by home or ambulatory blood pressure monitoring, these untreated participants were not considered to have confirmed hypertension solely on the basis of the study-visit measurements.

Participants were excluded if they were younger than 18 years, declined participation, had incomplete blood pressure measurements precluding assessment of office blood pressure control, or had missing treatment data preventing classification of treatment category or treatment and blood pressure status group. For group-based analyses, participants with missing data preventing allocation to one of the predefined treatment and blood pressure status groups were excluded from those specific analyses.

Data Collection

Data included sociodemographic and anthropometric characteristics (age, sex, geographical region, and body mass index [BMI]), clinical variables (comorbidities, office blood pressure measurements), antihypertensive treatment details (such as antihypertensive drug classes), and

available laboratory parameters recorded by the investigators in participating family health centers. Comorbidities included diabetes, coronary artery disease, heart failure, ischemic cerebrovascular disease, hemorrhagic cerebrovascular disease, hypothyroidism, hyperthyroidism, and atrial fibrillation. Estimated glomerular filtration rate (eGFR) was calculated from serum creatinine, age, and sex using the 2021 Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation without a race coefficient.¹⁷

Blood Pressure Measurement Procedure and Definitions

Office blood pressure was measured using validated automated upper-arm sphygmomanometric devices available at each participating center, in accordance with international validation standards and guideline-based office measurement principles. After at least 5 minutes of seated rest, blood pressure was measured in both arms at the initial assessment, and repeat measurements were obtained at 1-2-minute intervals. The mean of the last 2 readings was used for the primary analyses. Blood pressure values displayed by the automated devices were manually entered into the study database by the investigators rather than transferred electronically. The recorded values were used for the statistical analyses without additional rounding or transformation at the analysis stage.

For the primary analysis, controlled office blood pressure was defined as a mean SBP < 140 mm Hg and a mean diastolic blood pressure (DBP) < 90 mm Hg; uncontrolled

office blood pressure was defined as values ≥ 140 and/or ≥ 90 mmHg. In addition, achievement of office blood pressure $< 130/80$ mm Hg was evaluated descriptively as a lower threshold to provide a complementary assessment of blood pressure control and facilitate comparison with contemporary studies.¹⁸ Achievement of $< 130/80$ mm Hg required both SBP < 130 mm Hg and DBP < 80 mm Hg. For descriptive classification, uncontrolled office blood pressure values were grouped within grade 1 (140-159 and/or 90-99 mm Hg), grade 2 (160-179 and/or 100-109 mm Hg), and grade 3 (≥ 180 and/or ≥ 110 mm Hg) ranges. An isolated systolic office blood pressure pattern was defined as SBP ≥ 140 mm Hg with DBP < 90 mm Hg, and an isolated diastolic office blood pressure pattern as SBP < 140 mm Hg with DBP ≥ 90 mm Hg.^{19,20}

Antihypertensive Treatment Assessment

Antihypertensive treatment was evaluated according to the number of prescribed antihypertensive agents and drug class. Participants were categorized as receiving no antihypertensive medication, monotherapy, 2-drug therapy, 3-drug therapy, or ≥ 4 -drug therapy according to the total number of antihypertensive agents used at the time of assessment. Medication dose was not available; therefore, these categories reflect the number of prescribed agents rather than pharmacological treatment intensity.

Antihypertensive drug classes were classified as angiotensin-converting enzyme inhibitors, angiotensin receptor blockers, dihydropyridine calcium channel blockers, non-dihydropyridine calcium channel blockers, diuretics, potassium-sparing diuretics, beta-blockers, alpha-blockers, centrally acting agents, and direct vasodilators. Individual agents were also recorded for descriptive subgroup analyses.

Treatment and Blood Pressure Status Groups

Participants were additionally categorized into 4 treatment and blood pressure status groups based on treatment status and contemporaneous office blood pressure control:

- Group 1: participants not receiving antihypertensive medication, irrespective of office blood pressure status.
- Group 2: participants using 1 or 2 antihypertensive agents with uncontrolled office blood pressure.
- Group 3: participants using 1 to 3 antihypertensive agents with controlled office blood pressure.
- Group 4: participants using at least 3 antihypertensive agents with uncontrolled office blood pressure or at least 4 antihypertensive agents with controlled office blood pressure.

Statistical Analysis

All statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS) Statistics version 25.0 (IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed using the Shapiro–Wilk test. As the continuous variables were not normally distributed, they were summarized as median (interquartile range [IQR]), while categorical variables were presented as number and percentage.

Comparisons between participants with controlled and uncontrolled office blood pressure were performed using the Mann–Whitney *U*-test for continuous variables and the chi-square test or Fisher's exact test, where appropriate, for categorical variables. Comparisons across the 4 treatment and blood pressure status groups were performed using the Kruskal–Wallis test for continuous variables and the chi-square test for categorical variables. As an additional descriptive analysis, the proportion of participants achieving office blood pressure $< 130/80$ mm Hg was calculated overall and according to antihypertensive treatment category.

To identify factors independently associated with uncontrolled office blood pressure, multiple binary logistic regression analysis was performed. The model included age, sex, BMI, diabetes mellitus, coronary artery disease, atrial fibrillation, eGFR, serum urea, geographical region, and antihypertensive treatment category. Geographical region and antihypertensive treatment category were entered as categorical variables, with Marmara and monotherapy as the respective reference categories. Male sex and the absence of diabetes mellitus, coronary artery disease, and atrial fibrillation were used as reference categories. The regression model was fitted using complete-case data ($n = 1436$). Odds ratios and 95% CIs were reported. Model fit was assessed using the Hosmer–Lemeshow goodness-of-fit test, and explanatory performance was summarized using Nagelkerke R^2 . A 2-sided $P < .05$ was considered statistically significant.

Ethical Approval

The study was approved by the Erzincan Binali Yıldırım University Non-Interventional Clinical Research Ethics Committee (decision no. 2025-01/01, dated January 9, 2025). The ethics approval was subsequently updated 3 additional times due to revisions involving changes in the research team. Written informed consent was obtained from all participants before enrollment. The study was conducted in accordance with the principles of the Declaration of Helsinki.

RESULTS

Among 1483 participants, the median age was 63.0 years (IQR 55.0–71.0), 60.2% were female, and the median BMI was 29.4 kg/m² (IQR 26.6–33.2). Median systolic and DBPs were 130.0 mm Hg (IQR 120.0–140.0) and 80.0 mm Hg (IQR 74.8–87.0), respectively (Table 1). Blood pressure according to age group is shown in Figure 2.

Blood pressure findings are summarized in Table 2. Office blood pressure was $< 140/90$ mm Hg in 902 of 1456 participants (62.0%), whereas 438 of 1458 participants (30.0%) met the descriptive $< 130/80$ mm Hg threshold; corresponding proportions according to treatment category are shown in Table 2. The grade 1 range was the most common uncontrolled office blood pressure category (29.0%), and the isolated systolic pattern was more frequent than the isolated diastolic pattern (16.4% vs. 4.9%).

Antihypertensive treatment patterns are summarized in Table 3. Two-drug therapy was the most common treatment

Table 1. Baseline Demographic, Clinical, and Laboratory Characteristics of the Study Population

Variables	Overall
Sample size, n	1483
Demographic and anthropometric characteristics	Median (IQR)
Age (years)	63.0 (55.0-71.0)
Female, n (%)	893 (60.2)
Male, n (%)	590 (39.8)
Height (cm)	164.0 (157.0-170.0)
Weight (kg)	80.0 (71.0-90.0)
Body surface area (m ²)	1.91 (1.79-2.04)
BMI (kg/m ²)	29.4 (26.6-33.2)
Blood pressure measurements	
Mean SBP of the last 2 measurements (mm Hg)	130.0 (120.0-140.0)
Mean DBP of the last 2 measurements (mm Hg)	80.0 (74.8-87.0)
Comorbidities, n (%)	
Diabetes mellitus	592 (39.9)
Coronary artery disease	470 (31.7)
Heart failure	121 (8.2)
Ischemic cerebrovascular disease	76 (5.1)
Hemorrhagic cerebrovascular disease	17 (1.1)
Hypothyroidism	174 (11.7)
Hyperthyroidism	8 (0.5)
Atrial fibrillation	144 (9.7)
Laboratory parameters	
White blood cell count	7.38 (6.26-8.73)
Hemoglobin, g/dL	13.6 (12.5-14.6)
Platelet count	256.0 (216.0-304.0)
Hematocrit, %	41.0 (38.3-44.0)
Creatinine, mg/dL	0.84 (0.71-1.02)
eGFR (mL/min/1.73 m ²)	86.8 (70.2-99.3)
Urea, mg/dL	32.0 (24.0-40.0)
Sodium, mmol/L	140.0 (138.0-142.0)
Potassium, mmol/L	4.41 (4.12-4.70)
Alanine aminotransferase, U/L	19.0 (14.0-25.0)
Aspartate aminotransferase, U/L	20.0 (16.0-24.0)
Albumin, g/L	43.75 (41.0-46.0)
Chloride, mmol/L	103.0 (101.0-105.0)
C-reactive protein, mg/L	3.50 (1.70-9.77)

Continuous variables are presented as median (25th-75th percentile), and categorical variables as n (%). Denominators vary across variables because of missing data.

BMI, body mass index; DBP, diastolic blood pressure; eGFR, estimated glomerular filtration rate; IQR, interquartile range; SBP, systolic blood pressure.

category (n=574; 38.7%), followed by monotherapy (n=402; 27.1%) and 3-drug therapy (n=275; 18.5%). Regarding antihypertensive drug classes, diuretics were the most frequently used agents (n=630; 42.5%), followed by angiotensin receptor blockers (n=582; 39.2%), dihydropyridine calcium channel blockers (n=524; 35.3%), and angiotensin-converting

enzyme inhibitors (n=501; 33.8%). The distribution of individual antihypertensive agents is presented in Supplementary Table 1.

Compared with participants with controlled office blood pressure, those with uncontrolled office blood pressure had higher body weight, body surface area, and BMI (all $P < .05$) (Table 4). Coronary artery disease, atrial fibrillation, and serum urea also differed between groups, whereas eGFR and the other evaluated laboratory parameters did not. Antihypertensive drug-class comparisons are presented in Supplementary Table 2.

Clinical characteristics according to treatment and blood pressure status groups are summarized in Table 5. Significant between-group differences were observed for age, BMI, urea, systolic and DBP, diabetes mellitus, coronary artery disease, heart failure, atrial fibrillation, and geographical region (all $P < .05$), whereas sex distribution was comparable.

Factors associated with uncontrolled office blood pressure are presented in Table 6. In the expanded multiple logistic regression model, older age and higher BMI were associated with greater odds of uncontrolled office blood pressure, whereas female sex, coronary artery disease, atrial fibrillation, and higher urea levels were associated with lower odds. Geographical region and antihypertensive treatment category were also significantly associated with office blood pressure control status, whereas diabetes mellitus and eGFR were not independently associated with the outcome.

DISCUSSION

In this multicenter primary care-based study conducted across the 7 geographical regions of Türkiye, 38.0% of participants with classifiable blood pressure had uncontrolled office blood pressure at the time of assessment. The grade 1 office blood pressure range accounted for most uncontrolled cases, and the isolated systolic pattern was more frequent than the isolated diastolic pattern, and combination therapy—particularly 2-drug treatment—was more common than monotherapy. In the multiple logistic regression analysis, office blood pressure control was associated with age, sex, BMI, coronary artery disease, atrial fibrillation, serum urea, geographical region, and antihypertensive treatment category.

Office blood pressure was <140/90 mm Hg in 62.0% of participants, higher than in earlier Turkish studies including Patent, Patent 2, and TURKSAHA, whereas only 30.0% met the additional descriptive <130/80 mm Hg threshold.¹⁴⁻¹⁶ A similar threshold-dependent reduction has been reported in National Health and Nutrition Examination Survey (NHANES): among US adults receiving antihypertensive medication in 2017-2018, 64.8% had blood pressure < 140/90 mm Hg, whereas 38.9% met the <130/80 mm Hg criterion.²¹ The 2024 European Society of Cardiology (ESC) guidelines retain $\geq 140/90$ mm Hg as the office threshold for hypertension but recommend an on-treatment target of 120-129/70-79 mm Hg for most adults when treatment is well tolerated.¹⁸ Accordingly, the <130/80 mm Hg analysis should be regarded

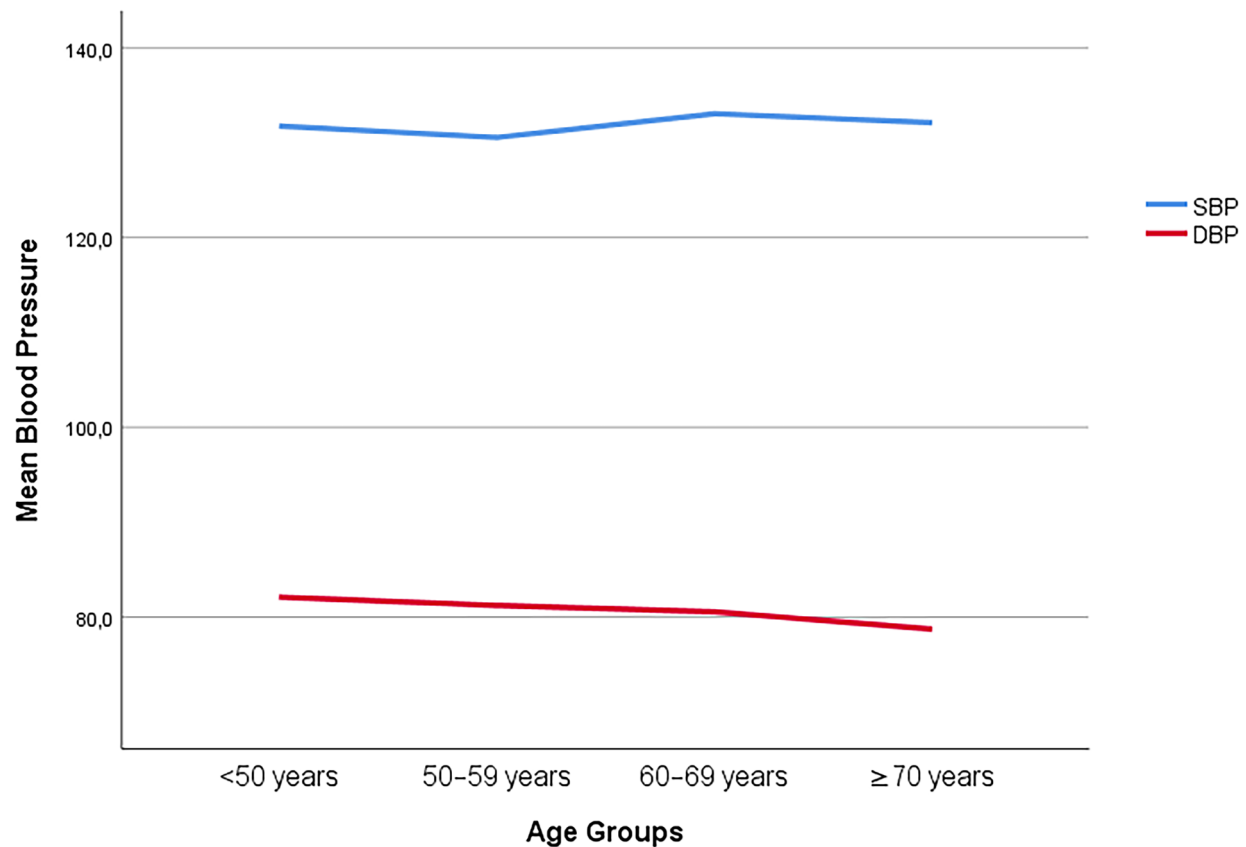


Figure 2. Mean systolic and diastolic blood pressure according to age groups.

Table 2. Office Blood Pressure Control Status, Descriptive Lower-Threshold Achievement, Grade Ranges, and Isolated Systolic/Diastolic Patterns in the Study Population

Variables	n (%)
Primary office blood pressure control threshold	
Office BP < 140/90 mm Hg	902 (62.0)
Office BP ≥ 140 and/or ≥ 90 mm Hg	554 (38.0)
Additional descriptive lower threshold (<130/80 mmHg)	
Overall	438 (30.0)
No antihypertensive medication	4 (3.1)
Monotherapy	137 (34.9)
2-Drug therapy	186 (33.2)
3-Drug therapy	84 (30.7)
≥4-Drug therapy	27 (26.5)
Uncontrolled office blood pressure ranges	
Grade 1 range	422 (29.0)
Grade 2 range	114 (7.8)
Grade 3 range	18 (1.2)
Isolated office blood pressure patterns	
Isolated systolic pattern	238 (16.4)
Isolated diastolic pattern	71 (4.9)

*Percentages were calculated using available classifiable data for each blood pressure threshold; therefore, denominators may vary slightly between analyses. Treatment-specific percentages for the descriptive <130/80 mm Hg threshold were calculated within each treatment category.

Table 3. Antihypertensive Treatment Category and Drug Class Distribution in the Study Population

Variables	n (%)
Treatment category	
No antihypertensive medication*	129 (8.7)
Monotherapy	402 (27.1)
2-Drug therapy	574 (38.7)
3-Drug therapy	275 (18.5)
≥4-Drug therapy	103 (6.9)
Antihypertensive drug classes	
Angiotensin-converting enzyme (ACE) inhibitors	501 (33.8)
Angiotensin receptor blockers	582 (39.2)
Dihydropyridine calcium channel blockers	524 (35.3)
Non-dihydropyridine calcium channel blockers	31 (2.1)
Any diuretic	630 (42.5)
Potassium-sparing diuretics	53 (3.6)
Beta-blockers	427 (28.8)
Alpha-blockers	36 (2.4)
Centrally acting agents	1 (0.1)
Direct vasodilators	2 (0.1)

*A total of 129 participants were not receiving antihypertensive medication at the time of assessment; this category included participants with previously diagnosed hypertension as well as untreated participants with elevated office blood pressure at the study visit.

Table 4. Comparison of Participants with Controlled and Uncontrolled Office Blood Pressure

Variables	Controlled Office Blood Pressure (n = 902)	Uncontrolled Office Blood Pressure (n = 554)	P
Demographic and anthropometric characteristics			
Age, years	63.0 (55.0-71.0)	63.0 (55.0-71.0)	.576
Height, cm	164.0 (157.0-170.0)	164.0 (157.0-170.0)	.280
Weight, kg	79.0 (70.0-88.0)	83.0 (74.0-92.0)	<.001
Body surface area, m ²	1.90 (1.78-2.03)	1.96 (1.82-2.08)	.001
Body mass index, kg/m ²	28.9 (25.9-32.7)	30.5 (27.1-34.2)	.002
Comorbidities, n (%)			
Female	550 (61.0)	323 (58.3)	.312
Diabetes mellitus	353 (39.1)	228 (41.2)	.445
Coronary artery disease	309 (34.3)	150 (27.1)	.004
Heart failure	77 (8.5)	42 (7.6)	.518
Ischemic cerebrovascular disease	43 (4.8)	30 (5.4)	.582
Hemorrhagic cerebrovascular disease	7 (0.8)	9 (1.6)	.132
Hypothyroidism	105 (11.6)	61 (11.0)	.713
Hyperthyroidism	4 (0.4)	4 (0.7)	.485
Atrial fibrillation	102 (11.3)	41 (7.4)	.015
Laboratory parameters			
White blood cell count	7.35 (6.20-8.60)	7.50 (6.40-8.90)	.131
Hemoglobin, g/dL	13.7 (12.6-14.7)	13.4 (12.4-14.5)	.077
Platelet count	257.0 (217.0-304.0)	255.0 (216.0-303.0)	.218
Hematocrit, %	41.2 (38.6-44.1)	40.8 (38.0-43.8)	.106
Creatinine, mg/dL	0.84 (0.71-1.01)	0.84 (0.71-1.04)	.450
eGFR, mL/min/1.73 m ²	86.1 (69.1-98.8)	87.8 (72.8-99.7)	.142
Urea, mg/dL	33.0 (25.0-41.0)	30.0 (23.0-38.0)	.008
Sodium, mmol/L	140.0 (138.0-142.0)	140.0 (138.0-142.0)	.157
Potassium, mmol/L	4.40 (4.10-4.70)	4.40 (4.20-4.70)	.352
Alanine aminotransferase, U/L	19.0 (14.0-25.0)	19.0 (14.0-25.0)	.474
Aspartate aminotransferase, U/L	20.0 (16.0-24.0)	20.0 (16.0-24.0)	.481
Albumin, g/L	43.0 (41.0-46.0)	44.0 (41.0-46.0)	.328
Chloride, mmol/L	103.0 (101.0-105.0)	103.0 (101.0-105.0)	.498
C-reactive protein, mg/L	3.0 (1.6-8.4)	4.5 (2.0-11.1)	.061

*Percentages were calculated among participants with non-missing blood pressure control status.

eGFR, estimated glomerular filtration rate.

as a complementary indicator of more intensive control rather than as the exact ESC treatment target. Direct comparisons across studies should also be made cautiously because of differences in sampling, population characteristics, and hypertension definitions. In addition, because elevated office blood pressure in untreated participants was not confirmed at separate visits or by out-of-office monitoring, the estimates represent cross-sectional office blood pressure status rather than control rates derived exclusively from individuals with confirmed hypertension.

Earlier Turkish data were generated in a period when monotherapy was more prominent, whereas contemporary European recommendations favor combination-based treatment and stepwise intensification when targets are not achieved.²²⁻²⁶ The predominance of 2-drug therapy in the cohort is therefore consistent with current treatment strategies. The frequent occurrence of an isolated systolic office

blood pressure pattern is also compatible with the older age distribution of the study population and the established relationship between aging, arterial stiffening, and systolic hypertension.^{27,28}

The association between antihypertensive treatment category and office blood pressure control requires particular caution. Untreated participants could enter the study because they had elevated office blood pressure at the same visit; therefore, the strong association for the no-medication group partly reflects the inclusion mechanism. These regression estimates should not be interpreted as evidence of the effectiveness or ineffectiveness of any treatment category.

Higher BMI remained independently associated with greater odds of uncontrolled office blood pressure in the expanded multiple logistic regression model. This association is

Table 5. Clinical Characteristics According to Treatment and Blood Pressure Status Groups

Variables	Group 1 (n = 129)	Group 2 (n = 314)	Group 3 (n = 831)	Group 4 (n = 196)	P
Age (years)	56.0 (48.0-63.0)	64.0 (56.0-70.0)	63.0 (54.0-71.0)	68.0 (60.0-75.0)	<.001
BMI, (kg/m ²)	29.4 (26.5-32.4)	30.2 (26.9-33.2)	29.2 (26.2-32.7)	31.3 (27.8-34.8)	.001
Urea (mg/dL)	27.0 (21.0-34.0)	30.0 (23.0-37.0)	32.0 (24.0-40.0)	37.0 (29.0-48.0)	<.001
Mean SBP of the last 2 measurements (mm Hg)	152.0 (145.0-160.0)	150.0 (142.0-160.0)	126.0 (120.0-130.0)	142.0 (135.0-150.0)	<.001
Mean DBP of the last 2 measurements, (mm Hg)	95.0 (90.0-100.0)	90.0 (87.0-95.0)	80.0 (74.0-83.0)	80.0 (75.0-90.0)	<.001
Female, n (%)	67 (51.9)	188 (59.9)	509 (61.3)	118 (60.2)	.257
Diabetes mellitus, n (%)	39 (30.2)	140 (44.6)	316 (38.0)	91 (46.4)	.006
Coronary artery disease, n (%)	34 (26.4)	77 (24.5)	265 (31.9)	90 (45.9)	<.001
Heart failure, n (%)	15 (11.6)	17 (5.4)	64 (7.7)	25 (12.8)	.012
Atrial fibrillation, n (%)	12 (9.3)	21 (6.7)	77 (9.3)	33 (16.8)	.002
Region, n (%)					<.001
Central Anatolia	10 (7.8)	57 (18.2)	163 (19.6)	32 (16.3)	
Black Sea	0 (0.0)	47 (15.0)	125 (15.0)	36 (18.4)	
Eastern Anatolia	16 (12.4)	32 (10.2)	48 (5.8)	9 (4.6)	
Mediterranean	30 (23.3)	37 (11.8)	150 (18.1)	35 (17.9)	
Southeastern Anatolia	9 (7.0)	34 (10.8)	46 (5.5)	17 (8.7)	
Marmara	64 (49.6)	95 (30.3)	247 (29.7)	65 (33.2)	
Aegean	0 (0.0)	12 (3.8)	52 (6.3)	2 (1.0)	

Group 1: no current antihypertensive medication, irrespective of office blood pressure status; Group 2: 1 or 2 antihypertensive agents with uncontrolled office blood pressure; Group 3: 1 to 3 antihypertensive agents with controlled office blood pressure; Group 4: at least 3 antihypertensive agents with uncontrolled office blood pressure or at least 4 antihypertensive agents with controlled office blood pressure. BMI, body mass index; DBP, diastolic blood pressure; SBP, systolic blood pressure.

biologically plausible and consistent with evidence showing that excess adiposity contributes to elevated blood pressure through sympathetic nervous system activation, renin-angiotensin-aldosterone system dysregulation, impaired pressure natriuresis, and sodium retention.^{29,30} Although the increase in odds per unit increase in BMI was modest, this finding should be interpreted as one of several factors associated with office blood pressure control rather than as a clinically dominant association. Weight management nevertheless remains an important component of hypertension care.^{31,32} Importantly, although the explanatory performance of the expanded model was substantially greater than that of the original model, the Nagelkerke R^2 of 0.210 indicates that a considerable proportion of the variability in office blood pressure control remained unexplained; therefore, the model should not be interpreted as a predictive model.

Coronary artery disease and atrial fibrillation showed inverse associations with uncontrolled office blood pressure in the expanded multiple logistic regression model; however, these findings should be interpreted cautiously and should not be considered protective effects. Patients with established coronary artery disease generally receive structured secondary prevention and guideline-directed cardiovascular risk-factor management, including blood pressure management.³³ Although differences in clinical follow-up and treatment patterns may partly contribute to the observed associations, residual confounding and other unmeasured factors remain

plausible explanations. Higher serum urea levels remained inversely associated with uncontrolled office blood pressure after adjustment for eGFR, whereas eGFR itself was not independently associated with the outcome. Given the small effect size and the multiple renal and nonrenal influences on serum urea, this association may reflect residual confounding or other unmeasured clinical differences and should be regarded as exploratory, not as evidence of a physiological relationship.³⁴

Despite pharmacological treatment, a substantial proportion of participants had uncontrolled office blood pressure, and the number of prescribed antihypertensive agents alone may not fully reflect effective treatment exposure in routine practice. Medication adherence is particularly relevant, as nonadherence is common among patients with uncontrolled blood pressure and adherence-enhancing interventions have been associated with improved blood pressure control.^{35,36} Simplified treatment strategies, including single-pill or fixed-dose combinations, have also been associated with better adherence and persistence than free-equivalent combination regimens.^{37,38}

Study Limitations

This study has several limitations. Its cross-sectional design precludes causal inference, and consecutive center-based recruitment rather than probability-based national sampling limits national representativeness; although all 7 geographical regions were included, regional comparisons—particularly

Table 6. Factors Associated with Uncontrolled Office Blood Pressure: Multiple Binary Logistic Regression Analysis

Variables	B	SE	Wald	OR	95% CI	P
Age, per year	0.022	0.006	12.087	1.022	1.009-1.034	.001
Female	-0.373	0.130	8.191	0.689	0.533-0.889	.004
BMI, kg/m ²	0.041	0.012	11.785	1.042	1.018-1.066	.001
Diabetes mellitus	0.118	0.123	0.922	1.126	0.884-1.433	.337
Coronary artery disease	-0.354	0.141	6.311	0.702	0.532-0.925	.012
Atrial fibrillation	-0.512	0.225	5.172	0.599	0.386-0.932	.023
eGFR, per mL/min/1.73 m ²	0.001	0.004	0.074	1.001	0.994-1.008	.785
Urea, mg/dL	-0.014	0.005	7.037	0.986	0.976-0.996	.008
Geographical region			36.501			<.001
Central Anatolia	-0.136	0.175	0.602	0.873	0.619-1.231	.438
Black Sea	-0.097	0.187	0.268	0.908	0.629-1.309	.604
Eastern Anatolia	0.533	0.260	4.200	1.705	1.024-2.840	.040
Mediterranean	-0.610	0.193	9.986	0.543	0.372-0.793	.002
Southeastern Anatolia	0.719	0.235	9.368	2.053	1.295-3.254	.002
Aegean	-0.626	0.347	3.249	0.535	0.271-1.056	.071
Antihypertensive treatment category			94.360			<.001
No antihypertensive medication	3.057	0.328	87.004	21.270	11.189-40.436	<.001
2-Drug therapy	0.001	0.149	<0.001	1.001	0.748-1.340	.992
3-Drug therapy	0.043	0.178	0.060	1.044	0.736-1.481	.807
≥4-Drug therapy	0.410	0.253	2.637	1.507	0.919-2.472	.104

*Reference categories were male sex, absence of diabetes mellitus, absence of coronary artery disease, absence of atrial fibrillation, Marmara region, and monotherapy. Bold values indicate the overall (omnibus) Wald test statistics and corresponding p values for multilevel categorical variables.

Model n=1436.

Omnibus test $P < .001$.

Hosmer Lemeshow $\chi^2=5.669$, $df=8$, $P=.684$.

-2 log likelihood=1665.069.

Cox & Snell $R^2=0.154$; Nagelkerke $R^2=0.210$.

BMI, body mass index; eGFR, estimated glomerular filtration rate; OR, odds ratio.

those involving the relatively small Aegean sample—should therefore be interpreted cautiously. Blood pressure was assessed during a single study visit without confirmation at separate visits or by home or ambulatory monitoring; thus, untreated participants with elevated office blood pressure should be considered a single-visit elevated blood pressure subgroup rather than individuals with confirmed newly diagnosed hypertension, and white-coat or masked hypertension could not be assessed. Because device readings were manually transcribed, some terminal-digit preference or recording-related rounding cannot be excluded. Medication adherence was not assessed, and information on antihypertensive dose, longitudinal treatment adjustments, hypertension duration, lifestyle factors, and whether combination therapy was administered as a single-pill fixed-dose combination or as separate tablets was unavailable. Consequently, uncontrolled office blood pressure could not be attributed specifically to poor adherence, inadequate pharmacological treatment, or therapeutic inertia, and categories based on the number of prescribed agents reflect regimen complexity rather than actual pharmacological treatment intensity. The association involving the no-medication category may partly reflect the inclusion mechanism because untreated participants could enter the study on the basis of elevated office blood pressure

at the same visit; it should therefore not be interpreted as evidence of the effectiveness or ineffectiveness of any treatment category. Nevertheless, the multicenter design provides broad geographic coverage and a real-world primary care perspective, while the relatively large sample supports robust statistical and subgroup analyses.

CONCLUSION

In conclusion, office blood pressure was <140/90 mm Hg in nearly two-thirds of participants with classifiable measurements, whereas 30.0% met the additional descriptive <130/80 mmHg threshold. The observed treatment profile was broadly consistent with contemporary combination-based management, with 2-drug therapy representing the most frequent treatment approach. Higher BMI was independently associated with uncontrolled office blood pressure, alongside several demographic, clinical, regional, and treatment-related factors. Given the cross-sectional design and the remaining unexplained variability in the multiple logistic regression model, these associations should be interpreted cautiously. These findings support the need for regular follow-up, adherence-oriented care, lifestyle-sensitive risk reduction, and timely treatment optimization in primary care.

Ethics Committee Approval: This study was approved by the Erzincan Binali Yıldırım University Non-Interventional Clinical Research Ethics Committee (Approval No: 2025-01/01, Date: January 9, 2025).

Informed Consent: Written informed consent was obtained from all participants.

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Supplementary Table 1. Distribution of individual antihypertensive agents in the study population

Drug subclass / agent	n (%)
ACE inhibitors	
Ramipril	144 (9.7)
Perindopril	281 (18.9)
Zofenopril	15 (1.0)
Trandolapril	23 (1.6)
Enalapril	6 (0.4)
Lisinopril	8 (0.5)
Captopril	5 (0.3)
Other ACE inhibitor	19 (1.3)
Angiotensin receptor blockers	
Candesartan	209 (14.1)
Olmesartan	78 (5.3)
Telmisartan	42 (2.8)
Valsartan	127 (8.6)
Irbesartan	87 (5.9)
Losartan	34 (2.3)
Other ARB	5 (0.3)
Dihydropyridine calcium channel blockers	
Amlodipine	441 (29.7)
Benidipine	44 (3.0)
Nifedipine	5 (0.3)
Other dihydropyridine CCB	36 (2.4)
Non-dihydropyridine calcium channel blockers	
Verapamil	24 (1.6)
Diltiazem	7 (0.5)
Diuretics	
Hydrochlorothiazide	438 (29.5)
Indapamide	149 (10.0)
Furosemide	38 (2.6)
Torsemide	2 (0.1)
Other diuretic	13 (0.9)
Potassium-sparing diuretics	
Spironolactone	46 (3.1)
Eplerenone	3 (0.2)
Other potassium-sparing diuretic	4 (0.3)
Beta-blockers	
Metoprolol	202 (13.6)
Carvedilol	47 (3.2)
Nebivolol	115 (7.8)
Bisoprolol	45 (3.0)
Labetalol	1 (0.1)
Other beta-blocker	18 (1.2)
Alpha-blockers	
Doxazosin	29 (2.0)
Prazosin	0 (0.0)
Terazosin	0 (0.0)
Other alpha-blocker	7 (0.5)
Centrally acting agents	
Clonidine	0 (0.0)
Methyldopa	1 (0.1)
Other centrally acting agent	0 (0.0)
Direct vasodilators	
Minoxidil	0 (0.0)
Hydralazine	0 (0.0)
Other direct vasodilator	2 (0.1)

Supplementary Table 2. Comparison of antihypertensive drug classes according to blood pressure control status

Variables	Controlled hypertension (n=902)	Uncontrolled hypertension (n=554)	P
ACE inhibitors	326 (36.1)	169 (30.5)	0.027
Angiotensin receptor blockers	375 (41.6)	195 (35.2)	0.016
Dihydropyridine calcium channel blockers	344 (38.1)	171 (30.9)	0.005
Non-dihydropyridine calcium channel blockers	15 (1.7)	15 (2.7)	0.173
Any diuretic	401 (44.5)*	219 (39.5)*	0.065
Potassium-sparing diuretics	40 (4.4)	12 (2.2)	0.024
Beta-blockers	300 (33.3)	120 (21.7)	<0.001
Alpha-blockers	20 (2.2)	16 (2.9)	0.424
Centrally acting agents	1 (0.1)	0 (0.0)	1.000
Direct vasodilators	1 (0.1)	1 (0.2)	1.000